Welcome to the

Seventh International Congress on
Bone Conduction Hearing and Related Technologies

December 11-14, 2019
1 Hotel South Beach Miami
Miami, Florida USA

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*in comparison to the previous BCI 601 implant
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maps</td>
<td>5</td>
</tr>
<tr>
<td>Welcome Addresses</td>
<td>6</td>
</tr>
<tr>
<td>2019 Co-Chairs</td>
<td>7-8</td>
</tr>
<tr>
<td>Sponsors, Patrons and Exhibitors</td>
<td>9-11</td>
</tr>
<tr>
<td>Awards</td>
<td>12-17</td>
</tr>
<tr>
<td>Scientific Advisory Board</td>
<td>18</td>
</tr>
<tr>
<td>Moderators</td>
<td>19</td>
</tr>
<tr>
<td>Keynote Speakers</td>
<td>20-21</td>
</tr>
<tr>
<td>Networking Events</td>
<td>22</td>
</tr>
<tr>
<td>Program Overview at a Glance</td>
<td>23-25</td>
</tr>
<tr>
<td>Oral Poster Pitch Schedule</td>
<td>26-27</td>
</tr>
<tr>
<td>Presenter Disclosure Statements</td>
<td>28-29</td>
</tr>
<tr>
<td>Scientific Program Schedule</td>
<td>30-36</td>
</tr>
<tr>
<td>Symposiums</td>
<td>37-39</td>
</tr>
<tr>
<td>Workshop Overview</td>
<td>40</td>
</tr>
<tr>
<td>Oral Presentation Abstracts</td>
<td>43-114</td>
</tr>
<tr>
<td>Thursday</td>
<td>44-70</td>
</tr>
<tr>
<td>Friday</td>
<td>70-106</td>
</tr>
<tr>
<td>Saturday</td>
<td>106-114</td>
</tr>
<tr>
<td>Poster Presentations (alpha by last name)</td>
<td>115-120</td>
</tr>
<tr>
<td>Poster Presentation Abstracts</td>
<td>121-201</td>
</tr>
<tr>
<td>Save the Date</td>
<td>203</td>
</tr>
</tbody>
</table>

RES SEMINARS
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Maps
2019 Welcome Address

Dear Colleagues,

It is our pleasure to welcome you to Miami Beach, Florida for the 7th International Symposium on Bone Conduction Hearing and Related Technologies. A city known for its rich cultural diversity, Miami is an international hub for the arts and sciences. Scholars travel from all around the world to study and train in Miami, bringing new perspectives and important considerations to our thriving education and healthcare industries. Like our great city, the foundation of the OSSEO meetings is built on a rich history of international collaboration. The Department of Otolaryngology at the University of Miami is proud to serve as your host for 2019, and to continue in the OSSEO tradition of growing academic relations, international knowledge base, and industrial partnerships.

With rapid growth and advancement of hearing rehabilitation by bone conduction and related technologies, OSSEO 2019 will offer an exciting program developed by clinical and scientific experts from around the world. The symposium provides an excellent platform for scientists, audiologists and otologists to exchange their most recent outcomes of research.

The aim of the conference is to provide researchers and practitioners from both academia as well as industry a forum to meet and share cutting-edge development in the field. As a considerable number of projects are collaborative research with industry partners, and findings discussed at the symposium are of great interest for the development of new and improved products, the symposium is beneficial for all those involved in this field, professionals and manufacturers alike.

The mission of the 2019 symposium is to drive evidenced-based science and methodology in the evaluation and management of patients with bone conduction devices and related technologies. This will include invited lecturers, free paper presentations, scientific debates, poster presentations, workshops and practical training sessions.

We are looking forward to welcoming old friends and new to the cool breezes and warm sands of Miami Beach in December 2019, and to continue in our collaborative effort towards advancing the field and improving outcomes for individuals with hearing loss.

Hillary Snapp, AuD, PhD
Chief of Audiology
Director of Clinical Education in Audiology
Associate Professor of Otolaryngology
Department of Otolaryngology
University of Miami Miller School of Medicine

Fred F Telischi, MEE, MD, FACS
Chandler Chair in Otolaryngology
Chairman of Otolaryngology and Professor
Neurological Surgery and Biomedical Engineering
University of Miami Miller School of Medicine
Hillary Snapp, AuD, PhD is Chief of Audiology, Director of Clinical Education, and Associate Professor in the Department of Otolaryngology at the University of Miami, Miller School of Medicine. Dr. Snapp received her clinical doctorate in audiology from Rush University Medical Center in 2007 and her PhD from the University of Miami in 2017.

A clinician-scientist, Dr. Snapp’s work examines the mechanisms underlying the variations observed in hearing impaired individuals for complex auditory tasks such as speech perception in noise and localization ability. She established the Auditory Spatial Laboratory at the University of Miami where she strives to better understand the benefits and limitations of hearing treatment. Current work focuses on identifying behavioral and objective markers of hearing, and includes novel methods of evaluating spatial auditory perception, speech recognition, and processing of acoustic signals. She is a Fellow of the American Academy of Audiology and the American Speech Language Hearing Association. She serves on the Board of Directors for the American Academy of Audiology Foundation, and on numerous national and international scientific committees.

Dr. Snapp serves as a lead researcher, clinician and educator to students, residents and fellows at the University of Miami. She has served as the Director of Clinical Education in Audiology since 2008, and in 2017 received the Exceptional Membership Award by the American Medical Women’s Association. Specialized training and education includes auditory implants, auditory spatial perception, and vestibular diagnostics. She has lectured nationally and internationally on these topics. As the Director of Clinical Education in Audiology, she established a comprehensive clinical training program for Doctor of Audiology students. Now a highly sought-after training program, the audiology fellowship at UM has proudly trained several rising leaders in audiology. She is also the 2014 recipient of the Glass Ceiling Award by the Business and Professional Women of Florida, and has been recognized by the American Academy of Audiology as a Jerger Future Leader of Audiology.
Fred F. Telischi, M.D., MEE, FACS is Chairman of the Department of Otolaryngology, Professor of Neurological Surgery and Biomedical Engineering at the University of Miami Miller School of Medicine. Dr. Telischi is board certified by the American Boards of Otolaryngology (1990) and Neurotology (2010). He is a graduate of Cornell University with bachelors and masters degrees in electrical and biomedical engineering. He received his M.D. from the University of Miami School of Medicine. His fellowship training in ear and skull base surgery was completed at the House Ear Clinic in Los Angeles. Dr. Telischi has almost 30 years experience practicing all aspects of otology and neurotology in an academic setting, training many resident and fellows.

Dr. Telischi is a fellow, member or holds leadership positions in the following medical societies: American Academy of Otolaryngology-Head & Neck Surgery, American Otology Society, American Neurotology Society, North American Skull Base Society, American College of Surgeons, Association for Research in Otolaryngology. Dr. Telischi sits on the editorial board or is manuscript reviewer for most of the major peer-review journals in the specialty. He is Chairman-of the AAO Implantable Hearing Devices Committee. Dr. Telischi received the American Academy of Otolaryngology-Head & Neck Surgery’s Distinguished Honor Award for contributions in teaching instructional courses and participation in scientific activity at AAO conferences. He has written ABOto Board Examination questions and prepared educational materials for the Academy.

Dr. Telischi’s research (as principle or co-investigator) has been funded by the NIH NIDCD, Deafness Research Foundation and industry. He has authored many peer reviewed publications, book chapters, and monographs. His research interests involve treatment of hearing losses, cochlear function, cochlear implantation, skull base disorders, implantable hearing devices (implantable middle ear hearing device and bone anchored auditory implants), otoacoustic emissions, hearing testing interoperatively, facial nerve disorders.
Cochlear is the global leader in implantable hearing solutions. We have provided more than 550,000 implantable devices, helping people of all ages to lead full and active lives. Cochlear develops a range of products including cochlear implants, bone conduction implants and acoustic implants, which address different types of hearing loss. We empower people to connect with others and live a full life. We help transform the way people understand and treat hearing loss. We innovate and bring to the market a range of implantable hearing solutions that deliver a lifetime of hearing outcomes.

Oticon Medical is a global company in implantable hearing solutions, dedicated to bringing the magical world of sound to people at every stage of life. As part of the Demant group, a global leader in hearing healthcare with 14,500 people in over 130 countries, we have access to one of the world's strongest research and development teams, the latest technological advances and insights into hearing care. Our competencies span more than a century of innovations in sound processing and decades of pioneering experience in hearing implant technology. We work collaboratively with patients, physicians and hearing care professionals to ensure that every solution we create is designed with users' needs in mind. We share an unwavering commitment to provide innovative solutions and support that enhance quality of life for people wherever life may take them. Because we know how much sound matters.
MED-EL Medical Electronics, a leader in implantable and non-implantable hearing solutions, is driven by a mission to overcome hearing loss as a barrier to communication. The Austrian-based, privately owned business was co-founded by industry pioneers Ingeborg and Erwin Hochmair, whose ground-breaking research led to the development of the world’s first micro-electronic multi-channel cochlear implant (CI), which was the basis for what is known as the modern CI today. MED-EL offers the widest range of implantable and non-implantable solutions to treat all types of hearing loss, enabling people in 123 countries enjoy the gift of hearing with the help of a MED-EL device. MED-EL’s hearing solutions include cochlear systems, a combined Electric Acoustic Stimulation hearing implant system, auditory brainstem implants as well as middle ear implants, surgical and nonsurgical bone conduction devices. With the introduction of the ADHEAR and the brand-new BCI 602 implant for the BONEBRIDGE system, MED-EL’s bone conduction portfolio shows unrivalled innovation in the field, for the best benefit of professionals and users.
We wish to thank our Sponsors, Patron, Exhibitors and Organizations for their generous support. This meeting would not be possible without their contributions. We encourage all delegates to visit exhibit booths to review the latest advancements in products and services.
Awards

The Bone Conduction Hearing Award Recipient

Stefan Stenfelt
Linköping University
Department of Clinical and Experimental Medicine
Linköping, Sweden

Stefan Stenfelt is currently professor and head of Applied Auditory Research at Linköping University in Sweden. He is a trained biomedical engineer (M.Sc. EE) from Chalmers University of Technology where he also received a PhD in 1999 under the supervision of prof. Bo Håkansson. After his PhD on bone conduction physiology he spent a couple of years at Stanford University working on sound transmission in the human skull. Stenfelt has published extensively in the area of bone conduction and has 90+ journal articles, several book chapters, and numerous conference contributions in the area. Beside his interest in bone conduction, Stenfelt’s research interests include hearing diagnosis, hearing physiology, hearing aids and cognitive hearing science. Stenfelt share his time between the university and the hearing clinic and is senior researcher at Linnaeus Centre for Hearing and Deafness. Stenfelt is currently general secretary in the European Federation of Audiological Societies (EFAS) and associate editor for The International Journal of Audiology.

The Bone Conduction Hearing Award is an international recognition award presented by the Osseo organizers to an individual exemplifying excellence and demonstrating significant contributions in the field of bone conduction hearing and related technologies. It is the successor of the well-known Tjellström Award.

7TH INTERNATIONAL CONGRESS ON
BONE CONDUCTION HEARING
AND RELATED TECHNOLOGIES
Early Career Investigator Awards

Aren Bezdjian
McGill University
PhD candidate
Quebec, Montreal Canada

Aren Bezdjian is Ph.D. candidate in the Department of Experimental Surgery at the faculty of Medicine of McGill University. Aren has obtained a B.Sc. in Neurosciences (Bishop’s University) and M.Sc. in Otolaryngology (McGill University) and conducted auditory implant related research in University Medical Center Utrecht in the Netherlands. He has been the recipient of prestigious institutional, provincial and federal grants for his post-graduate training and research. Aren has been featured as a keynote speaker on platforms such as TEDx and Medicine. He is the founder of Curotic Solutions; a natural product start-up for ear related problems. Recently, Aren was recognized as being one of the very few researchers to have published 30 peer-reviewed scientific articles before the age of 30.

Srđan Prodanović
Technical Audiology
Department of Clinical & Experimental Medicine,
Linköping University
Linköping, Sweden

Srđan Prodanović (BS, MSc, PhD) is a post-doctoral fellow at the Department of Clinical and Experimental Medicine, Linköping University, Sweden. Research and development engineer with expertise in auditory science. Current work is focused in research of bone conducted sound. Expert in finite element analysis and mathematical programming.
Lindsey Westover PhD
Assistant professor
Department of Mechanical Engineering, University of Alberta
Canada, Edmonton, Alberta

Dr. Lindsey Westover is an Assistant Professor in Mechanical Engineering at the University of Alberta with a research focus in biomechanics and biomedical engineering. She completed her M.Sc. in Mechanical Engineering at the University of Calgary where she investigated knee joint laxity and an in-vivo measure of ligament stiffness. She completed her Ph.D. in Mechanical Engineering at the University of Alberta with a focus on investigating osseointegration in bone anchored hearing aid implants through vibration analysis. Dr. Westover completed a Post-Doctoral Fellowship in the Faculty of Rehabilitation Medicine at the University of Alberta investigating various aspects of hearing aid technology and hearing health.

Student Investigator Awards

Meredith Berger
Teachers College, Columbia University
New York, New York USA

I am a PhD student at Teachers College, Columbia University in the Deaf Education Program under the Department of Health and Behavioral Studies. With 25 years of experience in the education of children who are deaf and hard of hearing, I was motivated to begin my doctoral studies by the need for quality research on issues affecting outcomes for these children. The focus of my research is on children with microtia/atrophia. While there is research on surgically implanted devices and reconstructive surgery, the available research on needs, interventions, amplification recommendations and supports for children prior to surgery being an option is limited. This is a stark contrast to the research and guidance available for children with sensorineural hearing loss. This current research study, focusing on the experience of parents following the birth of a child with microtia/atrophia is the first of what I hope will be many studies that will help advance the discussion on what best practice looks like for young children with microtia/atrophia and their families.
Tim Calon  
Department of Otorhinolaryngology  
Head and Neck Surgery  
University Medical Center Utrecht  
Utrecht, Netherlands  

Tim G.A. Calon (1988) obtained his medical degree in 2013 after studying at Maastricht University (The Netherlands) and KU Leuven (Belgium). Following his graduation he started his PhD under the supervision of professor Stokroos, University Medical Center Utrecht (The Netherlands) working on Bone Anchored Hearing Devices. In February 2019, he successfully defended his PhD thesis “The Bone Anchored Hearing System: Understanding and improving clinical outcomes”. Currently he is doing his residency at Maastricht University Medical Center and Catharina Hospital Eindhoven (The Netherlands). He is specifically interested in clinical research with a translational background.

Michael Canfarotta  
University of North Carolina at Chapel Hill  
Head and Neck Surgery resident  
Chapel Hill, North Carolina, USA  

Michael Canfarotta, MD is a PGY-3 resident in Otolaryngology/Head and Neck Surgery at the University of North Carolina at Chapel Hill. Dr. Canfarotta is completing at two-year NIH T-32 fellowship with faculty members in the Division of Neurotology & Skull Base Surgery and the Division of Auditory Research. He investigates the binaural processing and auditory development of pediatric recipients of bone conduction technology, and the patient and device variables that influence outcomes with other implantable auditory technologies.
Mona Eng
Institute of Neuroscience & Physiology
Sahlgrenska Academy, University of Gothenburg
Trollhättan, Sweden

Mona Eng lives in Trollhättan, a small town in the western part of Sweden with her husband and two daughters. She has been working as an audiologist for almost 18 years, mostly with rehabilitation of adults and with bone conducted devices as a specialty. Mona also has been tutoring students who have been making their clinical training in her clinic. She has stated that she really enjoys the variety of her occupation; meetings with patients and development in the audiological area. Her recent studies have been challenging, in a good way, and her goal is to be able to work more with research in the future.

Tom Gawliczek
PhD student
Hearing Research Laboratory
ARTORG Center for Biomedical Engineering Research,
University of Bern
Bern, Switzerland

Tom Gawliczek received his BSc (2013) in Medical Engineering from the University of Koblenz and his MSc (2016) in Sports Engineering from the University of Chemnitz, Germany. His focus is on biomedical signal processing and implant technologies in the field of medicine. In March 2017 he continued his academic education with a PhD in Biomedical Engineering at the Hearing Research Laboratory (HRL) at the ARTORG Center for Biomedical Engineering Research at the University of Bern. His current research focuses on the influence of fitting parameters on audiological outcome in bone-anchored hearing systems.
Arno Janssen, PhD
Radboud University Medical Center
Nijmegen, The Netherlands

Arno Janssen received the B.Sc and M.Sc degree in Natural Science from the Radboud University, Nijmegen, The Netherlands, in 2009. In the same year he started as a Ph.D. student on the topics of transcranial magnetic stimulation and freezing of gait in Parkinson’s disease, for which he received his degree in 2016 at the Radboud University, Nijmegen, The Netherlands. In 2015 he also worked as a researcher at the Interdisciplinary Cardiology Institute Netherlands on the topic of inverse modeling of the human electrocardiogram. In 2016 he started with his four-year training program to become a Medical Physicist - Audiologist at the department of ENT at the Radboudumc, Nijmegen, The Netherlands.
<table>
<thead>
<tr>
<th>Name</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martijn Argterberg / The Netherlands</td>
<td>Ann-Louis McDermott / UK</td>
</tr>
<tr>
<td>Marlene Bagatto / Canada</td>
<td>Griet Mertens / Belgium</td>
</tr>
<tr>
<td>Arjan Bosman / The Netherlands</td>
<td>Peter Monksfield / UK</td>
</tr>
<tr>
<td>Steve Cass / USA</td>
<td>Kari Morgenstein / USA</td>
</tr>
<tr>
<td>Juan A. Chiossone-Kerdel / Florida</td>
<td>David Morris / Canada</td>
</tr>
<tr>
<td>Dan Coelho / USA</td>
<td>Emmanual Mylanus / The Netherlands</td>
</tr>
<tr>
<td>Maura Cosetti / New York</td>
<td>Eeg Olofsson / Sweden</td>
</tr>
<tr>
<td>Cor Cremers / The Netherlands</td>
<td>Blake Papsin / Canada</td>
</tr>
<tr>
<td>Arnaud Deveze / France</td>
<td>Andrea Pittman / USA</td>
</tr>
<tr>
<td>Adrien Eshraghi / Florida</td>
<td>James Ramsden / UK</td>
</tr>
<tr>
<td>Bo Hakkanson / Sweden</td>
<td>JayDip Ray / UK</td>
</tr>
<tr>
<td>Allan Ho / Canada</td>
<td>Sabine Reinfeldt / Sweden</td>
</tr>
<tr>
<td>Bill Hodgetts / Canada</td>
<td>Alejandro Rivas / USA</td>
</tr>
<tr>
<td>Myrthe Hol / The Netherlands</td>
<td>Cristof Roosli / Switzerland</td>
</tr>
<tr>
<td>Martin Kompis / Switzerland</td>
<td>Henryk Skarsinski / Poland</td>
</tr>
<tr>
<td>Luis Lassaletta / Columbia</td>
<td>Ad Snik / The Netherlands</td>
</tr>
<tr>
<td>Thomas Lenarz / Germany</td>
<td>Stefan Stenfelt / Sweden</td>
</tr>
<tr>
<td>Larry Lustig / USA</td>
<td>Anders Tjellstrom / Sweden</td>
</tr>
<tr>
<td>Hannes Maier / Germany</td>
<td>Jack Wazen / USA</td>
</tr>
</tbody>
</table>
Moderators
Wednesday, December 11
Poster Pitch Session 1: Emerging Technologies  
Moderators: James Ramsden & Benajmin McGrew
Poster Pitch Session 2: Evaluation, Fitting and Verification  
Moderators: Brianna Kuzbyt & Jaydip Ray
Poster Pitch Session 3: Pediatrics  
Moderator: Ken Kazahya
Poster Pitch Session 4: Surgical Considerations  
Moderators: Christine Dinh & Piotr Skarzyński
Poster Pitch Session 5: Basic and Clinical Research  
Moderator: Thomas Wesarg
Poster Pitch Session 6: Measuring Outcomes  
Moderators: Bo Hakkanson & Sabine Reinfeldt

Thursday, December 12
Opening Ceremony: Hillary Snapp & Fred Telischi  
Keynote Speaker: Gershon Dublon
Session: Emerging Technologies  
Moderators: Bill Hodgetts & Emmanuel Mylanus
Session: Surgical Considerations  
Moderators: Allan Ho & Courtney Voelker
Session: Bilateral Panel  
Moderators: Hillary Snapp & Benjamin McGrew
Session: Binaural Hearing  
Moderators: Christoff Roosli & Mans Eeg-Olofsson
Session: Evaluation, Fitting and Verification  
Moderators: Jolene Desmet & Alyssa Whinna
Session: Topics in Pediatrics  
Moderators: Blake Papsin & Ivette Cejas

Friday, December 13
Keynote Speaker: Judith Lieu
Session: Pediatrics Outcomes  
Moderators: Cor Cremers & Ann-Louis McDermott
Session: Middle Ear Devices  
Moderators: Jack Wazen & Nancy Young
Session: Medical Considerations  
Moderators: David Morris & Sharon Cushing
Session: Hearing Science  
Moderators: Michael Hoa & Susan Arndt
Session: Measuring Outcomes  
Moderators: Sarah Sydowski & Arjan Bosman
Session: MPO  
Moderators: Ad Snik & Stefan Stenfelt

Saturday, December 14
Keynote Speakers: Dr. Michael Ivan & Dr. Timur Urakov
Session: The Great Debate  
Moderators: Myrthe Hol & Fred Telischi
Session: Future Directions  
Moderators: Sabine Reinfeldt & Martin Kompis
Keynote Speakers

Dr. Gershon Dublon
Researcher, Artist, and Electrical Engineer

Gershon Dublon is a researcher, artist, and electrical engineer. Dr. Dublon invents technologies and crafts environments that use environmental sensing and AI to foster new human sensitivities and perceptions in and of the natural world. His writing appears in a broad array of periodicals, among them Presence (MIT Press), Scientific American, IEEE Sensors, Body Sensor Networks, and New Interfaces for Musical Expression. His projects have been covered widely by the media and exhibited in venues including Boston’s Museum of Fine Arts, the National Center for the Arts in Mexico, and Ars Electronica. Dublon received an S.M. (2011) and Ph.D. (2018) from MIT, and a B.S. in Electrical Engineering (2008) from Yale. In 2018, he co-founded slow immediate LLC, a creative engineering studio based in New York City. He is also a director of Living Observatory, a non-profit focused on wetland restoration, and a research affiliate in the MIT Media Lab's Responsive Environments Group.

Dr. Michael E. Ivan
Department of Neurological Surgery
Director of Research, UM Brain Tumor Initiative
Specializing in Brain Tumor, Skull Base, and Epilepsy Surgery

Dr. Michael E. Ivan is currently an Assistant Professor at the University of Miami where he specializes in skull base and brain tumor surgery. He acts as the Director of Research for the University of Miami Brain Tumor Initiative as well as the Site Disease Group Director in Neuro-Oncology. He is the Vice Chairman of the Young Neurosurgeon’s Committee for the American Association of Neurological Surgeons and President-Elect for the Florida Neurosurgical Society. Dr. Ivan graduated from Cornell University with a degree in chemical engineering and received his MD from Rutgers University. He completed his neurosurgery training at UCSF and a fellowship in Neuro-Oncology at UM. Currently he acts as the PI of his laboratory which focuses on invasive qualities of brain tumors. Clinically his research focuses on novel technology to enhance minimally invasive brain tumor management, including laser interstitial thermal therapy, photodynamic therapy, fluorescence guided surgery, and augmented reality.
Judith E. C. Lieu, MD MSPH
Professor, Program Director
Vice-Chair for Education
Department of Otolaryngology
Head and Neck Surgery
St. Louis, MO USA

Judith E.C. Lieu, MD MSPH is currently a Professor, Residency Program Director, and Vice-Chair in the Department of Otolaryngology-Head and Neck Surgery at Washington University School of Medicine. She received her MD at Washington University and MSPH at St. Louis University School of Public Health. She completed her Otolaryngology residency at Washington University, clinical research fellowship in the Robert Wood Johnson Clinical Scholars Program at Yale University, and Pediatric Otolaryngology fellowship at St. Louis Children’s Hospital. She is the Section Editor for Systematic and Evidence-based Reviews for the Laryngoscope. She is a practicing pediatric otolaryngologist. Her research interests include quality of life in children with otolaryngologic disorders, hearing loss in children, and improving the level of evidence in the otolaryngology literature.

Timur M. Urakov MD
Neurological Surgery Resident

Dr. Timur Urakov is an Assistant Professor at the Department of Neurological Surgery, University of Miami. Dr Urakov completed his residency and fellowship in Complex Spine Surgery at the University of Miami. His research includes development and adaptation of Augmented Reality technologies to operating room, education, and patient counseling.
Networking Events

Wednesday, December 11th

Poster Session
Time: 16:45
Please join us for the OSSEO 2019 Poster Session out on the beautiful Ocean Front Terrace at 1Hotel.

Welcome Reception
Time: 17:45 – 20:00
Please join us for the OSSEO 2019 Welcome Reception. This will take place directly after the Poster Pitch out on the Ocean Front Terrace. Pick up your credentials and see familiar faces from past OSSEO conferences.

Friday, December 13th

Networking Dinner Event
Time: 19:00 – 23:00
The Networking Event will be a time to catch up with your colleagues and network with your peers. This evening’s festivities will take place oceanfront at the W Hotel and include a Cocktail Reception, Dinner and local entertainment.

On-Site Delegate Fee: $150 USD / person
Dress: Cocktail / Resort
Reservations required
## Program Overview at a Glance

### Wednesday, December 11

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:00 - 14:00</td>
<td>Cochlear Latin American Symposium</td>
<td>Terra Ballroom I</td>
</tr>
<tr>
<td>12:00 - 19:00</td>
<td>Conference Registration</td>
<td>Terra Ballroom Foyer</td>
</tr>
<tr>
<td>13:00 - 16:00</td>
<td>Poster Set-Up</td>
<td>Ocean Front Terrace</td>
</tr>
<tr>
<td>15:00 - 15:45</td>
<td>Poster Pitch Session 1 - Location: Terra Ballroom I: Emerging Technologies</td>
<td>Terra Ballroom I</td>
</tr>
<tr>
<td></td>
<td>Poster Pitch Session 2 - Location: Terra Ballroom III: Evaluation, Fitting and Verification</td>
<td>Terra Ballroom III</td>
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<td>Poster Pitch Session 3 - Location: Terra Ballroom IV: Pediatric</td>
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</tr>
<tr>
<td>15:45 - 16:30</td>
<td>Poster Pitch Session 4 - Location: Terra Ballroom I: Surgical Considerations</td>
<td>Terra Ballroom I</td>
</tr>
<tr>
<td></td>
<td>Poster Pitch Session 5 - Location: Terra Ballroom III: Basic and Clinical Research</td>
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<tr>
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<td>Poster Pitch Session 6 - Location: Terra Ballroom IV: Measuring Outcomes</td>
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</tr>
<tr>
<td>16:45 - 17:45</td>
<td>Poster Session</td>
<td>Ocean Front Terrace</td>
</tr>
<tr>
<td>17:45 - 20:00</td>
<td>Welcome Reception</td>
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</tr>
</tbody>
</table>

### Thursday, December 12

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>06:30 - 08:30</td>
<td>Exhibits / Continental Breakfast</td>
<td>Terra Gallery &amp; Atrium</td>
</tr>
<tr>
<td>07:00 - 08:30</td>
<td>Industry Symposium – Cochlear</td>
<td>Terra Ballroom</td>
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<tr>
<td>08:45 - 09:00</td>
<td>Opening Ceremony: Hillary Snapp &amp; Fred Telischi</td>
<td>Terra Ballroom</td>
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<tr>
<td>09:00 - 10:00</td>
<td>Keynote Speaker: Dr. Gershon Dublon From Sensing to Hearing: Extending Perception through Audio Augmented Reality</td>
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<td>10:00 - 10:30</td>
<td>Exhibits / AM Coffee Break</td>
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<td>10:30 - 12:00</td>
<td><strong>Session Title:</strong> Emerging Technologies</td>
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<td><strong>Session Title:</strong> Binaural Hearing</td>
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<td>12:00 - 13:00</td>
<td>Lunch and Networking Exhibits</td>
<td>Terra Gallery &amp; Atrium</td>
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<tr>
<td>13:00 - 15:00</td>
<td><strong>Session Title:</strong> Surgical Considerations</td>
<td>Terra Ballroom I</td>
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<td><strong>Session Title:</strong> Evaluation, Fitting and Verification</td>
<td>Terra Ballroom II</td>
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| 13:00 - 15:00 | Cochlear Workshop  
Technology Experience Workshop  
Session I: 13:00-13:45 & Session II: 13:45-15:00  
Location: Oyster I & III |
| 15:00 - 15:30 | Exhibits - PM Break                                                                            | Terra Gallery & Atrium    |
| 15:30 - 17:00 | **Oticon Medical Workshop**  
Ponto 4- Connectivity & FM Solutions  
15:30-16:15 & 16:15-17:00  
Location: Oyster II & IV |
| 15:30 - 17:00 | **Session Title:** Bilateral Panel                                                               | Terra Ballroom I          |
|             | **Session Title:** Topics in Pediatrics                                                         | Terra Ballroom II         |
| 17:00 - 18:15 | Industry Symposium – Oticon Medical                                                               | Terra Ballroom II         |
## Program Overview at a Glance

### Friday, December 13

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<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<td>Exhibits / Continental Breakfast</td>
<td>Terra Gallery &amp; Atrium</td>
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<td>07:30 - 08:30</td>
<td>Industry Symposium – Med El</td>
<td>Terra Ballroom</td>
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<td>Welcome Address and Special Presentation</td>
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<td>09:00 - 10:00</td>
<td>Keynote Speaker: Dr. Judith Lieu</td>
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<td><em>Pediatric Unilateral Hearing Loss</em></td>
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<td><strong>Session Title:</strong>&lt;br&gt;Pediatrics Outcomes&lt;br&gt;Location: Terra Ballroom I</td>
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<td><strong>Session Title:</strong>&lt;br&gt;Hearing Science&lt;br&gt;Location: Terra Ballroom II</td>
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<td><strong>Session Title:</strong>&lt;br&gt;Measuring Outcomes&lt;br&gt;Location: Terra Ballroom II</td>
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<td><strong>Oticon Medical Workshop</strong>&lt;br&gt;<em>Ponto 4- Connectivity &amp; FM Solutions</em></td>
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<td>13:00-14:00 &amp; 14:00-15:00</td>
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<td></td>
<td>Location: Oyster II &amp; IV</td>
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<td>Exhibits / PM Coffee Break</td>
<td>Oyster II &amp; IV</td>
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<td><strong>Cochlear Workshop</strong>&lt;br&gt;Audiology Review&lt;br&gt;Location: Oyster I &amp; III</td>
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<td><strong>Session Title:</strong>&lt;br&gt;Medical Considerations&lt;br&gt;Location: Terra Ballroom I</td>
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<td><strong>Session Title:</strong>&lt;br&gt;MPO&lt;br&gt;Location: Terra Ballroom II</td>
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<td>17:00</td>
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<td>19:00 - 23:00</td>
<td>Networking Dinner Event (Pre-Registration Required)&lt;br&gt;Location: W Hotel, poolside</td>
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# Program Overview at a Glance

**Saturday, December 14**

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<td>07:00 - 08:00</td>
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<td>Location: Terra Gallery &amp; Atrium</td>
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<td>07:55 - 08:00</td>
<td>Welcome Address and Special Presentation</td>
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<td>Location: Terra Ballroom</td>
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<td>08:00 - 08:45</td>
<td><strong>Keynote Speakers: Dr. Michael Ivan &amp; Dr. Timur Urakov</strong></td>
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<td><em>The Future is Now: Augmented Reality in Surgery and Medical Education</em></td>
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<td>Location: Terra Ballroom</td>
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<tr>
<td>09:00 - 10:30</td>
<td><strong>Session Title:</strong> Atresia/Microtia: The Great Debate</td>
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<td><strong>Session Title:</strong> Future Directions</td>
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<td>10:30 - 11:00</td>
<td>Exhibits / AM Coffee Break</td>
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<td>11:00 - 12:30</td>
<td>General Session</td>
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<td>Location: Terra Ballroom</td>
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<td>11:30 - 11:45</td>
<td>Future of OSSEO</td>
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<td>12:00 - 12:15</td>
<td>Future OSSEO Meeting</td>
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<td>12:15 - 12:30</td>
<td>Closing Ceremony</td>
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<td>Conference Adjoums</td>
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The Program Committee reserves the right to modify the program schedule as circumstances might dictate. Views expressed by speakers at this meeting are solely their own and do not necessarily reflect the positions or policies of the conference program committee.
**Oral Poster Pitch Schedule**

**Wednesday, December 11, 2019**

<table>
<thead>
<tr>
<th>Time</th>
<th>Poster Pitch 1</th>
<th>Poster Pitch 2</th>
<th>Poster Pitch 3</th>
<th>Poster Pitch 4</th>
<th>Poster Pitch 5</th>
<th>Poster Pitch 6</th>
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### Poster Pitch Sessions: 1, 2 & 3

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<thead>
<tr>
<th>Time</th>
<th>Session 1: Emerging Technologies</th>
<th>Session 2: Evaluation, Fitting &amp; Verification</th>
<th>Session 3: Pediatrics</th>
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<tbody>
<tr>
<td>15:00-15:05</td>
<td>Guy Fierens - Feasibility Study for Measuring Unintended Acoustic Stimulation During MRI</td>
<td>Janez Rebol - Patient Satisfaction of Percutaneous and Transcutaneous Bone Conduction Devices</td>
<td>Zsofia Bere - Preliminary Study of Osia in Childhood</td>
</tr>
<tr>
<td>15:05-15:10</td>
<td>Bob Lerut - Transcutaneous BCD and Magnetic Resonance Imaging</td>
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<tr>
<td>15:40-15:45</td>
<td>Assen Koitschev - Bone Conduction or Middle Ear Implant? A Decision Making Algorithm</td>
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# Poster Pitch Sessions: 4, 5 & 6

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<tr>
<th>Session 4: Surgical Considerations</th>
<th>Session 5: Basic and Clinical Research</th>
<th>Session 6: Measuring Outcomes</th>
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<tr>
<td>Location: Terra Ballroom I</td>
<td>Location: Terra Ballroom III</td>
<td>Location: Terra Ballroom IV</td>
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<tr>
<td>Moderators: Christine Dinh &amp; Piotr Skarzynski</td>
<td>Moderators: Thomas Wesarg &amp; Luis Lassaletta</td>
<td>Moderators: Bo Hakansson &amp; Sabine Reinfeldt</td>
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<thead>
<tr>
<th>Time</th>
<th>Poster题目</th>
<th>Authors</th>
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<tbody>
<tr>
<td>15:45-15:50</td>
<td>Lindsay Moore - The Cleating Stitch: An Adjunctive Technique for Percutaneous Osseointegration Screws</td>
<td>Adrien Eshraghi - Otoprotection Using L-N-Acetylcysteine and Dexamethasone Combination in an In-Vitro Model&lt;br&gt;Tom Gawliczek - Audiological Performance of a New Nonimplantable Wearing Option for Baha</td>
</tr>
<tr>
<td>15:55-16:00</td>
<td>Shyam Singam - Ten Year Review of Baha Surgery Without Soft Tissue Reduction</td>
<td>Bernd Waldmann - Cochlear Reserve with the Carina® Active Middle Ear Implant&lt;br&gt;Hannes Maier - Long Term Stability of Middle Ear Transducers T1 and T2&lt;br&gt;Tove Rosenbom - Effect of Noise Reduction on Speech Intelligibility and Self-Reported Performance</td>
</tr>
<tr>
<td>16:00-16:05</td>
<td>Alfonso Bonilla - Percutaneous Implants Minimally Invasive Surgery: Our Punch Technique Results</td>
<td>Gianluca Scotta - Is there a Future for Percutaneous Bone Conduction Implants&lt;br&gt;Leonardo Elias Ordonez - Transition from Percutaneous to Transcutaneous Bone Conduction Hearing Aid: Outcomes</td>
</tr>
<tr>
<td>16:05-16:10</td>
<td>Håkan Hua - Clinical Success Rates in Restoring Hearing Among Patients with COM</td>
<td>Thomas Lenarz - A Novel Transcutaneous Bone Conduction Device&lt;br&gt;Rafael Jaramillo - Multi-Centric Experience with the Baha System: Pre-Implantation Demographic Profile</td>
</tr>
<tr>
<td>16:10-16:15</td>
<td>Gianluca Scotta - Surgical and Functional Comparison Between Baha Attract and Bonebridge</td>
<td>Marcus Holmberg - Experiences with the Minimal Invasive Ponto Surgery Surgical Technique&lt;br&gt;Laura Gomez - Baha Use in Elderly Population. Correlations with Social and Cognitive&lt;br&gt;Rajae Bouzega - Hearing Outcomes and Daily use with an Active Trascutaneous BCI</td>
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<tr>
<td>16:15-16:20</td>
<td>Marco Mrowka - Skin Reaction in Patients Using Transcutaneous Titanium Implants</td>
<td>Mohammad Ghoncheh - Output Evaluation of a Bone Conduction Implant in Human Cadavers&lt;br&gt;Alfonso Bonilla - SSD and Osseointegrated Implants Long Term Follow-Up</td>
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<td>16:20-16:25</td>
<td>Coosje Caspers - Long-Term Quality of Life with a Percutaneous BCD</td>
<td>Joseph Toner - BONEBRIDGE in Single Sided Deafness (SSD)</td>
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</tbody>
</table>
**Presenter Disclosure Statements**

The Program Committee requests that all presenters shall disclose any affiliation with financial interest in a company or a product related to the subject matter of the presentation as a part of the Presenter’s Agreement. The intent of this policy is not to prevent a presenter with an affiliation or financial interest from making a presentation but any potential conflict must be identified openly so that the attendees have the full disclosure of the facts and may form their own judgments about the presentation. Any portion of the information submitted below will be shared with the attendees to gain perspective on the educational merits of the presentation.

The following presenters have indicated that they have a financial interest in a commercial product(s) or services that will be discussed in their presentation.

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<td>Maria Conceicao</td>
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<td>Ignacio</td>
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<td>Shyam</td>
<td>Zernotti</td>
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<td>Ramsden</td>
<td>James</td>
<td>Skarzynski</td>
<td>Piotr H.</td>
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*The views and opinions expressed in this activity are those of the presenter and do not necessarily reflect the views of the International Symposium or supporting institutions.*
## Scientific Program Schedule

### Wednesday, December 11

<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:00 - 14:00</td>
<td>Cochlear Latin American Symposium</td>
<td>Terra Ballroom I</td>
</tr>
<tr>
<td>12:00 - 19:00</td>
<td>Conference Registration</td>
<td>Terra Ballroom Foyer</td>
</tr>
<tr>
<td>13:00 - 16:00</td>
<td>Poster Set-up</td>
<td>Ocean Front Terrace</td>
</tr>
<tr>
<td>15:00 - 15:45</td>
<td>Poster Pitch Session 1: Emerging Technologies</td>
<td>Terra Ballroom I</td>
</tr>
<tr>
<td>15:00 - 15:45</td>
<td>Poster Pitch Session 2: Evaluation, Fitting and Verification</td>
<td>Terra Ballroom III</td>
</tr>
<tr>
<td>15:00 - 15:45</td>
<td>Poster Pitch Session 3: Pediatrics</td>
<td>Terra Ballroom IV</td>
</tr>
<tr>
<td>15:45 - 16:30</td>
<td>Poster Pitch Session 4: Surgical Considerations</td>
<td>Terra Ballroom I</td>
</tr>
<tr>
<td>15:45 - 16:30</td>
<td>Poster Pitch Session 5: Basic and Clinical Research</td>
<td>Terra Ballroom III</td>
</tr>
<tr>
<td>15:45 - 16:30</td>
<td>Poster Pitch Session 6: Measuring Outcomes</td>
<td>Terra Ballroom IV</td>
</tr>
<tr>
<td>16:45 - 17:45</td>
<td>Poster Session</td>
<td>Ocean Front Terrace</td>
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<tr>
<td>17:45 - 20:00</td>
<td>Welcome Reception</td>
<td>Ocean Front Terrace</td>
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### Thursday, December 12

<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>06:30 - 08:30</td>
<td>Exhibits / Continental Breakfast</td>
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</tr>
<tr>
<td>07:00 - 08:30</td>
<td>Industry Symposium – Cochlear</td>
<td>Terra Ballroom</td>
</tr>
<tr>
<td>08:45</td>
<td>Opening Ceremony: Hillary Snapp &amp; Fred Telischii</td>
<td>Terra Ballroom</td>
</tr>
<tr>
<td>09:00</td>
<td>Keynote Speaker: Dr. Gershon Dublon</td>
<td>From Sensing to Hearing: Extending Perception through Audio Augmented Reality</td>
</tr>
<tr>
<td>10:00-10:30</td>
<td>AM Break – Exhibits</td>
<td>Terra Gallery &amp; Atrium</td>
</tr>
<tr>
<td>10:30-12:00</td>
<td>Session Title: Emerging Technologies</td>
<td>Session Title: Binaural Hearing</td>
</tr>
<tr>
<td>10:30-12:00</td>
<td>Moderators: Bill Hodggets &amp; Emmanuel Mylanus</td>
<td>Moderators: Christoff Roosli &amp;</td>
</tr>
<tr>
<td>10:30-12:00</td>
<td>Location: Terra Ballroom I</td>
<td>Mans Eeg-Olofsson</td>
</tr>
<tr>
<td>10:30</td>
<td>Charlotte Borgers - Intracochlear Pressure Measurements to Study Human Bone</td>
<td>Martijn Agterberg - Sound</td>
</tr>
<tr>
<td>10:30</td>
<td>Conduction Perception</td>
<td>Localization After Ear-Canal-</td>
</tr>
<tr>
<td>10:38</td>
<td>Ann-Charlotte Persson - Three Year Follow-Up with the Bone Conduction Implant</td>
<td>Sabine Reinfeldt - Binaural</td>
</tr>
<tr>
<td>10:46</td>
<td>Charlotte Borgers - Characterization of a Novel Bone Anchored Device Using</td>
<td>Binaural for BCI and Baha Users</td>
</tr>
<tr>
<td>10:54</td>
<td>Torsten Rahne - Changes in Bone Conduction Implant Geometry Improved the Bone Fit</td>
<td>Marcos Goycoolea - Evaluation</td>
</tr>
<tr>
<td>11:02</td>
<td>Zsofia Bere - Baha Attract-Osia Conversion Patients: Comparison of the Two</td>
<td>Arno Janssen** - An Investigation</td>
</tr>
<tr>
<td></td>
<td>Systems</td>
<td>of Directional Hearing with</td>
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<tr>
<td></td>
<td></td>
<td>Bilateral Bone Conduction Devices</td>
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**Location:**
- Terra Ballroom I
- Terra Ballroom II
- Terra Ballroom III
- Terra Ballroom IV
- Ocean Front Terrace
- Terra Ballroom Foyer
<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>moderators/Location</th>
<th>Session Title</th>
<th>moderators/Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:10</td>
<td>Ann-Charlotte Persson - First Results with a Transcutaneous Sound Processor from Oticon Medical</td>
<td>Michael Canfarotta **- Bone-Conduction Amplification and Binaural Hearing in Unilateral Congenital Aural Atresia</td>
<td>11:18</td>
<td>Christiane D'hondt - In-Situ Microphone Sensitivity of a Fully-Implantable Middle Ear Implant</td>
</tr>
</tbody>
</table>
| 12:00-13:00 | Lunch and Networking Exhibits                              | Location: Terra Gallery & Atrium                          | 13:00-15:00 | Session Title: Surgical Considerations
Moderators: Allan Ho & Courtney Voelker
Location: Terra Ballroom I | Session Title: Evaluation, Fitting & Verification
Moderators: Jolene Desmet & Alyssa Whinna
Location: Terra Ballroom II |
| 13:00  | Linda Lange - Postoperative Infection Rates in Linear Incision
Versus the Punch Technique | Patrick Maas - Investigation of an Objective Measurement Device for Bone Conduction Stimulation |
<p>| 13:16  | Brian Kellermeyer - A Multi Institutional Review of the Punch Technique | A.F.M Snik - Mixed hearing Loss; Power Bone-Conductor or a Middle Ear Implant? |
| 13:24  | Srđan Prodanovic* - Consequences of Ear Surgery on Bone Conducted Sound | Martijn Toll - Prescription of Low Frequency Gain in BCDs |
| 13:32  | Sumit Agrawal - Middle Fossa BONEBRIDGE Implantation: Surgical and Audiometric Outcomes | Susan Small - Bone-Conduction Effective Masking Levels for Infant Auditory Brainstem Responses |
| 13:40  | Peter Monksfield - Prospective Study of Peri-Implant Cytokines and Long-Term Implant Survival | Arjan Bosman - Relating Real-Life Experiences to Listening Environments and Device Settings |
| 13:48  | John McElveen - Next Day Loading of Bone Anchored Hearing System: Preliminary Results | Marlene Bagatto - Performance of Non-Surgical Transcutaneous Bone Conduction Hearing Devices |
| 13:56  | Sharon Cushing - Surgical Considerations for Implantation of a New OSI | Luis Lassaletta - Implantable Hearing Devices in Patients with Open Cavities: Baha, Bonebridge or Vibrant Soundbridge: Audiological and Quality of Life Outcomes |
| 14:04  | Nneka Eze - Middle Cranial Fossa Implantation of the Bonebridge Assessed with LDV | Alessandra Murri - Subjective and Objective Evaluation of Two Fitting Rationales for BAHS |
| 14:12  | Gianluca Scotta - Surgical and Functional Comparison Between BAHA Attract and Bonebridge | Alex Gascon - A Comparison of Threshold Measurements in Adult Bone Conduction Users |
| 14:20  | Panel/Questions                                                               | Panel/Questions                              |</p>
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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<tbody>
<tr>
<td>14:30</td>
<td>Myrthe Hol - Mini Session: Surgical Tips and Tricks</td>
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<tr>
<td>14:30</td>
<td>Bill Hodgetts - Mini Session: Fitting Tips and Tricks</td>
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<tr>
<td>15:00</td>
<td>Exhibits - PM Break</td>
<td>Location: Terra Gallery &amp; Atrium</td>
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<tr>
<td>15:30-17:00</td>
<td>Session Title: Bilateral Panel Moderator: Hillary Snapp &amp; Benjamin McGrew</td>
<td>Location: Terra Ballroom I</td>
</tr>
<tr>
<td>15:30</td>
<td>Henrik Smeds - Early Experience of a Transcutaneous Bone Conduction System in Children</td>
<td></td>
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<tr>
<td>15:38</td>
<td>Ann-Louise McDermott - Paediatric Evaluation of Implants with and Without Surface Modification</td>
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<tr>
<td>15:46</td>
<td>Special Topic: Bilateral Fitting of BCD’s Panel Session</td>
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<tr>
<td>15:46</td>
<td>Jaya Nichani - Parental Perception of Impact of Unilateral Conductive-Hearing Loss in Children</td>
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<tr>
<td>15:46</td>
<td>Jaya Nichani - Perspectives of Children on Impact of Unilateral Conductive-Hearing Loss</td>
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<tr>
<td>15:54</td>
<td>Assen Koitschev - Transcutaneous Bone Conduction Implants (Bci) in Children and Adolescent</td>
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<tr>
<td>15:54</td>
<td>Piotr H. Skarzynski - Bone Conduction Hearing Aids for Children with Moderate Hearing Loss</td>
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<tr>
<td>16:02</td>
<td>Max Osborne - Longitudinal Study of Adhesive Bone Conducting Hearing Systems in Children</td>
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<tr>
<td>16:26</td>
<td>Consensus Working Group Round Table</td>
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<tr>
<td>16:26</td>
<td>Blake Papsin - Paediatric Candidacy Assessment for a New OSI</td>
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<tr>
<td>16:34</td>
<td>Martijn Agterberg - Congenital Single-Sided Deafness; to Treat or Not to Treat</td>
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<tr>
<td>16:42</td>
<td>Industry Symposium – Oticon Medical</td>
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<tr>
<td>17:00 - 18:15</td>
<td>Industry Symposium – Oticon Medical</td>
<td>Location: Terra Ballroom I</td>
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**Friday, December 13**

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<tr>
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<tr>
<td>07:00 - 08:30</td>
<td>Exhibits / Continental Breakfast</td>
<td>Location: Terra Gallery &amp; Atrium</td>
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<td>07:30 - 08:30</td>
<td>Industry Symposium – Med El</td>
<td>Location: Terra Ballroom</td>
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<tr>
<td>08:45</td>
<td>Welcome Address and OSSEO Award Presentation</td>
<td>Location: Terra Ballroom</td>
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<tr>
<td>09:00</td>
<td>Keynote Speaker: Dr. Judith Lie</td>
<td>Location: Terra Ballroom</td>
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<tr>
<td>Time</td>
<td>Session Title</td>
<td>Location</td>
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</table>
| 10:00-10:30  | **Session Title:** Pediatrics Outcomes  
Moderators: Cor Cremers & Ann-Louis McDermott  
Location: Terra Ballroom I |                        | **Session Title:** Hearing Science  
Moderators: Michael Hoa & Susan Arndt  
Location: Terra Ballroom II |                        |
| 10:30        | Jacob Barnaby - Survival of the Cochlear™ Baha® Implants in Children          |                        | Ivo Dobrev - Dependence of Bone Conduction Surface Wave Propagation on Stimulations Sites |                        |
| 10:38        | Mary Lynn Feness - Audiological Management of Children Using an OSI           |                        | Stefan Stenfelt - Skin Attenuation of Bone Conducted Sound                   |                        |
| 10:46        | Mario Zernotti - Adhesive Bone Conduction Hearing System: Audiological Outcomes in Atresia Patients |                        | Christof Röösli - The Coupling Method Affects Bone Conduction Surface Wave Propagation |                        |
| 10:54        | Myrthe Hol - Bone-Anchored Hearing Implants Surgery in Children: A Systematic Review |                        | Christof Röösli - Topological Variation of Young’s Modulus and Microstructure Across the Skull |                        |
| 11:02        | Ivette Cejas - Depression & Anxiety: Prevalence in Hearing Loss & Screening Implementation |                        | Stefan Stenfelt - Soft Tissue Stimulation Result in Hearing by Skull Bone Vibration |                        |
| 11:10        | Emilie Heuninck - Audiological Benefit and Subjective Satisfaction of Children with Adhear System |                        | Ivo Dobrev - Promontory Motion and Intracranial Pressure Interaction in Bone Conduction |                        |
| 11:18        | Blake Papsin - Children with Longstanding SSD, an Expanded Treatment Paradigm with OSI |                        | Martin L. Johansson - Multiscale and Multimodal Analysis of Retrieved Bone-Anchored Hearing Implants |                        |
| 11:26        | Sharon Cushing - Early Outcomes of a New Bone Conduction Device in Children   |                        | Bill Hodgetts - Hey Siri: You Make Listening Easy                          |                        |
| 11:34        | Panel/Questions                                                              |                        | Panel/Questions                                                             |                        |
| 12:00        | Lunch and Networking Exhibits                                                 |                        |                                                                             |                        |
| 13:00-15:00  | **Session Title:** Middle Ear Devices  
Moderators: Jack Wazen & Nancy Young  
Location: Terra Ballroom I |                        | **Session Title:** Measuring Outcomes  
Moderators: Sarah Sydowski & Arjan Bosman  
Location: Terra Ballroom II |                        |
| 13:00        | Guy Fierens - Coupling Stability of Carina Middle Ear Actuator After 1.5T MR |                        | Aren Bezdjian* - Investigation of Novel Primary Stability Tools in Human Cadaveric Bones |                        |
| 13:08        | Ute Alice Gamm - Do Ambient Pressure Changes Affect Middle Ear Implant Actuator Efficiency? |                        | Lindsey Westover* - Word Recognition and Word Recall with Softband Bone Conduction Devices |                        |
| 13:16        | Susan Busch - Coupling Efficiency and Outcome with a Fully-Implantable Hearing System Carina |                        | William Brassington - Listening Effort at Different Signal-to-Noise Ratios for Bone-Anchored Users |                        |

**Oticon Medical Workshop**

Ponto 4 – Connectivity & FM Solutions

(13:00-14:00 & 14:00-15:00)

Location: Oyster II & IV
<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Moderator/Panel/Questions</th>
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</thead>
<tbody>
<tr>
<td>13:32</td>
<td>Mario Cebulla - Reliability of Intraoperative ABR Measurements Via Vibrant Soundbridge®</td>
<td>Myrthe Hol - Loading Time Sound Processor After BAHI; The Preferences of Patients</td>
</tr>
<tr>
<td>13:40</td>
<td>James Ramsden - The UK Experience of the Carina Fully Implantable Hearing Device</td>
<td>Peter Monksfield - Outcome Measures for Conductive and Mixed Hearing Loss Treatment</td>
</tr>
<tr>
<td>13:48</td>
<td>Arnaud Deveze - Cochlear Carina Implant: Tips &amp; Tricks</td>
<td>Tove Rosenbom - Bone-Conduction Sound Transmission Comparison Between Softband and an Adhesive Plaster</td>
</tr>
<tr>
<td>13:56</td>
<td>Ute Geiger - Determination of Coupling Efficiency During Carina Implant Surgery Using ABRs</td>
<td>Chrisanda Sanchez - Comparision of Remote Microphone Technology in BCDs</td>
</tr>
<tr>
<td>14:04</td>
<td>Anja Kurz - First Audiological Results with the Fully-Implantable-Active-Middle-Ear Implant Carina™</td>
<td>Annemarie Wollet - Initial Outcomes with Med-El Adhear in Pediatric Patients</td>
</tr>
<tr>
<td>14:12</td>
<td>Marsha Jenkins - Carina MEI Outcomes Compared to Existing and Previous Devices</td>
<td>Martin Kompis - Performance of Two Different Non-Implanted Bone Conduction Hearing System</td>
</tr>
<tr>
<td>14:20</td>
<td>Farid Alzhrani - Vibrant Soundbridge Outcome; KAESC Experience</td>
<td>Bo Hakansson - The Bone Conduction Implant – Review and One Year Follow Up</td>
</tr>
<tr>
<td>14:28</td>
<td>Laura Fröhlich - Objective Monitoring of Active Middle Ear Implant Coupling Efficiency</td>
<td>Denise Leese - An Evaluation of the Benefits of New Bilateral BAHA Software</td>
</tr>
<tr>
<td>14:36</td>
<td>William McFeely - The Esteem® Totally Implantable Active Middle Ear Implant: A Large, Single-Surgeon Cohort</td>
<td>Panel/Questions</td>
</tr>
<tr>
<td>14:44</td>
<td>Panel/Questions</td>
<td>Exhibits / PM Coffee Break Location: Terra Gallery &amp; Atrium</td>
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<tr>
<td>15:00</td>
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**Session Title:** Medical Considerations
Moderators: David Morris & Sharon Cushing
Location: Terra Ballroom I

**Session Title:** MPO
Moderators: Ad Snik & Stefan Stenfelt
Location: Terra Ballroom II

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Cochlear Workshop
Audiological Workshop
(15:30 - 17:00)
Location: Oyster I & III
<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Speaker/Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>16:18</td>
<td>Bob Lerut - Laser Epilation as Treatment for Recurrent Infections Around BCI Abutment</td>
<td></td>
</tr>
<tr>
<td>16:26</td>
<td>Carolina Der - Active Transcutaneous Bone-Conduction Implant: Middle Fossa Placement Technique in Children</td>
<td>Roundtable Discussion</td>
</tr>
<tr>
<td>16:34</td>
<td>Maarten Vijverberg - Autologous Versus Prosthetic Reconstruction – Patient, Professional &amp; Laymen Perception</td>
<td></td>
</tr>
<tr>
<td>16:42</td>
<td>Panel/Questions</td>
<td>Panel/Questions</td>
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<tr>
<td>17:00</td>
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<td>Adjourn</td>
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<tr>
<td>18:00</td>
<td>Networking Dinner Event (Pre-Registration Required)</td>
<td>Location: W Hotel, Poolside</td>
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**Saturday, December 14**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Session Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>07:00 - 08:00</td>
<td>Exhibits / Continental Breakfast</td>
<td>Session Title: Future Directions</td>
</tr>
<tr>
<td></td>
<td>Location: Terra Gallery &amp; Atrium</td>
<td>Moderator: Sabine Reindfelt &amp; Martin Kompis</td>
</tr>
<tr>
<td>07:55 – 08:00</td>
<td>Welcome Address</td>
<td>Location: Terra Ballroom</td>
</tr>
<tr>
<td>08:00 – 08:45</td>
<td><strong>Keynote Speakers: Dr. Michael Ivan &amp; Dr. Timur Urakov</strong></td>
<td><strong>Session Title: Future Directions</strong></td>
</tr>
<tr>
<td></td>
<td>The Future is Now: Augmented Reality in Surgery and Medical Education</td>
<td><strong>Moderator: Sabine Reindfelt &amp; Martin Kompis</strong></td>
</tr>
<tr>
<td></td>
<td>Location: Terra Ballroom</td>
<td><strong>Location: Terra Ballroom II</strong></td>
</tr>
<tr>
<td>09:00 - 10:30</td>
<td><strong>Session Title:</strong> Atresia/Microtia: The Great Debate</td>
<td><strong>Session Title:</strong> Future Directions</td>
</tr>
<tr>
<td></td>
<td><strong>Moderator:</strong> Myrthe Hol &amp; Fred Telischi</td>
<td><strong>Moderator:</strong> Sabine Reindfelt &amp; Martin Kompis</td>
</tr>
<tr>
<td></td>
<td>Location: Terra Ballroom</td>
<td><strong>Location: Terra Ballroom II</strong></td>
</tr>
<tr>
<td>09:00</td>
<td>Myrthe Hol - Introduction</td>
<td>Ahmad Alshadwi - Virtual Surgical Planning Using Cochlear™ Vistafix® System for Microtia Reconstruction</td>
</tr>
<tr>
<td>09:10</td>
<td>Harry Powell - Thirteen Years Experience from a Specialist Clinic for Microtia/Atresia</td>
<td>Mohammad Ghoncheh - Effects of Placement and Surgical Method of the Sentio transducer</td>
</tr>
<tr>
<td>09:18</td>
<td>Meredith Berger** - Parents’ Experiences Following the Birth of a Child with Microtia/Atresia</td>
<td>Jerome Nevoux - Outcomes of the New OSIA System Compare to Baha Attract</td>
</tr>
<tr>
<td>09:26</td>
<td>Malou Hultcrantz - Rat Study and Human Adults to Compare and What Implication that can have on Children</td>
<td>Susan Ellsperman - Active Osseointegrated Steady-State Implant System for Treatment of SSD</td>
</tr>
<tr>
<td>09:34</td>
<td>Su De - Syndromic Children with Congenital Conductive Hearing Loss</td>
<td>Ignacio Pla Gil - OSIA, a New Active Transcutaneous Bone Conduction Device: Preliminary Results</td>
</tr>
<tr>
<td>09:42</td>
<td>Alex Bennett - Outcomes of Combining Hearing</td>
<td>Jaydip Ray - Surgical and Functional Outcomes</td>
</tr>
</tbody>
</table>
**Implants with Autologous Auricular Reconstruction**

09:50


**Emmanuel Mylanus** - *The Osia System – Results from an International, Multicenter Clinical Investigation*

09:58

Panel/Questions

**Susan Busch** - *Osia - A New Active Osseointegrated Implant System in SSD*

Panel/Questions

10:30-11:00

Exhibits / AM Coffee Break
Location: Terra Gallery & Atrium

11:00

Consumer Driven Trends in Bone Conduction Hearing

11:30

Future of OSSEO

12:00

Future OSSEO Meeting

12:15

Closing Ceremony

12:30

Conference Adjourns

*Early Career Investigator Award Recipient

**Student Investigator Award Recipient

The Program Committee reserves the right to modify the program schedule as circumstances might dictate. Views expressed by speakers at this meeting are solely their own and do not necessarily reflect the positions or policies of the conference program committee.
# Symposiums

**Cochlear Symposium**  
Thursday, December 12  
07:00 - 08:30  
Location: Terra Ballroom

<table>
<thead>
<tr>
<th>Title</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderator: Brianna Kuzbyt AuD, FAAA University of Miami, Miami</td>
<td></td>
</tr>
</tbody>
</table>
| Welcome                                                    | Tony Manna  
President, Cochlear Americas                                             |
| Clinical outcomes with acoustic implants                   | George Cire AuD  
Principal Clinical Project Manager, Cochlear Americas                      |
| DermaLock - Optimizing surgical technique and patient management | Robert Temple MB, ChB, FRCS  
Countess of Chester Hospital, Chester                                      |
| COM-related hearing loss - Redefining the treatment pathway | Myrthe Hol MD, PhD  
Radboud University Medical Centre, Nijmegen                               |
| Osia System – Technology overview                         | Mats Dotevall MSc  
Director Design and Development, Cochlear Bone Anchored Solutions           |
| Osia System – Surgical technique and development           | Robert Briggs MBBS, FRACS  
University of Melbourne, Melbourne                                          |
| Osia System - Audiological outcomes                       | Terry Zwolan AuD, PhD  
University of Michigan, Ann Arbor                                            |
| Osia System – Pediatric outcomes                          | Blake Papsin MD, FRCS, FACS, FAAP  
Hospital for Sick Children, Toronto                                         |
| Close                                                      | Rom Mendel  
President Acoustics, Cochlear Bone Anchored Solutions                      |
## Symposia

**Oticon Medical Symposium**  
**Thursday, December 12**  
**17:00 - 18:15**  
**Location: Terra Ballroom**

<table>
<thead>
<tr>
<th>Title</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welcome</td>
<td>Jes Olsen</td>
</tr>
<tr>
<td>What it’s like living with a Ponto</td>
<td>Kevin Hotaling</td>
</tr>
<tr>
<td>10 years of progress in bone anchored treatment</td>
<td>Ann-Louise McDermott, David Morris, Arjan Bosman</td>
</tr>
<tr>
<td>A systemic literature review of the Ponto system results</td>
<td>Malou Hultcrantz</td>
</tr>
<tr>
<td>Hearing - It’s all about the brain</td>
<td>Marcus Holmberg</td>
</tr>
<tr>
<td>This is just the beginning</td>
<td>Jes Olsen</td>
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<tr>
<td>Let’s celebrate!</td>
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</table>
### Med El Symposium

**Friday, December 13**  
**07:30 - 08:30**  
**Location: Terra Ballroom**

<table>
<thead>
<tr>
<th>Title</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welcome</td>
<td>Marcus Schmidt</td>
</tr>
<tr>
<td>ADHEAR Introduction</td>
<td>Amanda O’Donnell</td>
</tr>
<tr>
<td>ADHEAR Clinical Results</td>
<td>Javier Gavilan</td>
</tr>
<tr>
<td>BONEBRIDGE Introduction</td>
<td>Amanda O’Donnell</td>
</tr>
<tr>
<td>BONEBRIDGE - Long-term Results with Active Bone Conduction</td>
<td>Sumit Agrawal</td>
</tr>
<tr>
<td>BONEBRIDGE BCI 602 - Always a Step Ahead</td>
<td>Christine Mühlöcker</td>
</tr>
<tr>
<td>BONEBRIDGE BCI 602 - First Clinical Experience</td>
<td>Patrick Müller</td>
</tr>
<tr>
<td>Closing Remarks</td>
<td>Kevin Vukovich</td>
</tr>
</tbody>
</table>
Workshop Overview

Cochlear Workshops

<table>
<thead>
<tr>
<th>Thursday, December 12</th>
<th>Technology experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:00 – 15:00</td>
<td>In this workshop the participants will learn about the key technologies of the Osia System. Participants will be taken through four separate stations focusing on different technology aspects to create a good understanding of what benefits the system will bring to the end user. The stations will focus on implant technology, sound processor technology, verification of performance and patient lifestyle. The stations will be manned by the designers of the system to allow for questions and discussions. There will also be opportunities to get hands-on experience with the solutions as well as listen to the output from the system.</td>
</tr>
</tbody>
</table>

Key learning objectives
• Discover the key technology features of the Osia System
• Learn about how the Osia System was developed and tested
• Understand how the technology will benefit the end user

*Booth to Register for these workshops.*

<table>
<thead>
<tr>
<th>Friday, December 13</th>
<th>Audiology review</th>
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<tr>
<td>15:30 - 17:00</td>
<td>In this workshop we will host a live discussion with the designers of the Osia Fitting Software and the Osia Sound Processor. They will discuss candidacy and counselling of the Osia System as well as how to demonstrate it to candidates and how to best fit the system. Participants will have the opportunity to ask questions during the session to build their understanding of the solutions. There will also be a review of a typical fitting using the Osia Fitting Software. This will cover the typical adjustments based on user needs as well as relating specific features that is introduced with the Osia System.</td>
</tr>
</tbody>
</table>

Key learning objectives
• Learn about candidacy and counselling for the Osia System
• Review the Osia Fitting Software and how to use it
• Ask questions to the designers of the fitting software and sound processor

*Please see Cochlear’s Sponsor Booth to Register for these workshops.*

Oticon Medical Workshops

<table>
<thead>
<tr>
<th>Thursday, December 12</th>
<th>Description: We present Ponto 4 and the new options with wireless connectivity and Bluetooth FM solution. The workshop will be in two parts. A presentation of Ponto 4 and its connections and then a hands-on of the function and use of the ConnectClip and brand new Bluetooth FM solution as well as a possibility to try out the Oticon ON App, IFTTT and wireless home appliances yourself.</th>
</tr>
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<tbody>
<tr>
<td>15:30-16:15 &amp; 16:15-17:00</td>
<td>Learning Objectives:</td>
</tr>
<tr>
<td></td>
<td>– Know the wireless possibilities with Ponto 4 and when to use which solution</td>
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<td></td>
<td>– Be able to set up Ponto 4 and the educational microphone (EduMic) for class room use and adjusting settings</td>
</tr>
<tr>
<td></td>
<td>– Be able to set up IFTTT and guide my tech-interested patients on how to use it themselves.</td>
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</tbody>
</table>

*Please see the Oticon Medical Sponsor Booth to Register for these workshops.*
Ponto 4

Open Sound. Open Life

The world’s smallest bone anchored sound processor*

OpenSound Navigator™

Velox S™ platform

Truly connected

With its all new elegant design, and high speed extreme precision sound processing, Ponto 4 makes a paradigm shift in bone anchored hearing.

Join the open sound revolution and a future of connected hearing.

*Data on file at Oticon Medical.

Please contact your Oticon Medical sales representative for information on availability in your market.

10 Years of sound that matters

www.oticonmedical.com

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OSSEO 2019  DECEMBER 11-14 – MIAMI, FL
Cochlear Program Highlights

Cochlear Booth
WHERE: Terra Gallery
WHEN: Thursday, 8:00am – 5:30pm
      Friday, 8:00am – 5:30pm
      Saturday, 8:00am – 12:00pm

Hospitality Suite
WHERE: Garnett II Room
WHEN: Thursday, 8:00am – 5:00pm
      Friday, 8:00am – 5:00pm
      Saturday, 8:00am – 12:00pm

Cochlear Symposium  Moderated by Brianna Kusbyt, AuD, FAAA, University of Miami, Miami
WHERE: Terra Ballroom
WHEN: Thursday, 7:00am – 8:30am
Welcome Tony Manna, President, Cochlear Americas
Clinical outcomes with acoustic implants
George Cire, AuD, Principal Clinical Project Manager, Cochlear Americas
DermaLock – Optimizing surgical technique and patient management
Robert Temple, MB, ChB, FRCS, Countess of Chester Hospital, Chester
COM-related hearing loss – Redefining the treatment pathway
Myrthe Hol, MD, PhD, Radboud University Medical Centre, Nijmegen
The Cochlear "Osia" System
  – Technology overview Mats Dotsewall, Director Design and Development, Cochlear Bone Anchored Solutions
  – Surgical technique and development Robert Briggs, MBBS, FRACS, University of Melbourne, Melbourne
  – Audiological outcomes Terry Zwikian, AuD, PhD, University of Michigan, Ann Arbor
  – Pediatric outcomes Blake Papsin, MD, FRCS, FACS, FAAP, Hospital for Sick Children, Toronto
Closing Rom Mendel, President Acoustics, Cochlear Bone Anchored Solutions

Osia System Workshops  Seating is limited. Please visit Cochlear’s booth to register.
Technology Experience
WHERE: Oyster Room I & III
WHEN: Thursday, 1:00pm – 3:00pm
• Learn about how the Osia System was developed and tested
• Discover the key technology features
• Meet the designers of the Osia System

Audiology Review
WHERE: Oyster Room I & III
WHEN: Friday, 3:30pm – 5:00pm
• Experience the Osia Fitting Software
• Learn about candidacy and counseling for the Osia System
• Meet the designers of the Osia System
Oral Presentation Abstracts
Thursday, December 12

General Session

Invited Speaker
From Sensing to Hearing: Extending Perception through Audio Augmented Reality
Gershon Dublon PhD
Slow Immediacy LLC, MIT Media Lab
New York, NY, United States

Sensors are everywhere. While human perception focuses on our immediate surroundings, AI systems take in vast amounts of data and provide high-level insights. Naturally then, we are spending more time consuming, sharing, and acting on machine analyses. This benefit comes with a tradeoff: the more we rely on knowledge distilled by others, the less we develop our own sensitivities; the less sensitive we are, the more we rely on external systems to direct us. In this talk, I lay out a roadmap through which sensor networks instead become prosthetic extensions of human perception, forming the basis for a restoration of sensitivity and an augmentation of cognition. In some ways, this future is already here, exemplified by the increasing convergence of specialized assistive devices and consumer wearables, particularly around advanced sensing, interaction design, and digital connectivity. Coupled with head-tracking spatial sound and AI, bone conduction and related technologies are well-positioned to drive this revolution forward, enabling the seamless merging together of physical and virtual sound worlds for users across a spectrum of abilities. Presenting my own and others’ application of these technologies as case studies, I show how cleverly deployed sensing and audio augmented reality can transform how we perceive ourselves and access the world around us.

Session Title: Emerging Technologies

INTRACOCHLEAR PRESSURE MEASUREMENTS TO STUDY HUMAN BONE CONDUCTION PERCEPTION
Borgers, Charlotte *, Fieren, Guy (1,2,3), Putzeys, Tristan (1), Wouters, Jan (1), Van Wieringen , Astrid (1), Verhaert, Nicolas (1,4)
(1) Ku Leuven - University of Leuven, Department of Neurosciences, Expol, B-3000 Leuven, Belgium
(2) Cochlear Technology Centre, Mechelen, Belgium
(3) Ku Leuven – University of Leuven, Department of Physics and Astronomy, Laboratory for Soft Matter and Biophysics – Herlee, Belgium
(4) University Hospitals Leuven, Department of Otorhinolaryngology, Head and Neck Surgery – Leuven, Belgium
See Above for Complete Affiliations

Leuven, Belgium

Purpose/Aim: Multiple intracochlear pressure (ICP) and modeling studies have investigated air conduction (AC) transmission, but knowledge about the cochlear mechanics with bone conduction (BC) stimulation is still lacking. Therefore, this study aims to investigate relation between cochlear pressure during AC and BC stimulation in more detail and to compare objective findings with behavioral data.

Materials and Methods: A loudness balancing (AC vs. BC) experiment on 10 normal hearing subjects was performed. AC stimulation was unilaterally presented via insert phones, with the contralateral ear masked, and the BC stimulus via a bone actuator mounted on a Softband presented at a fixed level (50 and 60 dB HL) at nine frequencies (250 – 6000 Hz). The AC stimulus was changed until the subjects perceived the tone at a similar loudness level as the BC stimulus. Mean balanced thresholds were calculated and used as stimulation levels in the cadaver experiments (N = 4) to measure ICP during BC and AC stimulation. An extra level of 80 dB HL was added to assess linearity. Furthermore, ICP was compared with cochlear promontory velocity measurements in the normal condition and with a mass on the round window membrane to investigate the precision of both measurements.

Results: Results of the behavioral experiments revealed reproducible results with linear loudness functions between 50 and 60 dB HL. Preliminary data of the cadaver experiments showed comparable differential pressures between AC and BC stimulation at 50 and 60 dB HL without dominant resonance frequencies. At 80 dB HL different resonance frequencies appeared for both stimulation modes. During AC stimulation, the scala vestibuli pressure dominates the differential
pressure, whereas variable magnitudes were found between both scalae during BC stimulation. Furthermore, a significant change in differential pressure was found when a mass was placed on the round window membrane, but promontory velocity measurements showed no change.

**Conclusions:** The cochlear mechanics during AC and BC stimulation were studied using ICP measurements, which showed to be a reliable method to differentiate between stimulation modes or mechanical changes. Therefore, ICP seems to be a valuable measurement tool for preclinical characterization of different hearing solutions and to predict the best outcome for patients.

**THREE YEAR FOLLOW-UP WITH THE BONE CONDUCTION IMPLANT**

Department of Electrical Engineering, Chalmers University of Technology, Gothenburg, Sweden.
Department of Otorhinolaryngology Head and Neck Surgery, Institute of Clinical Sciences, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden

**Keywords:** Questionnaires, Implanted transducer, Transcutaneous

**Purpose/Aim:** The Bone Conduction Implant (BCI) is an active transcutaneous bone conduction device where the skin is intact. Sixteen patients have been implanted with the BCI with a planned follow-up time of five years. This study reports on hearing ability, quality of life and objective measures up to 36 months follow-up in ten patients.

**Materials and Methods:** Repeated measures were performed at the fitting visit and 1, 3, 6, 12 and 36 months after that, including sound field warble tone thresholds, speech recognition thresholds in quiet, speech recognition score in noise and speech-to-noise thresholds for 50 % correct words with adaptive noise. Three quality of life questionnaires were used. The results were compared to the unaided situation and a Ponto Pro Power on a soft band. Measurements of skull bone sound transmission were evaluated by nasal sound pressure, and the retention force from the audio processor against the skin using a retention magnet and a force gauge.

**Results:** Audiometry and quality of life questionnaires were significantly improved for both the BCI and the Ponto Pro Power on a soft band in comparison with the unaided situation, and the results were statistically supported. There was generally no significant difference between the two devices. The nasal sound pressure remained unchanged over the study period and the force on the skin from the audio processor was 0.69 ± 0.09 N (mean ± 1 SD).

**Conclusions:** The BCI improves hearing ability for tones and speech perception in both quiet and noise. The results remain stable after a three-year period and the patients subjectively report a beneficial experience from using the BCI. The transducer performance and contact to bone is unchanged over time, and there are no complications with the skin area under the audio processor.
CHARACTERIZATION OF A NOVEL BONE ANCHORED DEVICE USING INTRACOCHLEAR PRESSURE

Borgers, Charlotte *, Fieren, Guy (1,2,3), Walraevens, Joris (2), Van Wieringen, Astrid (1), Verhaert, Nicolas (1,4)
(1) Ku Leuven - University of Leuven, Department of Neurosciences, Expo, B-3000 Leuven, Belgium
(2) Cochlear Technology Centre, Mechelen, Belgium (3) Ku Leuven – University of Leuven, Department of Physics and Astronomy, Laboratory for Soft Matter and Biophysics – Heverlee, Belgium (4) University Hospitals Leuven, Department of Otorhinolaryngology, Head and Neck Surgery – Leuven, Belgium
Leuven, Belgium

Purpose/Aim: Percutaneous bone conduction (BC) implants are associated with a risk of skin infections. To overcome this problem, passive transcutaneous BCIs have been developed. Although the infection risk decreases, the device output is suboptimal for severe hearing losses. These shortcomings led to the development of active transcutaneous devices, in which the transducer is implanted under the skin to directly stimulate the bone. Although this development has a lot of advantages, more evidence is needed regarding the device performance in terms of implant location and coupling method. To objectively evaluate this, intracochlear pressures (ICP) are measured during stimulation with a novel Active Osseo-integrated Steady-state Implant system (OSI).

Materials and Methods: ICP, measured simultaneously in scala tympani and vestibuli, is used to investigate the performance of the OSI on human cadaveric heads (N=3). Three different implant locations are tested: (1) standard BAHA position, (2) recommended OSI position, (3) more posterior OSI position. Furthermore, different manners (screw or no-screw and use of different amounts of cement) to embed the implant in the skull are evaluated. The output of the OSI is compared with a state-of-the-art percutaneous BC device (Cochlear Ltd., Sydney, Australia). Stimulation levels are used corresponding to 60 dB HL and frequencies between 250-6000 Hz are tested. Velocity measurements at the promontory are also measured simultaneous with the pressure measurements.

Results: Results of a feasibility experiment indicate significant better output performance at position closest to the cochlea (position 2). Compared to a state-of-the-art percutaneous BAHA power system, the OSI showed a lower output performance at the low frequencies (<500 Hz), but higher output levels at the mid- and high frequencies. Preliminary results indicate the need of mounting the OSI in a stable way to avoid transmission losses.

Conclusions: A preference for implantation closest to the cochlea to obtain maximal output performance was found. ICP measurements can be used to evaluate different BC implants, which is important to characterize and optimize these implants before implantation in patients.

CHANGES IN BONE CONDUCTION IMPLANT GEOMETRY IMPROVED THE BONE FIT

Rahne, Torsten *, Plontke, Stefan; Wenzel, Claudia
University Medicine Halle (Saale), Martin Luther University Halle-Wittenberg
Department of Otorhinolaryngology,
Halle (Saale), Germany

Purpose/Aim: Because the bone conduction implant (BCI) introduced in 2012 did not fit into all adult mastoids and bone fit in children was challenging a geometry change of the transducer was proposed. The aim of this study was to figure out, whether these changes would improve the ability to appropriately place the bone conduction implant in the mastoids of children and young adults.

Materials and Methods: Computed tomography scans of 151 mastoids from 81 children and young adolescents from the age of 5 months to 20 years and 52 control mastoids from 33 adults were retrospectively analyzed. After three-dimensional reconstruction, the new transducer geometry was virtually implanted to compare its complete bone fit to the existing transducer.

Results: In adults and children with the age 12 years and older 100% of placements could be achieved without lifts. In children the bone fit without lifts was significantly improved to 75% in the age group 3-5 years and reached 100% at the age of 12 years.

Conclusions: The changes in the bone conduction implant geometry are beneficial for patients in all age groups. Since there still is a significant difference in bone fit between the groups of children age below 21 years and adults, radiological planning is recommended in children before BCI implantation.
BAHA ATTRACT-OSIA CONVERSION PATIENTS: COMPARISON OF THE TWO SYSTEMS

Bere, Zsofia *, Perenyi, Adam; Jarabin, Janos; Kiss, Jozsef Geza; Rovo, Laszlo
University of Szeged
Department of Otolaryngology, Head and Neck Surgery
Szeged, Hungary

Keywords: bone conducton1, Osia2, BAHA Attract3

Purpose/Aim: The aim of the study was to test the audiological performance and benefit of the new, active bone conductive hearing aid i.e. Osia (Cochlear®) system on patients, who have undergone passive transcutaneous BAHA Attract (Cochlear®) implantation previously, but the performance of the previous model is not enough to provide satisfactory audiological results due to further hearing loss. However, patients are still in the indication range of Attract.

Materials and Methods: 5 adults, previously BAHA Attract implanted patients (conductive or mixed type hearing loss, ? 18 years old) have been selected. Attract system was explanted during surgery and conversion to Osia was done. Each patient was screened audiologically: pure tone and speech audiometry was performed preoperatively with and without the patient’s own Attract sound processor (BAHA 5), and postoperatively with Osia. Quality of Life (QoL) test was also filled to compare the two systems. Self-comparison of audiological and QoL results with Attract and Osia were performed in each case. Results were analyzed statistically.

Results: Osia system accomplished significantly better both in pure tone and speech audiometry tests: the audiological gain of Osia was significantly higher in all test frequencies, especially in high frequencies (1000-8000Hz). Speech understanding has also improved better with Osia. However, patients were satisfied with both devices esthetically, compared to Attract, no discomfort, pain or numbness occurred in the period of sound processor-wearing. Quality of sound was also better in case of the Osia system based on the subjective opinion of the patients. However, surgical time was significantly longer in case of Osia, yet postoperative pain, or discomfort was acceptable, and by no means worse than after Attract surgery.

Conclusions: Compared to the passive transcutaneous Attract system, Osia provides better hearing performance and is much comfortable to wear, therefore results in significantly longer daily use with acceptable esthetic outcome.

FIRST RESULTS WITH A TRANSCUTANEOUS SOUND PROCESSOR FROM OTICON MEDICAL

Persson, Ann-Charlotte *, Marianne Philipsson, Måns Eeg Olofsson.
Region Västra Götaland, Habilitation & Health, Hearing Organization, Gothenburg, Sweden. Oticon Medical Ab, Askim, Sweden. Department of Otorhinolaryngology, Head and Neck Surgery, Sahlgrenska University Hospital, the Sahlgrenska Academy, University of Gothenburg
Gothenburg, Sweden

Keywords: Questionnaires, Bone conduction, Implanted transducer.

Purpose/Aim: Implantable bone conduction devices currently on the market are divided into three types: transcutaneous direct drive, percutaneous direct drive and transcutaneous skin drive bone conduction devices. Oticon Medical is in the process of developing a new transcutaneous direct drive system – the Sentio system. The purpose of the study was to evaluate the performance of first generation Sentio sound processor in terms of audibility and speech intelligibility. In addition, the study evaluated potential skin problems and processor retention force on the skin as well as subjective benefit, satisfaction and usability.

Materials and Methods: The study was a single-center prospective case study where ten patients previously implanted with a transcutaneous direct drive system, the BCI (Chalmers university of Technology in collaboration with Sahlgrenska University Hospital, Gothenburg), were fitted with the first generation Sentio sound processor. Scheduled for 3-4 visits under a period of 6 months sound field unaided and aided warble tone thresholds and speech recognition score in noise were measured. In addition, data on skin reactions using the Inflammation, pain and skin height/numbness (IPS) scale at baseline, 1 month and 6 months after the fitting of the device was collected. The Speech, Spatial and Quality questionnaire (SSQ) was used for self-reported benefit together with own developed questionnaires focusing on overall satisfaction and usability.

Results: Aided thresholds and speech intelligibility results showed a significant improvement compared to the unaided condition. No adverse skin reactions were reported and subjective outcomes showed positive results in terms benefit of and usability. Overall satisfaction with the device was high.
Conclusions: The first generation Sentio sound processor provides users with good audiological outcome in terms of improved audibility, speech intelligibility, subjective benefit and satisfaction.

IN-SITU MICROPHONE SENSITIVITY OF A FULLY-IMPLANTABLE MIDDLE EAR IMPLANT

D’hondt, Christiane *, Wouters, Jan +; Verhaert, Nicolas + ^
* Cochlear Technology Centre Belgium + Ku Leuven, University of Leuven ^
University Hospitals Leuven
* Research & Development + Department of Neurosciences, Research Group Expori ^ Department of Otolaryngology, Head and Neck Surgery
Leuven, België, Belgium

Keywords: fully-implantable middle ear implant, implantable microphone, microphone sensitivity

Purpose/Aim: The acoustic sensitivity of an implantable sub-cutaneous microphone is influenced by various factors that can vary in time such as scar tissue formation or skin thickness above the microphone. The purpose of this study was to evaluate the changes of the microphone acoustic sensitivity over time and the moment of stabilization. The ultimate goal is to provide input for future activation and fitting strategies.

Materials and Methods: The acoustic sensitivity of the implantable microphone of the Cochlear Carina Fully-Implantable Middle Ear Implant (see figure below) was measured in-situ in three patients at various time points after surgery using custom research software.

Results: It was possible to successfully measure the microphone acoustic sensitivity week by week in all three patients. The biggest changes in the acoustic sensitivity of the microphone happened around the resonance frequency of the microphone. The preliminary results suggest that the sensitivity stabilizes 6 to 8 weeks after surgery.

Conclusions: It is the first time that the sensitivity of the subcutaneous microphone was measured in-situ in patients at various time points after surgery in a controlled way. The implantable microphone is one of the key components of a fully-implantable system. It is therefore important to understand how the microphone sensitivity changes over time to identify a suitable moment for the first activation of the middle ear implant. For a good and stable fitting of the implant it should only be activated once the microphone sensitivity is stable (6-8 weeks after surgery).
Session Title: Binaural Hearing

SOUND LOCALIZATION AFTER EAR-CANAL-PLUGGING OF NORMAL-HEARING-LISTENERS USING THE ADHEAR

Agterberg, Martijn *, Katharina Vogt1; Hillary Snapp2; Martijn J.H. Agterberg1,3
1 Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, the Netherlands
2 University of Miami, Miami, Fl, Usa
3 Donders Institute for Brain, Cognition and Behaviour, Radboud University Medical Centre Nijmegen, the Netherlands
1 Department of Biophysics 2 Department of Otolaryngology 3 Department of Otorhinolaryngology Nijmegen, Netherlands

Keywords: non-invasive bone-conduction device, sound localisation, acoustical cues

Purpose/Aim: When dealing with a unilateral or bilateral conductive hearing loss the ability to determine the location of a sound source is affected. Amplification with a bone-conduction device is supposed to improve spatial hearing (i.e. the processing of acoustical cues), and the improvement in sound localization when listening with a (second) percutaneous bone conduction device has been demonstrated in several studies. Still many questions remain and therefore the aim of the present study was to investigate binaural hearing abilities with non-invasive bone-conduction devices in normal hearing listeners under simulated (plugged) unilateral and bilateral conductive hearing loss conditions.

Materials and Methods: Eleven normal hearing participants underwent localization testing in unilateral and bilateral plugged hearing conditions when listening with one or two adhesive bone-conduction devices (Adhear®). Broadband noise bursts (BB; 0.5-20 kHz), high-pass noise bursts (HP; 3-20 kHz), and low-pass noise bursts (LP; 0.5-1.5 kHz) were randomly presented at three different sound levels (45, 55, and 65 dB, A-weighted (dBA)). All stimuli had 150-ms duration and were presented in pseudo-random order within a block of 80 trials with equal right and left representation across the front hemifield.

Results: Unilateral plugged listeners relied on spectral cues to make judgments in Azimuth. Aided localization performance in the unilateral plugged condition did not significantly improve from the condition with a unilateral ear canal plug alone. Unilateral BCD for bilaterally plugged listeners restored audibility of low level stimuli, and disrupted localization performance of stimuli presented at supra-threshold levels. Bilateral BCDs for bilaterally plugged listeners restored audibility of low level stimuli and resulted in near-normal localization performance.

Conclusions: Sound localization abilities are disrupted by asymmetric hearing. Bilateral BCDs provided the best aided benefit in bilateral plugged conditions. These results suggest that good binaural hearing abilities can be achieved in developed auditory systems with bilateral BCDs. The lack of benefit of the BCD observed in the unilateral plugged listening condition might be related to remaining asymmetry, and dominance of the normal-hearing ear in this condition.
BINAURAL HEARING FOR BCI AND BAHA USERS
Reinfeldt, Sabine *, Rigato, Cristina; Asp, Filip.
Chalmers University of Technology
Electrical Engineering
Gothenburg, Sweden

Keywords: binaural, BCI, BAHA

Purpose/Aim: The purpose of this study is to investigate potential differences in binaural hearing abilities in patients fitted with a bone anchored hearing aid (BAHA) and with the bone conduction implant (BCI), an active transcutaneous device now tested in a clinical study. Previous studies have shown that the transmission to the ipsilateral and contralateral cochlea is affected by the position of the transducer, which might therefore have an effect on binaural hearing. The hypothesis is that the BCI supports binaural hearing more than the BAHA does because of its position on the skull bone.

Materials and Methods: The study consists of two measurement parts: (1) sound localization accuracy is tested with an eye tracking technology, and (2) speech recognition thresholds are measured for different listening setups to estimate the spatial release from masking (SRM). Eleven BCI-patients from the clinical study have been tested in both tasks, and measurements on a matched group of BAHA-users are planned for the spring. The matching is done at a group level to obtain similar hearing impairment, age and gender distribution in the two groups.

Results: For the BCI-patients, there was a positive SRM for all subjects in the unaided condition, and for 75% of them in the aided condition. 64% of them showed significantly improved sound localization when using a unilateral BCI compared to the unaided condition.

Conclusions: The conclusions from the measurements on BCI-patients were: (1) the BCI fitted unilaterally in patients with bilateral or unilateral conductive/mixed hearing loss seems to reduce SRM; (2) the speech recognition threshold is improved or maintained in aided condition, and (3) the BCI may provide improved sound localization. By our hypothesis, we expect that the SRM and the localization ability would be lower for the BAHA-patients, due to a less side-specific stimulation provided by the device.

EVALUATION OF BRAIN ACTIVATION BY UNI AND BILATERAL AUDITORY STIMULATION IN PATIENTS WITH BONE VIBRATORS WITH BILATERAL CONDUCTIVE HEARING LOSS WITH NEUROSPECT AND AUDIOLOGICAL EVALUATION IN PATIENTS WITH BILATERAL BONE VIBRATORS
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Keywords: Bilateral hearing, baha, audiological outcomes

Purpose/Aim: The purpose of this study is to evaluate the brain response to monaural versus binaural stimuli with bone vibrators in people with bilateral conductive hearing loss. 1. Determine which areas of the cerebral cortex are activated and what type is the activation (excitation or inhibition) when the ears are stimulated with pure tones in mono and binaural form through bone vibrators (BAHA Attract) in patients with conductive hearing loss bilateral. 2. To determine the potential hearing benefits of the use of bilateral versus unilateral bone vibrators in patients with bilateral conductive hearing loss.

Materials and Methods: Three patients with bilateral conductive hearing loss, bone vibrator users (BAHA Attract) on both sides were evaluated. Two with congenital hearing loss and one acquired. Brain SPECT studies were done stimulating with pure tones in monaural and binaural form. Two evaluations per subject were made: 1. Auditory stimulation of the left ear. 2. Simultaneous auditory stimulation of both ears. The results of the subjects were compared against a normative database and also in a paired way between unilateral and bilateral stimulation. In addition, audiological and localization studies were conducted using the Real Life Lateralization Test (RLLT).

Results: With monaural stimulation, hyperperfusion of the frontal and temporal areas was observed. With binaural stimulation, hyperperfusion was observed in the same areas but less severe in acquired hearing loss and greater in congenital hearing loss, suggesting that central auditory areas not stimulated early are functionally deficient. Sound quality, noise hearing and sound localization were significantly better with the binaural use of the implants.
Conclusions: The use of bilateral devices results in better sound quality and better sound lateralization capacity. In congenital conductive hearing loss there should be early auditory stimulation.

AN INVESTIGATION OF DIRECTIONAL HEARING WITH BILATERAL BONE CONDUCTION DEVICES

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Purpose/Aim: To investigate and optimise sound localization in patients bilaterally fitted with Bone Conduction Devices (BCDs).

Materials and Methods: Fifteen adults with bilaterally fitted BCDs participated in this study, and fourteen patients completed all visits. A baseline visit was scheduled with follow-up visits at 1 and 3 months. Sound localization performance, device use and scores on the Speech, Spatial and Qualities of Hearing Scale (SSQ) and the York questionnaire were measured during each visit. At baseline unaided and aided pure-tone thresholds, speech perception in quiet and in noise were also measured. At the end of the first visit a program was added to both BCDs with optimal settings for localizing sounds. Patients were instructed to use this program as often as possible. During the second visit a short localization training was given by presenting a series of sounds with visual feedback together with instructions on how to utilize localization cues in daily life. The third visit was planned to measure the combined effects of device settings and training on sound localization performance, device use and the questionnaires.

Results: Among patients there was a large variation in localization performance at all visits. At baseline six patients were able to localize sounds, whereby two patients showed near-normal localization performance. Six other patients were only able to localize sounds and three patients had difficulty in localizing sounds correctly. The added program caused an increase in device satisfaction, whereas device use remained stable. Scores on the SSQ domains spatial hearing and quality of hearing were significantly higher at the end of the study compared to baseline. Scores on the York questionnaire were not significantly different. There were no significant effects of the new program and the short training session on sound localization performance.

Conclusions: This study shows a large variability in sound localization abilities in patients with bilateral bone conduction devices with two patients even exhibiting near-normal sound localization performance. A listening program tailored for localizing sounds and a short training session did improve device satisfaction and scores on the SSQ questionnaire, however did not improve sound localization performance in the studied set-up.

INDICATION FOR BONE CONDUCTION DEVICE VERSUS COCHLEAR IMPLANT FOR BINAURAL HEARING REHABILITATION IN SSD PATIENTS

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Purpose/Aim: Although the importance of binaural hearing was demonstrated decades ago, the treatment of single-sided deafness (SSD) has only become an increased focus of attention since the beginning of the last decade. Problems related to SSD particularly include deficiencies in spatial perception, speech intelligibility in noise and spoken language. For the rehabilitation of patients with SSD different options are available: Contralateral Routing of Signals (CROS) hearing aids, non-implantable Bone conduction hearing systems, active and passive bone conduction implants (BCI) and cochlear implants (CI). While the treatment of SSD patients with CI can restore useful hearing of the auditory pathway and enable the benefits of binaural hearing (at least partially), all other hearing aid systems implementing the CROS principle allow at best a pseudo-binaural hearing. The cochlear implant treatment in SSD patients is acknowledged by many clinicians but reimbursed in only few countries.
Materials and Methods: The CI is a successful treatment in SSD patients with acquired hearing loss mostly following sudden hearing loss, chronic otitis with labyrinthitis, trauma or after several ear surgeries. Additionally, CI treatment in special cases, following resection of an intralabyrinthine schwannoma, after acoustic neuroma surgery, in patients with Meniere’s disease and simultaneous labyrinthectomy is a promising option for auditory rehabilitation.

Results: Only recently, CI treatment has been introduced in children with SSD. SSD in children can have a negative impact upon the normal development of the auditory cortex in the young child. Furthermore, the ability to develop and use binaural hearing and its subsequent hearing abilities in daily life can be affected. Especially when entering full-time education, children with SSD display behavioral problems and academic weaknesses, as well as increased needs for speech therapy in comparison to their normal-hearing peers. However, in children with congenital deafness we still do not know the critical time window for implantation. Last studies have shown that this window is comparable to children with bilateral deaf children, which is way before the age of 3 years, rather 1.5 years after onset of deafness.

Conclusions: However, because more than 50% of congenital SSD children suffer from cochlear nerve deficiency and therefore disqualified for CI treatment, there are many patients who may benefit from treatment with bone conduction devices. Patients after acoustic neuroma removal need regular MRI scans. The visibility after CI implantation (if indicated) is possible but reduced and in several cases without auditory nerve function the hearing rehabilitation with percutaneous bone conduction devices is indicated. The indication for CI versus BCI devices will be discussed in detail.

BONE-CONDUCTION AMPLIFICATION AND BINAURAL HEARING IN UNILATERAL CONGENITAL AURAL ATRESIA
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Keywords: Congenital aural atresia, binaural hearing, bone-conduction amplification

Purpose/Aim: Patients with unilateral congenital aural atresia (UCAA) are known to have poorer spatial hearing abilities, likely attributable to degradation of binaural processing. Yet, there remains significant variability in spatial hearing outcomes with bone-conduction amplification devices among this population. The aim of the present study was to: 1) investigate whether subjects with UCAA are able to access binaural cues when stimuli are presented at a high enough level to provide some auditory in the affected ear and 2) examine the impact on binaural hearing with bone-conduction amplification.

Materials and Methods: Twenty subjects with UCAA (aged 6 to 22 years) and 10 age-matched controls with normal hearing (NH) bilaterally completed two spatial hearing tasks: 1) sound source localization and 2) spatial release from masking (SRM). Localization ability in the horizontal plane was assessed in a 180-degree arc of eleven evenly-spaced loudspeakers. For assessment of SRM, target speech was Pediatric AzBio sentences, presented at 0 degrees. The masker was two-talker speech, either co-located with the target or spatially separated from the target (±90 degrees). Subjects with NH and one group with UCAA (n=10) completed unaided testing at 50 and 75 dB SPL. The second group with UCAA (n=10) completed aided testing with a BAHAn Softband.

Results: Subjects with UCAA performed more poorly than controls in regard to localization and SRM. Unaided localization improved as a function of age at 50 dB SPL, a trend which was not observed at the higher presentation level. Improvements in both tasks at 75 dB SPL suggest that these patients can use binaural cues when they are audible. The impact of a bone-conduction amplification device on spatial hearing abilities will be discussed.

Conclusions: Auditory deprivation associated with UCAA does not preclude development of the ability to use binaural difference cues in spatial hearing tasks. The marked improvement with age observed when subjects with UCAA are tested unaided at 50 dB SPL could be due to development in the ability to take advantage of subtle monaural cues in the unaffected ear. Implications for the timing of intervention with bone-conduction amplification devices within this population will be discussed.
INTERAURAL DIFFERENCES IN THE PROCESSING OF MONAURAL SOUND LOCALIZATION CUES

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Keywords: Sound Localization, Unilateral Hearing Loss, Monaural Cues

Purpose/Aim: Studies of functional imaging data and cortical lesions have demonstrated a right-hemispheric dominance in the processing of spatial audio in normal binaural conditions. It is unclear which spatial cues underlie this asymmetry. Listeners with profound sensorineural unilateral hearing loss (UHL) constitute a model for a “true” monaural listening condition and could reveal whether binaural cues solely elicit the right-hemispheric dominance, or if also monaural cues are involved. The aim here was to study differences between left and right monaural horizontal sound localization accuracy (SLA), under the assumption that each ear is more strongly represented in the contralateral cortical hemisphere. These data may be valuable prior to intervention with for example a bone conduction device.

Materials and Methods: Listeners with profound sensorineural UHL (left: n=6, mean age=44 years; right: n=6, mean age=46 years) and contralateral normal hearing (?25dB HL at 0.125–8kHz) participated in a horizontal sound localization task. Four continuous stimuli with various amounts of monaural level and spectral cues were used: 1) a broadband speech-weighted stationary noise, 2) a broadband speech-weighted musical melody with naturally occurring amplitude fluctuations (i.e. roving), 3) octave-filtered noise centered at 4 kHz, and 4) octave-filtered noise centered at 0.5 kHz. SLA was quantified by an Error Index (EI) ranging from 0–1.0 (perfect to random performance).

Results: No significant differences between left- and right-UHL mean EIs were found across stimuli. However, a repeated measures ANOVA showed a significant effect of stimuli on the EI for right-UHL (F(3, 15)=4.4, p<0.05), but not left-UHL (F(3, 15)=2.2, p=0.13). Post-hoc comparisons showed that right-UHL localized a broadband stationary noise more accurately (mean EI=0.43) than a roving broadband signal (EI=0.67, p=0.01) and a low-frequency noise (EI=0.68, p<0.01). For the broadband noise, 5 of 6 right-UHL listeners achieved an EI<0.58, which was significantly different from random performance (p<0.01).

Conclusions: Prominent level and spectral cues increase monaural horizontal SLA in listeners with right, but not left, profound UHL. This suggests an interaural difference in the processing of monaural localization cues, and has implications for counselling, assessment and treatment of profound UHL for which bone conduction devices may be an option.

Session Title: Surgical Considerations

POSTOPERATIVE INFECTION RATES IN LINEAR INCISION VERSUS THE PUNCH TECHNIQUE

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Purpose/Aim: The implantation technique of bone anchored hearing devices has significantly changed since their first introduction in 1977. In this study we compare two surgical methods of an auditory osseointegrated device: the linear incision method and the punch method. This study investigates the post-operative infection rates between the two surgical approaches.

Materials and Methods: Single institution, single surgeon retrospective study of patients who received either of the two surgical approaches. Patients with at least 6 months follow-up were evaluated for preexisting chronic illnesses, perioperative complications, length of surgery, and post-operative complications including infection after surgery. Post-operative soft tissue around the abutment was assessed with Holgers Classification scale.

Results: Thirty-nine patients were included in this study, nineteen female and twenty males. The average patient age was 68 years. Six patients had a history of diabetes mellitus (DM) (two in linear group, four in the punch group. Twenty-three patients underwent linear incision surgery and sixteen had the punch technique. Overall twelve patients (31%) had post-
operative infections requiring topical or oral antibiotic treatment including five (22%) in the linear group and 7 (43%) in the punch group. This was not significantly different (p = 0.17). Out of the twelve patients with post-operative infections, six were given topical antibiotics and six were given oral and topical antibiotics. Multiple logistic regression analysis compared age, sex, type of surgery, DM, operative time, skin thickness, and abutment size to post-operative skin infection requiring treatment. Only DM was statistically correlative with infection (OR=22.3, 95% CI 0.7-6.3, p=0.01). Holgers skin classifications post-operatively are displayed in Figure 1. One patient had a surgical procedure performed after surgery for skin overgrowth in the BAHA group. Operative time was not statistically significant between the two groups (p=0.37).

Conclusions: No statistically significant differences in post-operative infections were identified comparing linear incision and the punch techniques. Patients with diabetes in either group had higher incidence of post-operative skin infections.

![Holgers Skin Classification](image)

**CLINICAL OUTCOMES AFTER (MODIFIED) MINIMALLY INVASIVE PONTO SURGERY**

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Keywords: MIPS, linear incision

**Purpose/Aim:** To investigate and compare the clinical outcomes of the Minimally Invasive Ponto Surgery (MIPS) to the linear incision technique with soft-tissue preservation for percutaneous Bone-Anchored Hearing Implants (BAHI). Furthermore, to evaluate outcomes after the modified MIPS technique.

**Materials and Methods:** A prospective controlled study was performed in a tertiary referral center. 25 patients were prospectively included in the test group. The control group consisted of 25 patients who previously participated in another clinical trial and already underwent BAHI surgery. All patients were implanted with a 4.5-mm-wide implant, using the MIPS procedure (test group) or the linear incision technique with tissue preservation (control group). Follow-up visits were scheduled 7 days, 21 days (sound processor fitting), 12 weeks and 6 months after surgery. The primary outcome measure was skin sensibility around the implant, compared between groups. Secondary outcomes were self-perceived numbness, surgical time, soft tissue status, implant survival, Implant Stability Quotient (ISQ), subjective benefit and scar assessment.

**Results:** A total of 46 patients completed the 6-month follow-up. Four patients were pre-maturely withdrawn from the test-group due to implant loss (N=3) and abutment removal (N=1). No implants were lost in the control group. Sensibility, adverse soft tissue reactions, ISQ values and subjective benefit were comparable between groups. The test group had a shorter surgical time, better cosmetic outcomes and better self-perceived numbness. However, more wound dehiscences and a statistically non-significantly higher implant loss rate were observed in the test group. Based on this study (amongst others), the MIPS technique was modified and a second prospective controlled study with identical study design, sample size and outcome measures was conducted at the same center. Patient inclusion and data collection for this second study is currently in progress.

**Conclusions:** MIPS is comparable to the linear incision technique with tissue preservation regarding sensibility and soft-
tissue tolerability. MIPS is further reducing surgical time and provided better cosmetic outcomes. More research into MIPS and the associated implant loss is deemed necessary, before this technique can be implemented as the standard procedure in our clinic. In addition, short-term results of the modified MIPS will be available and presented at the conference.

A MULTI INSTITUTIONAL REVIEW OF THE PUNCH TECHNIQUE
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Keywords: Osseointegrated, MIPS, punch

Purpose/Aim: Describe and assess intraoperative and postoperative outcomes in the insertion of osseointegrated auditory implants with a newly designed surgical instrumentation set through a punch type technique.

Materials and Methods: Retrospective case series. Patients who underwent bone anchored auditory implant surgery using the MIPS (Oticon Medical, Somerset, NJ) surgical set through a punch technique at 9 neurotology tertiary referral based practices were identified. Demographic data, skin thickness at implant site, implant used, duration of surgery, adverse intraoperative events and postoperative outcomes were recorded.

Results: Seventy five patients comprised the study cohort (32 males, 43 females). Most patients (57.3%) were aged 51-75 years while 30.7% of the cohort comprised those aged 18-50 years and 12% were over 75 years. All but 2-patients received 4 mm fixeded implants and 68% received the Oticon Medical BTX implant. Two patients received 3 mm fixation implants and 32% received the Oticon Medical Wide Ponto implant. Mean surgical time was 12.2 minutes (6-45 minutes, standard deviation of 6.88 minutes). In 3 instances, surgery was converted to a linear incision to control brisk bleeding. Skin condition was Holgers 0-1 in 91.8%, while 5.5% had Holgers 2, and 2.7% had Holgers 3 at the first postoperative visit. At second postoperative visit, 94.2% had Holgers 0-1, 4.3% had Holgers 2, and 1.4% had Holgers 3. All instances of adverse skin reactions were treated with topical or systemic antibiotics and/or local debridement. There were no instances of implant loss. One patient had his implant traumatically displaced to a 45 degree angle necessitating implant replacement at a second site.

Conclusions: Punch technique placement of osseointegrated auditory implants using the MIPS surgical set represents a safe technique that further simplifies a progressively minimally invasive surgery.

CONSEQUENCES OF EAR SURGERY ON BONE CONDUCTED SOUND
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Keywords: bone-conduction, mastoidectomy, finite element model

Purpose/Aim: Bone conduction hearing aid devices are used in the cases of unilateral or conductive hearing loss or in any other case where a conventional hearing aid device cannot be used. One condition that can contribute to or cause the aforementioned types of hearing loss is ear surgery, for example radical mastoidectomy surgery. A radical mastoidectomy surgery consists in removal of part of the mastoid bone, the tympanic membrane, the tympanic cavity as well as the ossicles (canal wall up mastoidectomy), and in special cases (canal wall down mastoidectomy) removal of the posterior and superior wall of the ear canal as well. Given the invasiveness of the surgery, a bone conduction hearing aid is often the only type of hearing aid that can be used to rehabilitate the subsequent hearing loss.

Materials and Methods: The effects of the two types of radical mastoidectomy surgery on bone conduction sensitivity are evaluated for two types of bone conduction stimulations: 1) a stimulation at the skull bone approximately 55 mm behind the ear canal opening where normally a bone anchored hearing aid is positioned, and 2) on the skin just behind the ear where the audiometric bone conduction transducer Radioear B71 is positioned. The evaluations are conducted in the finite element model for bone conduction stimulation, the LiUHead and the vibration of the cochlear promontories are used as an estimate of the hearing perception.
Results: The results showed that a radical mastoidectomy surgery increased the cochlear vibration responses with bone conduction stimulation. The increase was up to 6 dB below 8 kHz, and up to 15 dB at higher frequencies. The increase was greater at the ipsilateral cochlea compared to the contralateral cochlea. The study also investigated the mechanical point impedance and found that the post-mastoidectomy magnitude impedance change was within 1 dB.

Conclusions: The radical mastoidectomy resulted in an increased level of cochlear vibrations but did not have a strong effect on the mechanical point impedance.

MIDDLE FOSSA BONEBRIDGE IMPLANTATION: SURGICAL AND AUDIOMETRIC OUTCOMES

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Keywords: BONEBRIDGE, Surgery, Audiology

Purpose/Aim: To describe the surgical and audiometric outcomes following a novel BONEBRIDGE surgical technique using the middle fossa approach with self-drilling screws.

Materials and Methods: A single site, retrospective review was performed of adult patients undergoing BONEBRIDGE implantation via the middle fossa approach with self-drilling screws. A total of 37 patients were reviewed with a mean follow-up time of 32 months (10-74 months). Audiologic testing was performed at activation and at 3-months postoperatively.

Results: No surgical complications were encountered from the middle fossa approach with self-drilling screws. Preoperative planning and modelling methods were developed to replace image guidance for appropriate device placement. Patients had an average functional gain of 40.3 dB with favourable speech perception outcomes. Overclosure was seen at 2 kHz and 3 kHz in patients with mixed hearing loss.

Conclusions: This is one of the largest BONEBRIDGE series in the literature, and the first to describe outcomes following the novel middle fossa approach using self-drilling screws. Overall audiometric outcomes were comparable to those in the literature using the mastoid or retrosigmoid approaches, as well to outcomes of traditional percutaneous bone-anchored hearing aids.

PROSPECTIVE STUDY OF PERI-IMPLANT CYTOKINES AND LONG-TERM IMPLANT SURVIVAL

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Purpose/Aim: • To prospectively study the peri-implant cytokine profile in maturing percutaneous bone anchored fixtures.
• To correlate the cytokine profile with the peri-implant skin and tissue state at the time and subsequent skin inflammation problems and implant survival.

Materials and Methods: Patients undergoing primary Bone anchored hearing system (BAHS) insertion were consecutively invited to participate in this study at our institution. 111 patients with 122 implants were recruited. Peri-implant fluid samples were collected at 1 week, 6 months and 12 months post implant insertion. Fluid volumes were measured and a clinical assessment of the peri-implant skin state was made using the Holgers score. Clinical photographs were taken of the implant at each of these visits. The fluid was analysed for 92 different cytokines. The
patients were then followed up for at least 4 years to capture the long term skin reactions and clinical outcomes including implant failure.

**Results:** A direct correlation was found between the peri-implant fluid volume collected and an increasing Holger’s score, hence increasing levels of inflammation were associated with a higher fluid volume yield. Peri-implant inflammation was also associated with increased cytokine concentration for many of the cytokines studied including IL-8 and MMP-1. The long term clinical outcomes and correlation with cytokine profile will be presented.

**Conclusions:** As in our previous work, increased levels of IL-8 and MMP-1 are strongly associated with peri-implant inflammation. We hope to demonstrate a predictive association of cytokine profile and long-term skin and implant problems.

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**NEXT DAY LOADING OF BONE ANCHORED HEARING SYSTEM: PRELIMINARY RESULTS**

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**Keywords:** Bone-anchored, Early Loading, Stability

**Purpose/Aim:** To demonstrate the feasibility and efficacy of next day loading of a percutaneous bone-anchored hearing device.

**Materials and Methods:** In this IRB approved, multi-center, prospective cohort study, bone-anchored hearing devices were implanted in adult subjects who suffered from a conductive hearing loss. One day postoperatively, the processor was fitted after the surgical site was assessed for soft tissue reaction using the Holger Scale and the implant stability determined by attaching a SmartPeg to the abutment and stimulating it with magnetic pulses. Using resonance frequency analysis, the Implant Stability Quotient (ISQ) of the abutment was obtained. Follow-up evaluations were at 1 week, 4 weeks, 3 months, 6 months and 12 months. A Glasgow Benefit Inventory was obtained at 4 weeks and a APHAB was obtained at the 6 months postoperatively.

**Results:** Since March 1, 2018, nine 4.5 mm diameter bone-anchored hearing devices were implanted in eight subjects. One subject underwent bilateral implantation. The mean ISQ measurement for the initial evaluations was 54.5 and implant stability was maintained for all subjects. Skin irritation was limited to Holger grade "0" or "1" with the majority having no skin irritation. The quality of life benefit results (GBI) ranged from 30.56% to 69.44% with a mean of 41.36%. Four of nine implants have been followed in excess of six months and all patients have been followed greater than four months.

**Conclusions:** Next day loading of a 4.5 mm diameter bone-anchored hearing system appears to be a feasible alternative to the traditional three month delayed loading. Although this is a preliminary study, the stability of the Implant Stability Quotient measurements, the lack of soft tissue reaction and the Glasgow Benefit Inventory results support continued investigation of a next day loading strategy.

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**SURGICAL CONSIDERATIONS FOR IMPLANTATION OF A NEW OSI**

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**Keywords:** OSI or Active Osseointegrated Steady State Implant system

**Purpose/Aim:** To identify surgical considerations of an Active Osseointegrated Steady State Implant system (OSI) in children.

Bone conduction devices (BCDs) are important in the rehabilitation of children with hearing loss (HL) who are unable to wear or fail to gain benefit from conventional hearing aids. BCDs can be held in place by bands, adhesives or surgically placed osseointegrated components connected percutaneously or transcutaneously. Surgical BCDs provide excellent access to sound in children but soft tissue complications are frequent.
Materials and Methods: A retrospective review of OSI surgery performed in 14 children.

Results: A total of 14 children, mean age of 14.2 years (SD 2.1; Range 10.3-17.7 years), have undergone surgical placement of 15 OSI devices. The indications for OSI placement were: bilateral aural atresia (n=3), acquired canal stenosis (n=2), unilateral conductive hearing loss due to unilateral aural atresia (n=5), and SSD due to either cochlear nerve aplasia (n=3) or enlarged vestibular aqueduct (n=1). Fourteen children received unilateral devices and 1 child received bilateral devices sequentially. Surgical technique has evolved from the first to most recent case. Device recessing has increased to decrease the profile on the head, particularly in children with underdeveloped mastoids (i.e. aural atresia) and younger children. Prior BCD placement was considered in 6 children; abutments were removed prior to OSI candidacy evaluation (n=5) or immediately prior to OSI implantation (n=2) or remained in place on the contralateral side (n=1). The OSI was placed on the contralateral side in 2 children and special consideration of device and incision placement was needed in one child whose prior percutaneous BCD was placed using the dermatome technique.

To date, no wound complications have occurred, but one child has had poor magnet retention despite undergoing a second procedure for soft tissue reduction at the magnet site.

Conclusions: The OSI implant offers a new option for an active BCD in children with varying etiology of hearing loss. Special surgical considerations are required for children, particularly those who had prior percutaneous BCDs.

MIDDLE CRANIAL FOSSA IMPLANTATION OF THE BONEBRIDGE ASSESSED WITH LDV

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Keywords: Bonebridge, Middle Cranial Fossa, Laser Doppler Vibrometer

Purpose/Aim: The Bonebridge is an active transcutaneous bone conducting implant that avoids a percutaneous abutment. The recommended site of implantation is the sinodural angle, followed by the retrosigmoid region. We assess the potential of a third implantation site in the middle cranial fossa (MCF).

The aim was to determine the preoperative planning and surgical considerations, assess the post-operative pain score and determine the effectiveness of each alternative implantation site as measured with the Laser Doppler Vibrometer (LDV).

Materials and Methods: We present 17 clinical cases in which the Bonebridge was implanted in the alternative sites. Postoperative pain was measured using the validated questionnaires. Audiological outcome was measured using speech discrimination. Six human cadaveric temporal bone studies were performed with the transducer implanted in the three regions. Cochlear promontory vibration was measured with the LDV.

Results: There was significantly reduced postoperative pain with the transducer placement in the sinodural angle and MCF. LDV studies show no difference in cochlear promontory vibration with the different implant sites.

Conclusions: The MCF is accessible from an extended postaural incision and should be considered as an alternative implantation site. Audiological results and cochlear promontory acceleration is comparable with the other sites.

SURGICAL AND FUNCTIONAL COMPARISON BETWEEN BAHA ATTRACT AND BONEBRIDGE

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Purpose/Aim: To evaluate surgical and functional outcomes in patients with two different type of semi-implantable tBCDs: the active Bonebridge device (BB) and the passive BAHA Attract device (BA).
Materials and Methods: We recruited two groups of patients (BB for Bonebridge and BA for BAHA Attract) operated between November 2014 and December 2016. Each group had 8 patients. A bilateral hearing loss was encountered in 3 patients for BB and 5 patients in BA. In each group 3 patients where previously fitted with hearing aids. Patients completed GHABP or GHADP and the COSI questionnaires where appropriate. Surgical outcomes were recorded in the surgical notes. Device choice driven largely by patient preference.

Results: No major skin or soft tissue related complications were reported in either group and audiological outcomes were comparable. The average follow up period was 3 years. GHADP showed a mean score of 83 (SD?23,5) in BB and 84 (SD?15,3) in BA. GHABP showed a mean score of 83 (SD?14,1) in BB and 85 (SD?8,6) in BA. COSI showed an improvement in the listening situations nominated by patients (Watching television, directionality of sounds, clarity with background noise, etc.). Post-Op SRT showed a mean threshold of 26.5dB (SD±5,3) and 30.5dB (SD±2,1) in BB and BA respectively when using the aid and a mean threshold of 45,7dB (SD±3,7) and 47,7dB (SD±4,3) in BB and BA respectively when unaided. Finally, in the Soundfield testing BB patients reached 100% of correct answers on an average threshold of 50dB when aided and 70dB when unaided, while BA patients reached 100% of the correct answers on an average of 55dB when aided and 70dB when unaided. No device failures in either group.

Conclusions: Both BB and BA are reliable semi-implantable tBCDs with excellent surgical and functional outcomes and patient satisfaction. The overall surgical time was much less in the BA group with no necessity for preplanning. The BA also has the possibility of conversion to other BCDs in the manufacturers portfolio and enjoys wide ranging wireless accessories. Further studies are needed to assess the longer term results in a bigger population.

Session Title: Evaluation, Fitting and Verification

INVESTIGATION OF AN OBJECTIVE MEASUREMENT DEVICE FOR BONE CONDUCTION STIMULATION
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Keywords: BoneConduction, Objective Measurements, Verification

Purpose/Aim: Insitu verification of Bone Anchored Hearing Systems on patients is a challenge. Particularly when vibrators are implanted under the skin without direct access. The Surface Microphone has been proposed as objective measurement method for verification purposes on patients with any type of bone conduction stimulation application. This allows for objective performance evaluation across patient and stimulation application. The objective of this study was to evaluate the effect of stimulation site for a BAHS soft band application and the position of the Surface Microphone on its efficiency in a population of real human heads.

Materials and Methods: On human test persons, a BAHS transducer was sequentially placed at different positions by means of the soft band. The Surface Microphone was placed at different relevant pick-up positions. To determine the efficiency of the Surface Microphone and effects of cranial attenuation sinusoidal sweeps were performed. To control the output of the transducer accelerometer measurements on the vibrator’s counterweight have been performed.

Results: Choice of stimulation site and measurement site have a significant effect on measurement outcomes. Increased distance between stimulation and measurement site leads to lower sound pressure level response in the high frequencies.

Conclusions: The preliminary results indicate that the measurement position with the Surface Microphone on the forehead yields stable and consistent results across population. Referencing sound pressure output of the Surface Microphone to the force stimulation of the human head in a large population can lead to a ‘sound to force’ transformation. The experiments are intended to provide suggestions for Surface Microphone placement for optimal outcomes. The results can also provide insights on the possibility of standardized ‘force to sound’ transformations for specific stimulation applications.
FACTORs INFLUENCING PATIENT TREATMENT SELECTION FOR SINGLE SIDED DEAFNESS
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Keywords: BAHA, CROS, Factors

Purpose/Aim: To determine patient factors that influence decision making in treatment selection for single sided deafness (SSD) between bone anchored hearing systems (BAHS) versus Contralateral Routing of Signal (CROS) hearing aids versus no treatment selection.

Materials and Methods: Inclusion criteria for enrollment include adult patients with single sided deafness referred to audiology to evaluate options of BAHS vs CROS hearing aids. Test band trial for Cochlear Corporation Baha and Oticon Medical Ponto implant was performed and CROS hearing aids were demonstrated to all patients. Questionnaires were given to each patient on completion of the initial trial and demonstration and again after 1 month of device usage. Factors such as age, sex, cause of hearing loss, length of time of hearing loss, and selected treatment option were tabulated. Device descriptors such as size, color, cosmetics, performance satisfaction, wireless capability, brand recognition, and warranty coverage were collected. Multivariate statistical analysis was performed.

Results: 50 consecutive patients with SSD were enrolled. All patients underwent evaluation with BAHS and CROS hearing devices. Patients choosing BAHS were compared to the patients choosing CROS hearing aids. Patients choosing none of the device options were evaluated. Factors that influence the decision such as length of time of hearing loss, cause of hearing loss, size of device, cosmetics, wireless capability, performance, and brand recognition are noted and impact device selection.

Conclusions: Single sided deafness has a significant impact on patients. Treatment options exist and many factors exist that influence a patient's decision to accept a device and which specific device to choose. Factors including size of device, cosmetics, wireless capability, performance, and brand recognition and reputation are summarized and discussed in further detail.

MIXED HEARING LOSS; POWER BONE-CONDUCTOR OR A MIDDLE EAR IMPLANT?
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Purpose/Aim: To rehabilitate patients with mixed hearing loss, implantable hearing devices like the Vibrant Soundbridge (VSB) or percutaneous bone conductors (BCDs) have been applied whenever conventional treatment fails.

Materials and Methods: Recently, we performed a systematic review to find recent studies (2017-2019) dealing with application of BCD or VSB in patients (n>10) with mixed hearing loss (with a mean sensorineural hearing loss component >35 dB HL). Apart from our two Nijmegen studies (Ponto 3SP and Baha 5SP power BCDs) and one from the Hannover group on VSBS, two more studies were identified, both using the VSB. BCDs and VSBS stimulate the cochlea directly, bypassing the impaired middle ear. Consequently, the quality of such device fittings is assessed by the ‘effective gain’ (bone-conduction thresholds minus the aided thresholds) and the measured ‘effective gain’ can be compared to prescribed values by applying well-validated fitting rules like e.g. the NAL rule. Recently, a modified, pragmatic version of the NAL fitting rule has been introduced for implantable devices, meant for validation purposes (Snik et al., 2019).

Results: The modified, pragmatic version of the NAL rule was applying to the five included studies, the reported aided thresholds of the Baha 5SP study (n=10 patients) were close to prescribed values (from 0.5 kHz to 2 kHz) while those of the Ponto 3SP study (n=18 patients) was approx. 10 dB below the targets. The VSB aided thresholds, averaged over the three studies (n=101 patients), were at target level only at 2 kHz. At 0.5 kHz and 4 kHz aided thresholds were 15 dB below targets. Regarding speech recognition, differences seemed to be less pronounced. However, different word materials and test procedures were used and, secondly, mean age at fitting of the devices varied considerably between studies from 55 to 70 years.
Conclusions: In summary, significant differences were found between studies. Best aided thresholds were found with the Baha 5SP. This conclusion might change over time when more powerful processors are released or, regarding the VSB, more effective coupling options are developed for the VSB actuator to the cochlea.

PRESCRIPTION OF LOW FREQUENCY GAIN IN BCDs
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Keywords: amplification, low frequency prescription, NAL-NL2

Purpose/Aim: In air conduction (AC) hearing aids a lot of research on how to prescribe output led to generally accepted and evidence based prescription methods. For Bone Conduction Devices (BCDs) these methods are missing, although recently a prescription rule, deducted form an AC strategy, is proposed. In this study we fitted BCD's to a BC-converted NAL-NL2 (AC) prescription, with showed a greater required output in low-frequencies. We verified the output of the BCD's with a skull simulator. Device constraints and patient preference stressed the need for an investigation into optimal low-frequency output prescription.

The objective was to assess to what extent perceived sound quality and auditory performance depend on the gain and compression settings for low frequencies (below 1kHz) in users of a percutaneous BCD.

Materials and Methods: For 20 experienced BCD-users we tested the effect of three different amplification settings on speech recognition in quiet and noise and sound quality ratings, obtained with paired comparisons for four different sounds. The amplification settings ranged from maximum low-frequency gain with a high compression factor to a setting with strongly reduced gain in the lower frequencies.

Results: Results show the difference in speech perception and perceived sound quality for the difference in low-frequency output

Conclusions: We will present the optimal low frequency output prescription, given the device constraints and patient preference.

BONE-CONDUCTION EFFECTIVE MASKING LEVELS FOR INFANT AUDITORY BRAINSTEM RESPONSES
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Keywords: infant bone conduction, infant bone-conduction masking, infant interaural attenuation

Purpose/Aim: The aim of this study was to investigate effective masking levels (EMLs) for bone-conduction (BC) auditory brainstem response (ABR) testing in infants and adults. Obtaining ear-specific BC ABR thresholds poses challenges as sound delivered to one ear can travel across the skull and activate the contralateral cochlea. Wave V amplitude and latency measures ipsilateral and contralateral to the bone oscillator can be compared to isolate the test cochlea. However, when ipsilateral/contralateral comparisons are inconclusive, clinical masking is required. A direct estimate of EMLs for BC ABR testing have not been previously measured. This study determined EMLs for ABRs elicited to 500- and 2000-Hz BC stimuli in normal-hearing infants and adults.

Materials and Methods: Participants were young adults and infants (0-18 months) all with normal hearing. BC 500- and 2000-Hz tone-pips were presented via a B-71 oscillator prioritizing normal minimum levels used for infant testing (20 and 30 dBnHL at 500 and 2000 Hz, respectively). Adults were also tested at 30 and 20 dBnHL at 500 and 2000 Hz, respectively. White-noise masking was presented binaurally via ER-3A earphones (22-82 dBSPL; 10-dB steps). The lowest binaural masking level to eliminate the BC ABR was deemed the EML.

Results: Mean(1SD) EMLs for 500 and 2000 Hz for adults for stimuli presented at 20 dBnHL were 65(9) and 53(6) dBSPL, respectively. Mean EMLs for infants for 500 Hz (20 dBnHL) and 2000 Hz (30 dBnHL) were 80(6) and 64(9) dBSPL, respectively. Compared to adults, infants required approximately 15 dB more masking at 500 Hz but a similar
amount of masking at 2000 Hz. Infants required 26 dB more masking at 500 versus 2000 Hz, whereas, adults required only 12 dB more masking at 500 versus 2000 Hz.

**Conclusions:** Maximum EMLs needed to eliminate BC ABRs arising from both cochleae in infants are 82 dB SPL for 500 Hz at 20 dBnHL, and 72 and 82 dB SPL for 2000 Hz at 30 and 40 dBnHL, respectively. Unsafe levels of white noise would be needed to effectively mask binaurally at greater stimulus levels. When masking only the non-test ear, however, EMLs are likely less when infant transcranial attenuation is considered.

**RELATING REAL-LIFE EXPERIENCES TO LISTENING ENVIRONMENTS AND DEVICE SETTINGS**

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**Keywords:** bone-conduction device, data logging, user experiences

**Purpose/Aim:** This study aims to relate experiences of users with a percutaneous bone-conduction device (BCD) to both listening environment and device settings. Depending on the listening environment, users may prefer different device settings such as gain, directionality and noise reduction. With the latest generation Ponto BCDs from Oticon Medical both environmental data and device parameters can be logged in real-time via an iOS research App. In this study, we evaluated experiences with two listening programs, each with different gain parameters and frequency responses.

**Materials and Methods:** Twenty experienced BCD users were given two listening programs in a random order. They were free to switch programs at any time. User experiences were collected in real-time by an App running on an iPhone together with an acoustic analysis of the listening environment by the BCD. The time-locked responses will provide detailed insights into listening experiences in ecologically relevant situations. Users were asked to fill in a short assessment whenever changing listening program and/or changing volume. Data on subjective experiences, listening environment, volume setting, program choice, and location were stored on the user's iPhone and retrieved by the experimenter at a follow-up visit.

**Results:** Data collection will finish in September 2019, followed by data analysis. Results will be presented at this conference.

**Conclusions:** This novel approach to evaluating BCD performance opens up interesting possibilities for optimizing device settings by combining real-life experiences to listening environments and device parameters. Additionally, experiences from ecologically relevant situations can be used as a basis for in-depth counselling

**PERFORMANCE OF NON-SURGICAL TRANSCUTANEOUS BONE CONDUCTION HEARING DEVICES**

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London, Ontario, Canada

**Keywords:** bone conduction hearing devices, non-surgical, transcutaneous

**Purpose/Aim:** Bone conduction hearing devices (BCHD) on soft headbands or adhesives are suitable for individuals who have conductive or mixed hearing losses. These transcutaneous devices are often used with children who are too young to undergo surgical placement of a similar device. Unfortunately, evidence-based clinical protocols for fitting these devices are not available like they are with air conduction hearing aids. This means that behavioural measures are used to verify the BCHDs, which can be limited with infants and do not individually quantify the optimal force output level of the device. Recently-developed prescriptive targets for percutaneous BCHD fittings are clinically available (Hodgetts & Scollie, 2017) as are skull simulators for objective force-level measurements. The performance of the various non-surgical transcutaneous BCHDs is of interest using currently available tools in order to inform a clinical fitting protocol.

**Materials and Methods:** An initial step for individualizing the fitting of non-surgical BCHDs is obtaining bone conduction
Results: Force-level outputs of a variety of transcutaneous devices will be compared to DSL targets for percutaneous devices. Measures of loudness and preference will be compared across devices. Results will provide information about the suitability of using the current DSL BC targets with transcutaneous fittings as well as information about bandwidth and dynamic range of a variety of devices.

Conclusions: Given the evolution of clinical tools for objectively fitting BCHDs, this work will provide evidence for the development of fitting protocols for these devices. It is hoped that this work will highlight next steps for research with infants with hearing loss who wear non-surgical BCHDs.

IMPLEMENTABLE HEARING DEVICES IN PATIENTS WITH OPEN CAVITIES: BAHA, BONEBRIDGE OR VIBRANT SOUNDBRIDGE: AUDIOLOGICAL AND QUALITY OF LIFE OUTCOMES

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Keywords: BAHA. Bonebridge. Vibrant Soundbridge. Open cavities

Purpose/Aim: Patients with canal wall-down cavities usually present poor results with conventional hearing aids or middle ear reconstructive surgery. The aim of this study was to compare the audiological and quality of life (QOL) results among different implantable devices including Bone Anchored Hearing Aid (BAHA®), Bonebridge® (BB) and Vibrant Soundbridge® (VSB) in patients with open cavities.

Materials and Methods: Twenty-four patients were implanted with a BAHA connect, 14 patients with a BB and 18 patients with a VSB due to conductive or mixed hearing loss following canal wall-down surgery. Data concerning demographics and audiometric evaluations were collected and studied. QOL was self-evaluated using the Glasgow Benefit Inventory (GBI) and the Nijmegen Cochlear Implant Questionnaire (NCIQ). Sound quality was self-evaluated using the Hearing Implant Sound Quality Index (HISQUI).

Results: A significant improvement in the audiometric scores after implantation was observed with all the devices. The GBI showed an important benefit on the total scale with a mean of +39 for the BAHA group, +38 for the BB group and +36 for the VSB group. In the NCIQ, all questionnaire respondents performed significantly better in all sub domains. Most of the patients also showed a “good” or “very good” subjective perception of the sound. The percentage of long-term users was 48%, 100%, and 78% for the BAHA, BB, and VSB respectively.

Conclusions: Both middle ear implants and bone conduction devices are useful implantable devices for patients with open cavities, most patients achieving good audiometric and QOL results. Based on the audiometry and patients’ expectations, it’s recommended to individualize each device selection.

SUBJECTIVE AND OBJECTIVE EVALUATION OF TWO FITTING RATIONALES FOR BAHS

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Purpose/Aim: When fitting a bone-anchored device (BAHS), gain is prescribed according to different rationales compensating for the patients hearing loss. Currently, there are two rationale options available for BAHS in the Oticon Medical fitting software: a modified version of NAL-NL1 (National Acoustics Lab - Non-linear version 1) and the DSL-BC (Desired Sensation Level – Bone Conduction). The aim of this study is to evaluate the patients’ performance with the two rationales in terms of self-reported performance and speech intelligibility.

Materials and Methods: This is a single-centre prospective study with a cross over design. Patients with a conductive or
mixed hearing loss were included in this study consisting of five visits. At the first two visits, patients undergo surgery and surgical follow-up. At the third visit, patients are fitted with a Ponto 3 SuperPower programmed with one of the two rationales (DSL-BC or NAL-NL1). After a trial period of about 3 weeks with the first rationale, a fourth visit is scheduled, where performance with the first rationale is subjectively and objectively evaluated via a speech-in-noise test, aided sound-field audiometry, and the SSQ questionnaire (Speech Spatial and Qualities of Hearing Scale). The same sound processor is then programmed with the other rationale. After a 3-weeks trial period with the second rationale, performance is subjectively and objectively evaluated with the second rationale via a speech-in-noise test, aided sound-field audiometry, and the SSQ questionnaire. A direct comparison between the two rationales was also carried out via a questionnaire of overall preference and the SSQ-C (comparative).

**Results:** The results of this study will be presented at the conference.

**Conclusions:** The outcomes of this study may suggest an overall preference towards one of the fitting rationales currently available for BAHS. These results can, thus, be highly relevant to help professionals fitting bone-anchored devices.

**A COMPARISON OF THRESHOLD MEASUREMENTS IN ADULT BONE CONDUCTION USERS**

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**Purpose/Aim:** Advancements in prescription formulae and fitting protocols for bone anchored hearing devices (BAHD) have highlighted the importance of measuring in-situ bone-conduction hearing thresholds (BCHT). In-situ BCHT are assessed routinely during fittings of percutaneous BAHD and BAHD worn on a soft-band. In-situ measurements are performed within the manufacturer’s software, using the patient’s BAHD device as a transducer. Uncertainty remains with respect to the relationship between transcutaneous (soft-band) in-situ, percutaneous (abutment) in-situ and traditionally measured (B71 transducer) BCHT; these differences have not been previously studied.

By exploring these potential differences, we aim to contribute to the development of more precise prescription and fitting protocols for soft-band BAHD users. The potential to develop and use correction factors to better estimate in-situ BCHT from thresholds measured on a B71 would be especially valuable for pediatric patients who are not always able to complete standard or play audiometry. The results of this study will contribute to future research with a pediatric population.

**Materials and Methods:** In this study, we are measuring each participant’s BCHT in three conditions; (1) in-situ with a percutaneous BAHD, (2) in-situ with the BAHD worn on a soft-band and (3) with the B71 transducer using standard audiometry. This cross-sectional study includes patients from the Institute for Reconstructive Sciences in Medicine (IrSM) over 18 years of age, with conductive or mixed hearing loss that use a BAHD. In-situ hearing thresholds are measured with two different BAHD, the Oticon Medical Ponto 3 Super Power and the Ponto 4.

**Results:** Not available at this time; data is currently being gathered.

**Conclusions:** Not available at this time; data is currently being gathered.

**Mini Session: Fitting Tips and Tricks**

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This session will offer practical solutions for people interested in the fitting and verification of bone conduction devices. We will cover skin-drive vs direct-drive differences, In-situ/direct bone conduction thresholds, targets for aided speech as well as verification tools like the skull simulator and the surface microphone.
EARLY EXPERIENCE OF A TRANSCUTANEOUS BONE CONDUCTION SYSTEM IN CHILDREN

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Keywords: transcutaneous, auditory outcome, pediatric

Purpose/Aim: This paper presents clinical outcomes and hearing performance of a new Bone Conduction system (OSIA) in a pediatric patient population with conductive or mixed hearing loss.

Materials and Methods: The OSIA system is an active transcutaneous system where the sound is transmitted to the cochlea through an osseointegrated implant. An externally worn sound processor, attached with a magnet, captures and digitizes sound which is transferred as a radio signal to the internal implant converting it to an electrical signal. This is conducted to a piezoelectric transducer attached to an osseointegrated screw allowing direct bone-conduction in the temporal bone.

Hearing and surgical outcomes from the first ten (n=10) implantations in pediatric patients receiving this system will be presented. All had either single sided or bilateral conductive or mixed hearing loss and were possible candidates for a percutaneous bone anchored system. Data was collected comparing pre- and post-surgical outcomes evaluated by pure tone audiometry, sound localization measurements, speech recognition in spatially separated competing speech and open-set monosyllabic word recognition.

Results: The aim of this study is to report our initial experience of implanting and fitting children with ten OSIA systems. We will present surgical outcomes and hearing performance data.

Conclusions: This transcutaneous system provides an alternative hearing option for children with conductive or mixed hearing loss.

PAEDIATRIC EVALUATION OF IMPLANTS WITH AND WITHOUT SURFACE MODIFICATION

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Purpose/Aim: Wide bone anchored implants provide an increased bone-to-implant contact surface to improve implant stability. Two equally designed prospective clinical trials investigating stability and survival of the Wide Ponto and Ponto BHX implants (Oticon Medical AB, Askim, Sweden). Both implants have identical macroscopic design, and only differs in the laser-ablated surface modification of the Ponto BHX implant.

The purpose of both studies was to longitudinally evaluate stability and clinical outcomes of the implants in children.

Materials and Methods: The studies were two sequential, prospective case series with planned data collection over a 12-month period for each child at a tertiary paediatric centre. Demographics were recorded including Full surgical details, high and low ISQ values at both implant and abutment levels. Clinical outcomes at follow up appointments: 1 week, 2 weeks, 4 weeks, 4 months, 6 months, 9 months and 12 months.

Results: Wide Ponto implant arm had 78 children. 51 were implanted prior to ISQ evaluations. The subsequent 27 children did have ISQ evaluation. There were 108 primary implants: 30 children had bilateral surgery, 35 children had unilateral surgery (all staged) and 13 single staged.

Ponto BHX arm, 60 children were included in the study, with a total of 95 primary implants. All had ISQ evaluation. 32 children had bilateral surgery, 16 had unilateral surgery(all staged) 12 children had single stage surgery (three bilateral cases) 4 children required repeated tightening of the abutment.

Across both studies, 4 mm implants showed higher ISQ than 3 mm implants. Overall, both single-stage and two staged implants demonstrated an increase at the 12 month end-of-study. 10 implants in the Ponto Wide arm were lost (3 were in...
a single child) and 7 implants in the BHX study. 
Comparative numbers of grade 2/3 Holgers reactions were noted throughout the study period with both the Ponto Wide group and the BHX group.

Conclusions: ISQ varies greatly between children. Low ISQs did not correlate with fixture loss and adverse clinical signs. Soft tissue outcomes and implant survival with both implants systems were better than previous results in our centre.

PARENTAL PERCEPTION OF IMPACT OF UNILATERAL CONDUCTIVE-HEARING LOSS IN CHILDREN
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Keywords: Unilateral hearing loss, qualitative study, children

Purpose/Aim: To understand parental perception of the impact of unilateral conductive hearing loss in their children.

Materials and Methods: Semi-structured interviews with parents of eleven children aged 11-17 years, with a known diagnosis of congenital or acquired, unilateral conductive hearing loss. A qualitative descriptive exploratory approach was used, with data coded and categorized using NVivo software.

Results: Three categories were identified:
(i) problems perceived by parents and acceptance. Main problem reported was perceived hearing difficulties in challenging listening situations and localizing sounds. They also described adaptations children made to overcome localizing and listening difficulties. Parents described the acceptance of hearing difficulties and resultant limitations.
(ii) monitoring, advice and support.
(iii) Parents described their experience and mixed feelings of advice given at the time of the diagnosis of conductive UHL and the role it played in the acceptance of their child’s hearing difficulties. Monitoring of hearing was a reassuring exercise. They also described the support their child received and its positive impact on their child’s education, although sometimes children found this annoying.
(iv) (iii) implications of active issues and parental concerns.
(v) The main subcategory was trial of hearing aids. Parents in the acquired hearing loss group were keen for their child to try this intervention, whilst parents in the congenital hearing loss group appeared to accept their child’s UHL and described the impact as limited. Parents in both groups described the dislike expressed by children in relation to hearing aids. Parents in the acquired hearing loss group also had concerns about the risk of ongoing ear infections, reflecting the underlying aetiologies in this group. Parental concerns also focused on the impact on education, their children’s future prospects and safely crossing roads.

Conclusions: This study highlights parental perceptions of impact of unilateral conductive hearing loss on childhood, and acceptance of these problems. As parents accept their child’s hearing loss, they may not perceive it as a health issue or seek intervention. There is an unmet need for a bespoke measurement instrument designed specifically for this patient group and incorporating the perspectives of parents, if evaluation of novel and existing interventions or conservative management strategies are to be clinically meaningful.

PERSPECTIVES OF CHILDREN ON IMPACT OF UNILATERAL CONDUCTIVE-HEARING LOSS
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Keywords: Unilateral hearing loss, qualitative study, children

Purpose/Aim: To understand the perspectives of children regarding the impact of unilateral conductive hearing loss on their lives.
**Materials and Methods:** Semi-structured interviews with 11 children with a known diagnosis of unilateral conductive hearing loss, aged 11-17 year, recruited from a tertiary paediatric hospital. A qualitative descriptive exploratory approach was used with data coded and categorized using NVIVO data analysis software.

**Results:** Six categories were identified: (i) self-perception of hearing ability, (ii) adaptations and impact of adaptations (behaviour issues and fatigue), (iii) support from friends, families and teachers, (iv) dealing with being different, (v) concerns about safety, and (vi) implications on future life. Children described their hearing as "normal"; however, exploring their daily routine, revealed hidden problems with hearing in noise, localisation, and hearing the teacher in the classroom. Children described how they adapted for example positioning themselves, in an attempt to overcome their hearing issues. They talked about some of the difficulties they encounter as a result of adaptions. They described issues such as tiredness, loss of concentration, isolation from friends. Families and teachers supported them through offering additional help in class, and at home. Friends helped with bullying at school and supported them in the classroom. Not only were children dealing and adapting to the physical impact of hearing loss, but were also having to deal with being different from their peers. At the same time children had considered the impact of their hearing loss on safety on roads, and took extra care to rely more on looking for traffic prior to crossing roads. They were aware of possible implications of their hearing loss on their future careers and general well-being.

**Conclusions:** Children with unilateral conductive hearing loss are keen to normalize their hearing loss and adapt to the resulting difficulties. There are, however, hidden problems which need to be identified by parents, teachers and caregivers to ensure appropriate treatment strategies can be advocated. This study highlights patient-specific outcome domains that are most relevant to children with unilateral conductive hearing loss.

**TRANSCUTANEOUS BONE CONDUCTION IMPLANTS (BCI) IN CHILDREN AND ADOLESCENT**

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**Keywords:** transcutaneous, BC implant, children

**Purpose/Aim:** Three transcutaneous BC implant products are certified for use in patients younger than 18 years in Germany. The aim of this study was to evaluate indications, safety and efficacy of hearing loss rehabilitation by this class of implants in juvenile patients.

**Materials and Methods:** Study design
Retrospective chart study, single-subject repeated-measures design, single tertiary referral center (Olghospital, Stuttgart). All patients, younger than 18, with a BCI were evaluated.

Patients and methods
29 patients aged 5 to 17 years received 34 implants. 32 active and 2 passive BCI were used.

Air and bone conduction threshold and improvement in word recognition scores in aided and unaided condition were measured. Tests varied according to individual abilities and age groups.

**Results:** The variety of individual surgical situations was summarized in 3 indication groups: a. malformations, b. revision surgery and c. single sided deafness.

Intraoperative complications were not observed. Significant speech discrimination improvement was found in all patients tested after 3 months.

In 2 cases revision surgery was required, due to skin dehiscence. Both cases had a history of previous extensive surgery for pinna reconstruction or percutaneous bone anchored hearing aids.

**Conclusions:** BCIs provide an effective option for hearing rehabilitation in patients not able to use a conventional hearing aids. In our hands complication rate was low and limited to skin problems especially in former percutaneous BAHAs users.
BONE CONDUCTION HEARING AIDS FOR CHILDREN WITH MODERATE HEARING LOSS

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Keywords: hearing aids, children, moderate hearing loss

Purpose/Aim: The aim of this study was assessing the development of auditory system in children under two years of age after application of hearing aids and assessing the effectiveness of auditory prosthesis used.

Materials and Methods: The research group consisted of 30 patients from the Institute of Physiology and Pathology of Hearing, children aged 7-23 months on the day of the study. To assess the threshold of hearing in children, auditory brainstem response and behavioral audiometry were performed. 20 children were provided with classical behind-the-ear hearing aids, in 10 children bone conduction hearing aids have been applied. The development of children auditory performance after the application of hearing aids was assessed with the LittleEars questionnaire and a re-examination of the behavioral observation audiometry about 6 months after the hearing aids were applied.

Results: The results of audiometric tests obtained from behavioral observation audiometry (BOA) in a wide range of frequencies showed improvement in hearing in all children. Analysis of the LittleEars questionnaire answers indicates progress in the areas of auditory skills of children who use hearing aids. The delay of auditory development in hearing impaired children using hearing aids tin relation to normally hearing children is on average 4 months. 70% of the research group achieves results within the normal range (the average achieved by children with normal hearing).

Conclusions: The use of hearing aids in children with moderate hearing loss allows for proper development of auditory perception. The use of the questionnaire supports the audiological evaluation and allows monitoring of auditory development. When assessing the child’s hearing reactions and development after using different types of hearing aids. There is a significant improvement in the development of listening skills in all devices. In order to reliably evaluate the effects after the use of hearing aids in addition to audiometric tests, standardized questionnaires intended for children of a given age should be conducted.

LONGITUDINAL STUDY OF ADHESIVE BONE CONDUCTING HEARING SYSTEMS IN CHILDREN

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Keywords: Adhesive, Bone, Conduction

Purpose/Aim: To evaluate audiological outcomes of the ADHEAR hearing system compared to the previously worn Ponto softband hearing solutions.

To evaluate subjective experiences of a paediatric population with the use of the adhesive bone conducting hearing systems (ADHEAR)

Materials and Methods: Retrospective review of all paediatric patients aged 4-15 years who have used the ADHEAR hearing system since 2015. Review of audiological outcomes Unaided, with ADHEAR and Ponto softband solutions. Long term follow up, including compliance, complications and impact on quality of life (QoL) was assessed though clinical review and validated questionnaires.

Results: 56 children were fitted with the ADHEAR hearing system to date. 3 non users were identified. 3.5 were subsequently implanted with a percutaneous bone anchored hearing implant system. 95% of children continue to use the ADHEAR hearing system with few complications reported. Audiological results demonstrated a sustained 26dB improvement in PTA thresholds with the ADHEAR after a period of acclimatisation with the ADHEAR hearing system. All QoL scores improved with the use of the adhesive device.

Conclusions: ADHEAR provides an alternative to traditional treatment of conductive hearing loss with comparable
audiological results to softband aids. To date it continues to be a very popular choice of bone conduction solution in children especially those who had previously refused any form of bone conducting aiding.

PAEDIATRIC CANDIDACY ASSESSMENT FOR A NEW OSI
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Keywords: OSI or Active Osseointegrated Steady State Implant system

Purpose/Aim: The current study examines paediatric candidacy for a new OSI. Although surgical bone conduction devices (BCD) provide children with good access to sound, soft tissue complications with percutaneous BCDs are frequent. The new OSI, presently in clinical trials, aims to provide excellent access to sound with reduced BCD complications in children.

Materials and Methods: A retrospective chart review of >50 children, identified through clinical visits 2016-2019, was conducted to identify potential candidates for inclusion in the clinical trial. Children with specifically defined co-morbidities who were unable to follow investigational procedures were excluded. Children with unilateral or bilateral conductive or mixed hearing loss (HL) as well as single sided deafness (SSD) were included. Overall, 25 children (13 (SD 2.5; Range 8 -17.7) years of age) underwent formal candidacy evaluation as part of a clinical trial.

Results: Eighteen children had conductive hearing loss due to bilateral aural atresia (n=4); acquired canal stenosis (n=2); narrow external auditory canals (n=4); and unilateral aural atresia (n=8). Seven children had SSD related to cochlear nerve aplasia (n=5); and enlarged vestibular aqueduct (n=2). Nine of these 25 children had previously received a surgical percutaneous BCD and one a transcutaneous magnet retained device. The majority of children evaluated were candidates for OSI implantation (20/25; 80%) but 2 of the 20 chose not to proceed to implantation. Of the 5 children who did not meet candidacy criteria, 2 had developmental delay and were unable to complete the preoperative assessment (both had Trisomy 21 and one also had alopecia and a tendency to excoriate her skin, raising concerns about wound healing) and two children with SSD and one with a mixed HL did not meet inclusion criteria as hearing thresholds in their better ear were poorer than the study limits (i.e. >20 dB HL). Fourteen of the 20 candidates, mean age of 14.2 years (SD 2.1; Range 10.3-17.7 years), have undergone surgical placement of 15 devices.

Conclusions: Current assessment of the OSI clinical trial suggests this device has potential benefit for children across a wide range of HL configurations and etiologies.

ONGENITAL SINGLE-SIDED DEAFNESS; TO TREAT OR NOT TO TREAT
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Keywords: Single-sided deafness, CI, C-BCD

Purpose/Aim: Potential treatment options for subjects with single sided deafness (SSD) are a conventional hearing aid with contralateral routing of sound (CROS), a CROS bone-conduction device (C-BCD), or a cochlear implant (CI).

The CI enables bilateral input and may ultimately provide binaural hearing. In contrast, CROS-devices cannot restore any bilateral hearing as only the contralateral hearing ear is stimulated.

Materials and Methods: We present an overview of sound localization performance of subjects with SSD listening with a C-BCD or a CI and we compare these results with SSD subjects who never asked for any treatment.

Results: We found moderate to good unilateral sound-localization abilities in the horizontal plane, at the side of their hearing ear in (unaided) SSD listeners. This performance proved to be related to processing of monaural spectral cues, which are only perceivable for SSD listeners with thresholds better than 40 dB HL at 4 and 8 kHz. Localization remains
unchanged when listening with a C-BCD. In contrast, sound-localization improved significantly when SSD subjects were listening with a CI. However, our data suggest that there is no true processing of binaural cues as the SSD subjects mainly lateralized sounds. It can be speculated that in daily live, when most sounds are not only audible but also visible, lateralization of sounds can already be really helpful.

We present our results with SSD in the context of treating unilateral conductive hearing loss with a BCD. In these patients, similar to treating SSD with a CI, binaural hearing is expected. However, we found that the improvement in sound-localization abilities is somewhat disappointing and device non-use was unexpectedly high (>40% within 3-4 years of follow-up).

Conclusions: We conclude that the non-invasive CROS device is to be preferred over a C-BCD in case of SSD; both offer reduction of the head shadow with no access to binaural cues (i.e. no bilateral input).

Although treatment of congenital SSD with a CI seems promising, we suggest a conservative approach in advocating a CI. There is a risk of non-use which might be related to a remaining hearing asymmetry after implantation, and unique dynamics of the normal hearing ear contralateral to the CI.

Friday, December 13

General Session

Invited Speaker

Pediatric Unilateral Hearing Loss

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Abstract: Until the 1980s, children with unilateral hearing loss (UHL) were assumed to develop speech and language normally and suffer no other consequences. Subsequent research, particularly in the past 10 years, have demonstrated that children with UHL are at substantial risk for speech language and cognitive delays and poorer quality of life. These studies mirror the studies that have been done in older adults who develop hearing loss. They are at risk for progression to bilateral hearing loss, including asymmetric hearing loss. Family and socioeconomic factors have been shown to modify the consequences of UHL.

Many small, uncontrolled studies into interventions to assist children with UHL to overcome the risks for future problems have been published. However, controlled studies that definitively establish the benefit and cost-effectiveness of various forms of amplification have yet to be performed. Part of the difficulty lies in the monitoring of outcomes longitudinally in children who are still developing speech and language. Assessing trajectory of development, rather than a pre- and post-intervention study as in adults, takes more patience and careful consideration of the possible confounding factors.

In this presentation, newer research regarding the consequences of UHL in children, the outcomes to be considered, and the benefits and limitations of interventions will be discussed. Needs for further research will also be mentioned.
Session Title: Pediatrics Outcomes

SURVIVAL OF THE COCHLEAR™ BAHA® IMPLANTS IN CHILDREN
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Keywords: Percutaneous, BAHA, Children

Purpose/Aim: Traditionally, the use of BAHAs in children has been limited by a high fixture failure rate, to the extent that some surgeons have sited 'sleeper' implants. We have previously demonstrated that early loading of the Cochlear™ Baha? BI300 implant is feasible in children, without fixture failure. This study aimed to determine the long-term failure rate of Cochlear Baha implants in children.

Materials and Methods: A retrospective case series review of 89 paediatric patients, receiving a total of 109 implants. The inclusion criteria were surgery performed at our children’s hospital and the study period commenced in 2008. Patients with implants from different manufacturers, or where data was insufficient, were excluded. The primary outcome measure was implant survival, with data collected using hospital casenotes, clinic letters and the audiology department database. Kaplan-Meier survival analysis was used to show survival curves of the Cochlear Baha implants.

Results: The age range of the 44 males and 45 females was 3-19 years (mean 10.4 years). Fourteen patients received bilateral implants. A single-stage technique was used for 77/109 implants, with the remainder being 2-stage. 71/109 were BI300 implants and 38/109 were BI200 implants. A total of 5/109 fixture failures (3 BI300, 2 BI200) were recorded, equating to a 4.5% overall failure rate (4.2% for the BI300 and 5.3% for the BI200). One failure, with a BI300 implant, was trauma-related and the remaining four were non-trauma related (failed osseointegration/infection).

Conclusions: The failure rate for Cochlear Baha fixtures in our institution is lower than most reported series in children. Together with our previous work demonstrating safe early loading after single-stage surgery using the BI300 implant, we no longer consider ‘sleeper’ implants to be necessary. The Cochlear™ Baha? BI300 implant addresses concerns about fixture loss in children.

AUDIOLOGICAL MANAGEMENT OF CHILDREN USING AN OSI
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Keywords: OSI, Osseointegrated Steady State Bone Conduction system

Purpose/Aim: To report audiological experiences in the first cohort of pediatric patients implanted with the new Osseointegrated Steady State Bone Conduction (OSI) system. This device is a new treatment option indicated for patients with unilateral and bilateral conductive hearing loss (CHL) or single-sided sensorineural deafness (SSD). Audiological protocols have yet to be defined.

Materials and Methods: Fifteen OSI devices were implanted in 14 children who were, on average, 14.2 years of age (SD 2.1; Range 10.3-17.7). Five had unilateral CHL, 5 had bilateral CHL, and 4 had SSD and did not meet CI candidacy criteria. Audiological involvement included assessment of OSI candidacy, activation of the device, family counselling, and follow-up.
Results: Candidacy assessments revealed bone conduction hearing thresholds within device criteria (<55 dB HL in the implanted ear) in 5 children with unilateral CHL, 1 with bilateral CHL, and 4 with SSD. Test-ear specific bone conduction thresholds could not be obtained in 4 children with bilateral CHL due to masking dilemmas. Initial device fitting relied on behavioral thresholds to stimuli presented directly from the device as device verification is not presently available. At initial activation, comfortable audibility was achieved immediately in 7/14 children. Six requested decreases in loudness. One child was only able to hear when pressure was applied to the device, reflecting skin flap thickness beyond recommended limits. Families of all children with SSD and unilateral CHL noted immediate improvement of responses to sound on the side of the implant. Family counselling focused on proper use and maintenance of the device and educational considerations given the lack of FM compatibility in this clinical trial device. Follow-up revealed overall ease of use and good device retention. 6/14 children asked for minor sound adjustments including gain reduction (n=2), gain increase (n=2), or an alternate program for noisy situations (n=2). Skin irritation at the magnet site was observed in 2 children and resolved after a short period of non-use, reduction of magnet strength where possible, and subsequent use of comfort pads.

Conclusions: Audiological management and follow-up of children using the new OSI is straightforward and paves the way for setting clinical protocols.

ADHESIVE BONE CONDUCTION HEARING SYSTEM: AUDILOGICAL OUTCOMES IN ATRESIA PATIENTS

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Keywords: adhesive bone conduction device, microtia, atresia

Purpose/Aim: The aim of this study is to evaluate the audiological benefit and subjective satisfaction of the adhesive hearing system in children with conductive hearing impairment (atresia/microtia) besides the changes in language, meaning and attention.

Materials and Methods: Prospective, single-subject repeated-measure study is presented. Each subject serves as his/her own control. Fourteen patients from 3 to 16 y.o. affected by unilateral or bilateral atresia/microtia were included. All patients were evaluate previous to fitting, 1 and 6 month after that. Audiological evaluation included sound field audiometry, speech recognition in quiet and noise in unaided and aided conditions, and MUSS (Meaningful Use of Speech) and MAIS (Meaningful Auditory Integration) questionnaires were used to evaluate: Voice control, Verbal language, Communication strategy (MUSS) and Reliability, Attention and Meaning (MAIS).

Results: The mean basic audiometry (PTA4- (pure tone average 5,1,2 and 4 KHz) thresholds for the air and bone conduction were 63,9 dB HL and 12 dB HL respectively. The aided PTA4 in sound field audiometry with the adhesive bone conductive hearing system reached 29.4 dB HL; therefore the mean functional gain was 34.4 dB. Word recognition score (WRS) at 65 dB SPL in quiet changed from 31% (unaided) to 91% (aided) one month after activation and 92% at six month. Speech in noise (speech at 65 dB SPL and noise at 65 dB was 12% unaided reaching 65 and 67 % at one and 6 month respectively.

On the other hand MUSS questionnaire improved from 27 points (unaided) to 29 (one month aided) and 33 six month after activation while MAIS changed from 25 (unaided) to 32 (one month) to 36 (six month). Therefore verbal language, communication, attention and meaning skills improved.

Conclusions: The new adhesive bone conduction hearing system is a valid option to improve the conductive hearing impairment due to atresia/microtia in children. This prosthesis can reach good thresholds of hearing and better speech understanding performance without surgery.

BONE-ANCHORED HEARING IMPLANTS SURGERY IN CHILDREN: A SYSTEMATIC REVIEW

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Keywords: Surgical technique, children, implant

Purpose/Aim: The aim of this study was to evaluate the efficacy of BAHIs in children and to elucidate the usage and outcomes of new surgical techniques and implants in this specific population

Materials and Methods: A systematic review was conducted, whereby PubMed and Embase were searched between July 2017 and April 2018 for terms related to BAHI surgery and treatment outcomes. In total, 20 articles were included: seven prospective cohort studies or case series and thirteen retrospective cohort studies or case series

Results: All studies combined encompassed 854 patients (952 implants), of which 851 patients were aged 18 years or younger. Demographic characteristics, surgical techniques, implant, study design, follow-up schedules and outcomes varied widely among studies. Osseointegration failure (OIF) occurred in 6.4% of the implants and the total rate of implant loss was 13.3% among all studies. Adverse soft tissue reactions were reported in 26.4% and revision surgery was needed in 16.8% of the implants. Implant loss, OIF, revision surgery, and soft tissue reactions occurred in 5.0%, 1.0%, 3.2%, and 15.0%, respectively, of the implants placed in one-stage surgery, compared to 17.0%, 6.7%, 33.3%, and 41.6%, respectively, of the implants placed in two-stage surgery. When comparing the tissue preservation technique to the tissue reduction technique, adverse soft tissue reactions were reported in 24% and 36% respectively, and revision surgery was reported in 2% and 24% respectively. Surgical outcomes of the wide and small diameter implant showed implant loss in 6% and 17% respectively and OIF in 2 and 8% respectively

Conclusions: BAHIs seem to be a safe method for hearing rehabilitation in children with the correct indication. Outcomes of new surgical techniques and implant design seem promising. However, because of the heterogeneity of the available literature, no definite conclusions regarding superiority of these new developments in surgical technique can be drawn and prospective, long-term comparative research with larger numbers is needed.

DEPRESSION & ANXIETY: PREVALENCE IN HEARING LOSS & SCREENING IMPLEMENTATION

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Keywords: depression, anxiety, screening

Purpose/Aim: The aims of this study are: 1) describe the implementation of a screening for anxiety and depression in a clinical setting for adolescents and adults with hearing loss and 2) examine the prevalence of depressive and anxiety symptoms in adolescents and adults with hearing loss.

Materials and Methods: All adolescents and adults ages 12 and older with hearing loss who came into the clinic for audiology and/or speech and language services were screened for depression and/or anxiety. The first step of the implementation process consisted of informing and training providers (i.e., audiologists, speech therapists, etc.) on anxiety and depressive symptoms. Subsequently, the psychology and social work staff administered the screening, which included the Patient Health Questionnaire (PHQ-8) for depression and the Generalized Anxiety Disorder (GAD-7) questionnaire. Additionally, patients were asked to rate how difficult the associated mental health concerns were affecting their life. Patients who scored a 10 or above on either measure or who reported difficulty due to those concerns (i.e., very difficult or extremely difficult) were then further assessed and/or referred to a community mental health provider.

Results: This presentation will review the mental health screening protocol that was implemented as part of a large Audiology/ENT practice. Overall, higher rates of depression and anxiety were reported for adolescents with hearing loss when compared to the general population (23% vs 13%, 21% vs 18% respectively). Future results will compare the prevalence of depression or anxiety based on the degree of hearing loss and hearing device used (i.e., BAHA, CROS, CI, hearing aid). Preliminary results showed that those who are not using any device, but had hearing loss and/or are being evaluated for hearing loss have a higher probability of reporting depressive or anxious symptoms.

Conclusions: The high prevalence of depressive and anxiety symptoms in this population highlights the need for integrated mental health care for this population. Further evaluation of the prevalence of these disorders in this population is warranted, as well as the implementation of evidence-based interventions. It is recommended that audiology/ENT practices implement mental health screeners and include psychology and social work as part of their multidisciplinary teams to help address these concerns.
AUDIOLOGICAL BENEFIT AND SUBJECTIVE SATISFACTION OF CHILDREN WITH ADHEAR SYSTEM

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Purpose/Aim: The main objective of this study was to evaluate the audiological benefit with the ADHEAR system in a group of children with a uni- or bilateral conductive hearing loss during a short-term exposure of three weeks, and to compare it with a conventional bone conduction hearing aid (BCHA) on a softband. The secondary aim was to assess the improvement of the quality of life and patient satisfaction with the ADHEAR system.

Materials and Methods: The study was designed as a prospective study with repeated measures, where each subject served as their own control. Ten children (4-17 y/o) with a uni- or bilateral congenital or acquired conductive hearing loss were included in this study. Pure tone audiometry and speech audiometry in quiet, both unaided and aided, were performed initially with the ADHEAR system and a BCHA on a softband and after three weeks with the ADHEAR alone. Furthermore, patient satisfaction and quality of life were assessed using the SSQ-12 and the ADHEAR questionnaire.

Results: Initially, the mean unaided free field hearing threshold of 50 dB HL (with 95%CI between 41.7-57.5 dB HL) expressed in BIAP, improved significantly by 22 dB (13.0-29.9) with the ADHEAR and by 23 dB (13.6-32.9) with the BCHA (p<0.001). Furthermore, the mean unaided speech recognition threshold (SRT) in quiet improved significantly by 19 dB (10.3-28.1) with the ADHEAR and by 21 dB (12.6-29.4) with the BCHA (p<0.001). For both audiological tests, there were no significant differences between the ADHEAR and the BCHA. After three weeks of use, the mean pure tone threshold of 28 dB HL (20.0-36.5) and the mean SRT of 47 dB SPL (41.9-51.5) with the ADHEAR system were comparable and not significantly different with the outcomes during the first visit. Speech understanding in noise and in multiple streams, sound localisation and sound quality were rated significantly better with the ADHEAR, compared with the ratings at the beginning of the study (p<0.001). No skin irritations or pain were reported.

Conclusions: The ADHEAR system helped most of the children and could therefore be considered as a temporary or definitive solution in all cases of conductive hearing loss.

CHILDREN WITH LONGSTANDING SSD, AN EXPANDED TREATMENT PARADIGM WITH OSI

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Keywords: OSI or Active Ossecintegrated Steady State Implant system

Purpose/Aim: The current study examines the utility of a new OSI in the treatment of single sided deafness (SSD) in children.

SSD in children requires intervention to mitigate deficits in auditory development. Cochlear implants can restore hearing from the deaf ear but children with long durations of congenital SSD and/or who have auditory nerve hypoplasia are not candidates in our program. CROS hearing aids or surgical bone conduction devices (BCD) provide an alternate solution. Bilateral hearing is not provided but the head shadow on the side of the deaf ear is reduced. This potential benefit may be subtle and further reduced by percutaneous BCDs as they are associated with frequent soft tissue complications. The new OSI aims to reduce these complications and provide hearing benefits to children with SSD, who are not cochlear implant candidates.

Materials and Methods: A retrospective chart review of >50 children, identified through clinical visits 2016-2019, was conducted to identify potential candidates with SSD for inclusion in the clinical trial. Children with specifically defined medical co-morbidities, who were unable to follow investigational procedures were excluded.

Results: Seven children with SSD presented for evaluation for inclusion in the study. Three were non-users of a percutaneous BCD. Etiologies of SSD included cochlear nerve aplasia (n=5) and enlarged vestibular aqueduct (EVA)
The majority of children evaluated with SSD were OSI candidates (5/7; 71%). Two children had SSD but hearing thresholds in the better ear were poorer than the study limits (i.e. >20 dB HL). One child with SSD was a candidate but declined implantation. In total, 4 children, mean age of 13.75 years (SD 2.7; Range 10.3-16 years), have received OSI. Previous percutaneous osseointegrated implants and soft tissue scarring were considered during surgical placement of the OSI but this did not preclude implantation and no soft tissue complications were experienced. All 4 children with SSD use their device daily, report satisfaction, and benefit from use.

Conclusions: Given these early results, we expect the OSI to provide a treatment option for children presenting with SSD who are unable to benefit from cochlear implantation.

EARLY OUTCOMES OF A NEW BONE CONDUCTION DEVICE IN CHILDREN
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Keywords: OSI or Osseointegrated Steady State Bone Conduction system

Purpose/Aim: To determine early effects of an Osseointegrated Steady State Bone Conduction system (OSI) on children’s hearing.

Bone conduction devices (BCDs) can provide access to sound in children with conductive (CHL) or mixed hearing loss who are unable to use or benefit from a device which amplifies acoustic sound and in children with single sided deafness (SSD) who are not candidates for cochlear implantation. The problem has been the frequent soft tissue complications associated with percutaneous BCDs. The Osseointegrated Steady State Bone Conduction system (OSI) aims to provide similar benefits as traditional BCDs while reducing complications. Outcomes in children are needed.

Materials and Methods: A prospective study of hearing outcomes in 14 children who have received 15 OSI devices is ongoing. Five of the children had unilateral CHL, 5 had bilateral CHL, and 4 had SSD. Thirteen children received unilateral devices and 1 received bilateral devices sequentially. Unaided (prior to implant) and aided (post-implant at mean(SD)=15.21(81.24) days) measures included: audiological threshold testing of the implanted ear (other ear plugged when necessary) across standard test frequencies and speech perception (Phonetically Balanced Kindergarten monosyllabic word test, presented at 65 dB SPL from a loudspeaker at 0 degree azimuth). Child and parent/caregiver perception of OSI benefit was assessed using the Speech, Spatial, and Qualities of Hearing Scale (SSQ) before and after implantation.

Results: Post-operative thresholds (mean(SD)= 23.25(8.30) dB were significantly improved from unaided pre-operative measures (53.61(13.54), t(324)=9.0, p<2e-16). Speech perception with the OSI device revealed excellent accuracy (mean(SD)= 88.57(11.16) %) post-implant. This was clearly improved from unaided perception measured prior to implantation (mean(SD)=16.80(22.69)%, t = 11.76(16.48), p= 1.975e-09). The SSQ indicated more subtle changes. There was a significant increase in parent/caregiver scores in the spatial hearing domain (from 5.35(2.09) to 7.59(2.18), t(100.34)=3.2, p<0.005) and very slight increases (p<0.05) in the parental ratings of qualities of hearing, speech and conversational uses of hearing sections of the SSQ and the child’s rating of their overall hearing.

Conclusions: Early outcomes with the OSI device in children reveal excellent speech perception and improvements in parental perception of spatial hearing.

Session Title: Hearing Science

DEPENDENCE OF BONE CONDUCTION SURFACE WAVE PROPAGATION ON STIMULATIONS SITES
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Keywords: Bone conduction, 3D Laser Doppler Vibrometer, Surface wave

Purpose/Aim: Investigation of the wave propagation on the surface of the skull and their dependence on osseous and non-osseous stimulation site of the bone conduction hearing aid (BCHA).

Materials and Methods: The electromagnetic actuators from commercial BCHAs (Baha® Cordelle and Power, and BoneBridge®) were used to provide stepped sine stimulus in the range of 0.1-10 kHz. Osseous and non-osseous pathways were activated sequentially via a skin drive (5-Newton steel band) and direct dura stimulation. Stimulation was sequentially applied at the forehead, mastoid, eye, neck and dura. Under each stimulation condition, the head motion was quantified by sequentially measuring ~200 points (~ 15-20mm pitch) on the across the ipsi-, top and contra-lateral skull surface via a three-dimensional laser Doppler vibrometer (3D LDV) system, guided by a robotic positioner.

Results: Low frequency motion (<1kHz) of the whole head depends on the stimulation position. Stimulation farther away from the base, results in predominantly rigid-body-like motion. The average head response and motion composition varied with stimulation direction and location at low frequencies. The predominant motion direction was only 5-10dB higher than other components below 1.5kHz, while all components contribute equally to the head motion at higher frequencies. Sound propagation direction across the parietal plates does not coincide with stimulation location.

Conclusions: Potentially, the head base remains rigid-like up to 3-4 kHz and acts a large source for the deformation patterns across the parietal sections of the skull. Comprehensive experiments, including the simultaneous motion across the skull surface and investigation of the interaction between different parts of the skull during sound propagation shows dependency on frequency, stimulation location, and stimulation direction.

SKIN ATTENUATION OF BONE CONDUCTED SOUND
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Keywords: skin attenuation, surface stimulation

Purpose/Aim: Bone conducted (BC) sound is usually applied by a vibrator pressed against the skin of the head or directly connected to the skull bone. With the BC transducer applied to the skin, the skin itself affects the vibration and the attenuation depend on several factors. Here we investigate the influence by the skin at the mastoid on BC sound transmission to the cochlea for three parameters: 1) the static force pressing the BC transducer to the skin, 2) the area of...
the interface of the BC transducer and the skin, and 3) the thickness of the skin and subcutaneous tissues between the BC transducer and the skull bone.

Materials and Methods: The evaluations were conducted on the LiUHead, a finite element model of a human head developed for simulations of BC sound. All simulations were done with a circular interface at the mastoid, approximately centered at 25 mm behind the ear canal opening. The effect of the static forces was evaluated in the range between 3 and 6 Newtons and the effect of skin thickness was evaluated by reducing the skin thickness from 12 mm to 3 mm. The effect of stimulation area was for circular areas with diameters between 5 mm and 30 mm. The evaluations of the manipulations were done with a constant dynamic force and using a model of a BC transducer.

Results: The effect of static force was limited to approximately 5 dB and was primarily seen at the higher frequencies independent if the stimulation reference was a force or the voltage to a transducer. When the stimulation was a constant force, a smaller area gave up to 5 dB better cochlear stimulation than the larger areas while 20 to 30 dB worse cochlear stimulation was found with the smallest area compared to the largest area when the stimulation was a BC transducer. A thickness of 3 mm gives around 20 dB better cochlear stimulation than a thickness of 12 mm.

Conclusions: The skin affects the BC sound transmission where larger interfaces and thinner skin results in the best cochlear excitation.

THE COUPLING METHOD AFFECTS BONE CONDUCTION SURFACE WAVE PROPAGATION

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Keywords: Bone conduction hearing aid, 3D Laser Doppler Vibrometer, surface waves

Purpose/Aim: The effect of the coupling method of bone conduction hearing aids (BCHA) on wave propagation on the surface of the skull is investigated

Materials and Methods: Experiments were conducted on five Thiel embalmed cadaver heads. Different commercially available BCHAs provided a stepped sine stimulus in the range of 0.1-10 kHz. Percutaneous stimulation (Baha Connect) was compared to transcutaneous passive bone drive (Baha Attract) and skin drive (AdHear / Baha on 5-Newton Headband). For each stimulation condition, the head motion was quantified by sequentially measuring ~200 points (~ 15-20mm pitch) across the ipsi-, top and contra-lateral skull surface via a three-dimensional laser Doppler vibrometer (3D LDV) system, guided by a robotic positioner.

Results: The head shows rigid body motion at low frequencies and deformation at higher frequencies. Additionally, the stimulation area, with a radius of 2-3cm around the stimulation location, undergoes deformations at lower transition frequencies than the whole head. The transition frequency of the stimulation area's motion is significantly dependent on coupling type. For percutaneous stimulation, it is about 500Hz and for transcutaneous passive stimulation it is around 5 kHz. For transcutaneous stimulation at the mastoid, the skull base remains rigid-like up to 3-4 kHz and acts a large source for the deformation patterns across the parietal sections of the skull. For percutaneous stimulation at the BAHa location, the bone deformation waves have its origin at the point of stimulation.

Conclusions: Surface wave propagation depends on the coupling method. The hearing threshold for different coupling methods of BCHA may not only be caused by different dampening, but also by different surface wave propagation.

TOPOLOGICAL VARIATION OF YOUNG’S MODULUS AND MICROSTRUCTURE ACROSS THE SKULL

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Page 77
Keywords: Young's modulus, human skull, micro tensile stage

Purpose/Aim: For better understanding of bone-conducted hearing, the sound wave propagation in a human skull should be investigated, and the Young's modulus of the skull is a significant factor to determine the wave speed in the skull. Therefore, we measured spatial distribution of the Young's modulus of the skull and compared it with published values.

Materials and Methods: Experiments were conducted on three Thiel embalmed cadaver heads. Thiel preserved human cadaver heads were used to measure the Young's modulus of the skull bone. Each specimen was first scanned via Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) to determine the approximate shape and thickness distribution of the skull bone and soft tissue within the head. Based on the volumetric data, several areas of interest on skull were selected, from which test samples were extracted, including: ipsi- and contralateral mastoid, temporal and parietal bones, forehead, occipital bone. Two to three samples were extracted from each section (3×2×15 mm2). Each sample was scanned with µCT (15 µm voxel size) to define its microstructure and corresponding bone fraction volume (porosity). Then, samples were individually fit into a micro tensile-compression stage, with a maximum range of 2 kN. Several tension-compression loading cycles within the linear elastic range were applied on each sample, after which the tensile load was increased until failure, providing experimental values for both Young's modulus and ultimate tensile strength. Theoretical values of the Young’s modulus were also predicted based on µCT data in combination with composite- and curved-beam theory.

Results: Due to the variation of the ratio between the cortical bone and the cancellous bone through the skull, the Young’s modulus of the skull also varied from 300 MPa to 4 GPa.

Conclusions: Merging experimental data from multiple domains, including MRI, CT, µCT volumetric data with tension-compression tests, allows for detailed exploration of the skull bone material properties and its spatial variation. Such multi-domain data could be used for improving existing numerical models and for optimization of the design of bone conduction hearing aids.

SOFT TISSUE STIMULATION RESULT IN HEARING BY SKULL BONE VIBRATION
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Keywords: soft tissue stimulation, skull bone vibration

Purpose/Aim: Several studies have reported hearing perception with vibratory stimulation on soft tissues such as the neck, eye, or direct to the dura, and claimed it to be different from ordinary bone conducted sound. It has been hypothesized that the perception from such stimulation is through a direct fluid pathway and not through skull bone vibration. Here, the induced skull bone vibrations with stimulations at the eye, neck and dura are estimated and compared with skull bone vibrations obtained with ordinary mastoid stimulation.

Materials and Methods: The evaluations were conducted on the LiUHead, a finite element model of a human head developed for simulations of bone conducted sound. All simulations were done with a circular interface of 15 mm in diameter, simulating the excitation from a B71 transducer. In addition, a computational model of the B71 transducer was used to estimate the output force at each stimulation position. The vibration of the cochlear promontory was evaluated for equal voltage provided to the B71 transducer.

Results: The magnitudes of the load impedances at the soft tissue stimulation positions were significantly lower at frequencies below 2 kHz compared to the mastoid position which lowered the stimulation output from the B71 transducer at low frequencies at these positions. Compared to mastoid stimulation, a stimulation at the neck is predicted to give hearing thresholds that worsen with frequency at 20 dB/decade, which is also reported in the literature. Similarly, a stimulation on the eye is predicted to give 10 to 20 dB worse hearing thresholds than at the mastoid, which is also reported in the literature. A stimulation on the dura should give 20 to 40 dB worse hearing thresholds than at the mastoid, which is also in the range reported in the literature.

Conclusions: The simulation indicate that the promontory vibration is a good predictor of the hearing perception when the stimulation is at a soft tissue position. Consequently, soft tissue stimulation is transformed to skull bone vibration that excite the inner ear as with ordinary bone conduction sound.
PROMONTORY MOTION AND INTRACRANIAL PRESSURE INTERACTION IN BONE CONDUCTION

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Keywords: 3D Laser Doppler Vibrometry, transcranial transmission, intracranial pressure

Purpose/Aim: Investigation of bone conduction sound propagation by osseous and non-osseous pathways, based on the correlation between 3D promontory motion and intracranial pressure.

Materials and Methods: The electromagnetic actuator from a commercial bone conduction hearing aid (BCHA) (Baha® Cordelle II) was used to provide a stepped sine stimulus in the range of 0.1-10 kHz. Osseous pathways (direct bone stimulation or transcutaneous stimulation) were sequentially activated by stimulation at the mastoid or the BAHA location using: a percutaneously implanted screw, Baha® Attract transcutaneous magnet and a 5-N steel headband. Non-osseous pathways (only soft tissue or intra-cranial contents) were activated by actuator stimulation on the eye or neck via attachment to a 5-N steel headband. The response of the skull was measured as motions of the ipsi- and contralateral promontory and intracranial pressure (ICP) in the central, anterior, posterior, ipsilateral and contralateral temporal regions of the cranial space. Promontory motion was monitored using a 3-dimensional Laser Doppler vibrometer (3D LDV) system.

Results: The promontory undergoes spatially complex motion with similar contributions from all motion components, regardless of stimulation mode. Transcranial transmission showed a gain at low frequencies (300-500 Hz) and attenuation above 1 kHz, independent of stimulation mode. The contralateral promontory motion did not follow the direction of ipsilateral stimulation above 500 Hz. Non-osseous stimulation on the neck and eye induced ICP level comparable with percutaneous mastoid stimulation. Corresponding phase data indicated lower phase delays for ICP when stimulation was via non-osseous means (i.e., to the eye) versus osseous means (i.e., to the mastoid or forehead). Spatial distribution of ICP indicated a sound propagation through the thicker bony sections first before activating the CSF.

Conclusions: Utilization of 3D promontory motion measurements provides more precise (lower inter-sample variability) information about bone vibrations than any individual component. A comprehensive combination of motion and pressures measurements across the head, combined with a variation of the stimulation condition, could reveal details about sound transmission within the skull.

MULTISCALE AND MULTIMODAL ANALYSIS OF RETRIEVED BONE-ANCHORED HEARING IMPLANTS

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Keywords: tissue response, bone-conducting device, osseointegration

Purpose/Aim: A detailed understanding of the biological processes around bone-conducting devices (BCD) is lacking. This knowledge is equally important in the absence and presence of adverse events, such as peri-implant inflammation and implant loss. Nowadays, most of the knowledge is based on subjective clinical measurements, whereas information on the biological events at the tissue-BCD interface remained inaccessible. Elective retrieval of BCD’s is rare and and only a few cases in literature analysed the implant and surrounding tissue. To further understand the mechanisms for successful and unsuccessful outcomes, multiple analytical and correlative strategies have been implemented in the present study, enabling multiscale and multimodal investigation of the interface between the tissue and the BCI in humans.

Materials and Methods: We have established a bilateral collaboration network with leading European clinics. We have hypothesized that using a logistic scheme; (i) compiling patient cohorts, (ii) implementing systematic retrieval protocols, (iii) efficient preservation of the tissue, will allow correlation of the clinical data of patients with retrieved implants with the underpinning microbiological, molecular and morphological finger-prints at the tissue interface. Different sampling procedures and analytical tools were employed, including X-ray micro-computed tomography (micro-CT), histology/histomorphometry, fluorescence in situ hybridization (FISH), microbiology, quantitative polymerase chain reaction (qPCR), backscattered electron scanning electron microscopy (BSE-SEM) and Raman spectroscopy.

Results: To date, six electively-retrieved BCD’s have been investigated. Reasons for removal were chronic pain, recurrent inflammation, cancer and mechanical complications. Prior to retrieval, tissue samples were obtained for molecular and microbial analyses in some cases. After retrieval, tissue samples were subjected to micro-CT analysis and embedded for histological and ultrastructural analyses. This presentation describes the sample preparation route for successive analyses allowing assessment of the different hierarchical levels of interest, going from macro to nano-scale of the tissue-interface. Examples of the results from the different analyses will be presented, with emphasis on correlating the clinical outcome with the analytical findings.

Conclusions: The implementation of a systematic retrieval network combined with a subsequent multi-scale analytical strategy enables an improved correlation between the clinical history of patients and the underpinning microbiology, cell biology and morphology of the tissues interfacing the electively removed or failed implants.

HEY SIRI: YOU MAKE LISTENING EASY
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Purpose/Aim: Previous work has shown that familiar voices are easier to understand in the presence of an unfamiliar competing masker. Interestingly, familiar voices are also easier to ignore when they are the masker and the target is an unfamiliar voice (Johnsrude et al., 2013). In this work we extend these findings to a virtual assistant, Siri, that is available on Apple devices.

Materials and Methods: Thirty adult listeners (6 males, 24 females) with normal hearing were recruited. Participants performed a complex hearing task called a coordinate response measure (CRM). Participants listened through speakers to a target (identified as Baron) saying a coloured number (one out of 32 options; 4 rows of differently-coloured numbers from 1 to 8) while simultaneously listening to a masker saying another call sign. Participants were asked to identify the target coloured number via a mouse. In one of the blocks, participants listened to a familiar target voice (i.e., Siri) and an unfamiliar masker voice (i.e., alternate Apple voice “Allison”). In the other block, participants listened to two unfamiliar voices (one target “Samantha” and one masker “Allison”). When the participant chose the correct Baron call sign, the level of the next target dropped by 1dB. When participant chose the incorrect call sign, the level of the next target increased by 3dB. This held the participant performance at a 75% accuracy. After 40 reversals, the target to masker ratio was calculated for each block. Additionally, there were two other outcomes of interest. First, there was an “unexpected” working memory block at the end of the CRM, where participants were asked to recall the last 5 Baron call signs. There were then two more “expected” working memory blocks where participants were asked to recall as many Barons as
Results: Our participants were familiar with Siri's voice and were able to hear Siri's voice at a target to masker level 2.53 dB better than the alternate Apple voice “Samantha”. As expected, recall in the unexpected working memory block was poor as subjects were primarily using a strategy of listening only. Performance improved for both voices in the “expected” working memory condition but target to masker ratio suffered as participants began to employ a strategy of listening to and retaining information. Finally, we found that, not only was Samantha harder to hear than Siri, when listening to Samantha, participants peak pupil dilation was greater, indicating that more effort was used to listen to this unfamiliar Apple voice.

Conclusions: Implications for people with hearing loss as well as normal hearing will be explored.

Session Title: Middle Ear Devices

COUPLING STABILITY OF CARINA MIDDLE EAR ACTUATOR AFTER 1.5T MRI

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Keywords: MRI safety, acoustic implants, magnetically induced force/torque

Purpose/Aim: Few data is available concerning the safety of active middle ear implants (AMEI) during MRI. Measurements in temporal bones are the gold standard for preclinical assessment of device safety. In this study the coupling stability of the T2 middle ear actuator as used in a fully implantable AMEI (Carina™ System, Cochlear Ltd., Sydney) was determined in temporal bones.

Materials and Methods: Eleven temporal bones were implanted with the T2 actuator according to the manufacturer's surgical guidelines. The actuator was coupled on the incus short process as recommended for sensorineural hearing loss. Temporal bones were exposed a total of 10 times to the MRI magnetic field by entering the MRI suite in a clinically relevant way. CT images were acquired before and after the experiment to investigate the risk of actuator dislocation. In addition, impedance curves were acquired using the manufacturer's fitting software to determine actuator loading to the incus short process. Relative actuator displacement was determined on the CT images by comparing the initial with the final actuator position in 3D space. The axes of the 3D coordinate system were centered at the actuator tip, with the x-axis aligned with the actuator's longitudinal axis. Impedance curves were analyzed to check the loading of the actuator to the ossicles. Actuators were considered to be unloaded if an impedance difference of more than 50 Ohm at the actuator's resonance frequency was detected after exposure.

Results: Analysis of CT images with a 0.6 mm in-plane resolution indicate no actuator displacement. The maximum detected change in impedance for all actuators was 8.43 Ohm. Impedance curves measured when the actuator was retracted from the short process after the experiment still indicate the presence of a clear resonance peak.

Conclusions: No actuator displacement or dislocation could be detected in the analysis of CT images and the measured impedance curves. Impedance curves measured when the actuator was retracted from the incus short process still show a clear resonance peak, indicating the device is still functional after entering and exiting the 1.5T static field 10 times.
DO AMBIENT PRESSURE CHANGES AFFECT MIDDLE EAR IMPLANT ACTUATOR EFFICIENCY?
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Keywords: Carina, active middle ear implant

Purpose/Aim: One of the options to treat moderate to severe sensorineural (SNHL) and mixed hearing loss (MHL) is the implantation of an active middle ear implant like the Cochlear™ Carina®. The actuator of the implant is fixed firmly to the skull and stimulates the ossicular chain through vibration. Clinicians and recipients need assurance that the coupling will be stable over time, even under slow movements of the ossicular chain caused by changes in barometric pressure. Therefore we designed a study to test whether pressure fluctuations to the middle ear expected from events of daily life could potentially move the ossicular chain enough to change coupling efficiency of the actuator.

Materials and Methods: Experiments were performed on 10 ASTM compliant human temporal bones. Two daily-life pressure events were simulated; Valsalva’s manoeuvres (500 cycles of -40 hPa - +60 hPa) and jumping into a swimming pool and diving 3 meters deep (a step change of 300 hPa). Actuator coupling efficiency was measured before and after the pressure events through Laser Doppler vibrometric measurement of stops motion for a frequency range between 100 Hz and 10 kHz. The actuator coupling efficiency was expressed as equivalent sound pressure levels at 1 Vrms actuator input. Three different coupling configurations were tested; coupling to the incus body, coupling to a small hole to the incus body made by a surgical laser (standard procedure at Hannover Medical School) and coupling to the long process of the incus via an âWengen clip.

Results: After the 500 pressure cycles as well as the larger pressure event of 300 hPa, no reduction in coupling efficiency of > 6 dB was observed in any of the TB in the frequency range 100-1000 Hz. Larger changes of 13-24 dB were seen in 2 temporal bones at frequencies >1000 Hz, which may be due to the well-known rocking vs piston motion at higher frequencies.

Conclusions: All 3 coupling configurations connected the actuator securely to the ossicular chain, under variations of barometric pressure that can be expected in daily life.

COUPLING EFFICIENCY AND OUTCOME WITH A FULLY-IMPLANTABLE HEARING SYSTEM CARINA
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Keywords: fully-implantable, audiological benefit, coupling efficiency

Purpose/Aim: The Carina® active middle ear implant (Cochlear™) is a hearing rehabilitation option for patients with a sensorineural (20 – 70 dB HL) or mixed hearing loss. The actuator of the implant can be directly coupled to the incus or attached to the round window, stapes head, stapes footplate by using different couplers or prostheses. Intended as a fully-implantable system, the external Button Audio Processor (BAP) can be used to increase stable gain and to avoid feedback noise. Our aim was to investigate the device performance and the audiological benefit for Carina implanted patients during clinical routine check-ups.

Materials and Methods: We present clinical data of ten patients implanted with a Cochlear™ Carina® system with the actuator coupled to the incus merely (N=3) and as power stapes (N=3), the stapes head (N=2), and the stapes footplate (N=2). Clinical data analyzed for this study from first activation up to one year comprised air and bone conduction thresholds, in situ thresholds via the implant, unaired and aided results of the Freiburg Monosyllable test (S0) in quiet and the Oldenburg Sentence test in noise at 65 dB SPL, (S0N0) performed monaurally and binaurally.

Results: The surgery did not cause deterioration of the residual hearing. The BAP was used immediately by three patients due to issues with feedback and higher amplification needs. The median WRS in quiet with Carina improved significantly compared to the unaired situation at 65 dB SPL (35% vs. 0%; p=0.004) and 80 dB SPL (75% vs. 5%,
Compared to the unaided situation, the median speech intelligibility in noise with the Carina was significantly better in monaural condition (unaided +19.6 dB SNR vs. aided 0 dB SNR; p=0.016) but not in binaural condition (unaided -1.5 dB SNR vs. aided -3.4 dB SNR; p>0.05). Actuator output based on clinical data was in the range of 80 and 120 eq dB SPL@1V and varied between coupling sites. Generally, coupling efficiency was high in the mid-frequencies but declined towards higher and lower frequencies.

Conclusions: The Carina system can significantly improve hearing, but there is a high variability in coupling efficiency and outcome across patients.

PRECISE ROUND WINDOW COUPLING OF VIBRANT SOUNDBRIDGE: EXPERIMENTS AND CLINICS
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Keywords: Vibrant Soundbridge, Round Window Coupling, Active Middle Ear Implant

Purpose/Aim: The Floating Mass Transducer (FMT) of the Vibrant Soundbridge (VSB) can be coupled to the ossicular chain or the round window (RW). Due to undefined boundary conditions, clinical-audiological outcomes in RW coupling vary quite extensively. To maximize sound pressure output and reduce variability the “Hannover Coupler (HC)” was designed. Here we report results of experimental investigations and audiological results of the first 8 patients implanted with a Custom Made Device (CMD) of a new (HC) coupler at the Hannover Medical School.

Materials and Methods: The FMT was coupled to the RWM using the HC coupler in N=10 human temporal bones. Coupling efficiency with the HC coupler was analyzed by measuring stapes footplate (SFP) responses to acoustic and FMT stimulation using Laser Doppler vibrometry (0.1 to 10 kHz) while contact forces were varied up to 100mN. Audiological outcomes in patients included pre- and post-operative hearing tests up to 6 months after first activation in N=8 patients. Word recognition scores (WRS) were determined using the Freiburg Monosyllables (FBM) at 65 dB SPL. Speech reception thresholds (SRT) in quiet and in 65 dB noise were measured using the Matrix Sentence test. In addition, questionnaires assessing subjective satisfaction were given pre-operatively and after 6 months.

Results: Experiments demonstrated a high dependency of SFP responses on the applied contact force. Forces > 4mN resulted in sufficient SFP displacement amplitudes, optimum results were achieved with a preload of 15mN. The CMD study revealed no change in bone conduction thresholds after the surgical invention. Even with a pre-operative WRS for monosyllables of 0%, 90% could be reached after 3 months. The SRTs in quiet were improved by > 20 dB after the initial fitting. For speech in noise SNR < 0 dB (SNR) were found in contrast to prior implantation.

Conclusions: Experiments indicate that static forces of ~ 15mN are optimal for efficient coupling. The new coupler is a reliable and safe method for round window coupling as BC thresholds of the implantees were not affected. First postoperative results demonstrate good speech perception outcomes in both, quiet and in noise.

RELIABILITY OF INTRAOPERATIVE ABR MEASUREMENTS VIA VIBRANT SOUNDBRIDGE®
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Purpose/Aim: The Vibrant-Soundbridge® (VSB) is an active middle ear implant which can be coupled to different structures in the middle ear, depending on the type of hearing loss and the specific pathology of the middle ear. Hearing improvement is highly dependent on the coupling efficiency between the floating mass transducer (FMT) of the VSB and the respective middle ear structure. The measurement of aided thresholds intraoperatively would facilitate a direct control of implant integrity and coupling efficiency and might be helpful to perform fitting in children and difficult cases in the postoperative course.

Materials and Methods: In the presented study, auditory brainstem responses (ABRs) were measured intraoperatively
using the implant itself. For this purpose, the wireless streamer MiniTek was used to transmit stimuli from the ABR system via the audio processor (Samba™) to the FMT of the implant. The ABRs were evoked by chirp-sounds optimized for the VSB implant system that account the properties of the signal chain of the VSB and the streaming device.

Results: Intraoperative ABR thresholds were determined in more than 40 patients. The comparison between the ABR thresholds, preoperative bone conduction (BC) thresholds and the postoperative Vibrogram (the recommended in-situ measurement method by manufacturer) shows significant good correlation between BC and intraoperative ABR thresholds as well postoperative Vibrogram. The mean intraoperative measurement time is relatively short with less than ten minutes.

Conclusions: The analysis of the data demonstrates that intraoperative ABR thresholds can be determined reliable via VSB. This can be used to estimate the coupling efficiency and the expected later outcome.

THE UK EXPERIENCE OF THE CARINA FULLY IMPLANTABLE HEARING DEVICE

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Purpose/Aim: The Carina is a fully implantable middle ear implant capable of amplifying up to 85dB SNHL. It can be attached to the incus or stapes and is suitable for pure SNHL or mixed hearing losses. We have found it useful to aid patients unsuitable for conventional or bone conduction hearing aids who have useful residual hearing.

Materials and Methods: 28 patients have been implanted in 5 centres in the UK, with 3 patients receiving bilateral implants. The indications were moderate to severe SNHL and unable to benefit from hearing aids (air or bone conduction) but better than the UK NICE guidelines for cochlear implantation (>80dBHL). 28/30 surgeries used the intact ossicular chain for connection. Average pre-op BC (1.2&4kHz) was 57.8dBHL.

Results: Surgery was well tolerated with the majority performed with same day discharge. Three complications occurred – (1) a seroma 5 days after surgery managed with aspiration (2) intraoperative displacement of the incus corrected during surgery (3) postoperative infection with device removal. Average follow up is 15.5 months (2 – 46 months) and there has been no device failure. 1 patient has intermittent loss of hearing related to head position and repositioning of the actuator is planned. There has been improvement in hearing threshold, and significant improvement in speech intelligibility (Pre-op best aided AB word list presented at 70dB was 68±24%; Post-op internal microphone 69±28%, post op external microphone 80.7±17%). Patients report more normal sound and all remain daily users with improvement in their Glasgow Hearing Aid Benefit score. There has been no deterioration in unaided thresholds confirming the device does not reduce natural hearing. Feedback has been an issue although this has reduced with altered surgical technique and improved feedback suppression within device software. No battery issues have occurred. Patients with severe loss often preferred to use an additional external microphone to improve clarity and reduce feedback.

Conclusions: The Carina is an effective and safe implant for patients with moderate to severe hearing loss; it offers a totally implantable system which is audiologically and cosmetically acceptable. It also allows hearing restoration in patients with hard to aid mixed hearing loss.

COCHLEAR CARINA IMPLANT: TIPS AND TRICKS

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Purpose/Aim: The Cochlear Carina Implant is the only fully implantable Middle Ear Implant that can be applied to both sensorineural and mixed hearing loss. However, its reputation is to be placed during a difficult surgical procedure. The objective of this presentation is to present the different surgical applications.

Materials and Methods: Across the experience of more than 100 implantations over 10 years, and the experimental research on coupling strategies, the author will present the different ways to place the carina implant for each of the
following indications: sensorineural hearing loss, conductive and mixed losses. The transducer can be, for instance, placed differently according to the expected desired amplification. The microphone placement will be discussed in terms of easiness and feedback control. In addition, the author will emphasise the main surgical tricks to make the implantation easier, as well as the tips to improve the audiologic outcomes. Especially, the various surgical pitfalls will be discussed (open mastoid cavity, low legmen tympani, high facial ridge, round window application...).

Results: Surgical placement of the Cochlear Carina can be made easier when following specific principles.

Conclusions: The cochlear Carina is nowadays the only fully implantable device that can be indicated for both sensorineural and mixed or conductive loss, even in difficult surgical anatomy.

DETERMINATION OF COUPLING EFFICIENCY DURING CARINA IMPLANTATION SURGERY USING ABRS

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Keywords: Middle Ear Implant, Acoustic Evoked Potential, Intraoperative Measurements

Purpose/Aim: The Carina(R) implant system from Cochlear is an active middle ear implant, which can be coupled intraoperatively to various structures in the middle ear, depending on hearing loss and middle ear physiology. The hearing improvement with implant depends on the coupling efficiency of the actuator. In particular, in patients with hearing losses close to the indication range sufficient coupling is necessary to ensure enough amplification to compensate the hearing loss effectively. So far, the coupling between the actuator and the respective middle ear structure is optimized intraoperatively indirectly by monitoring the electrical impedance of the actuator. However, it is not yet possible to make a statement on the ability of the implant to stimulate the hearing system or to verify the coupling efficiency.

Materials and Methods: Auditory evoked potentials (AEPs) are used intraoperatively to determine the coupling efficiency between actuator and the corresponding middle ear structure. The stimulation was carried out with broadband chirp stimuli, which were presented starting from suprathreshold levels to below the registration threshold.

Results: Intraoperative ABR measurements show, in meanwhile ten patients, that it is possible to derive reliable AEP thresholds via the actuator of the implant. The comparison with the results of the postoperative OC- direct measurements (Insitu audiogram via the Carina) and the preoperative bone conduction threshold confirm the intraoperative determined AEP thresholds with significantly lower variance.

Conclusions: The first results demonstrate that the direct actuator stimulation allows reliable intraoperative ABR measurements. The method can be used to estimate the coupling efficiency of the actuator and facilitates its positioning.

FIRST AUDIOLOGICAL RESULTS WITH THE FULLY-IMPLANTABLE-ACTIVE-MIDDLE-EAR IMPLANT CARINA™

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Keywords: audiological outcome, fully implantable technology Carina™ Cochlear

Purpose/Aim: The Cochlear Carina™ system is a fully implantable active middle ear implant, consisting of a subcutaneously placed microphone, implant, rechargeable battery and an electro-magnetic actuator. It is indicated in patients with middle- to severe sensorineural hearing loss or mixed hearing losses when there are contraindications for wearing conventional hearing aids e.g. chronic otitis externa, anatomical abnormalities or an active life style or working conditions are desired and are restrained by conventional hearing aids. This system is CE marked since 2013 by Cochlear and has been implanted for the first time in our clinic in summer 2017.

Materials and Methods: Between July 2017 and January 2018, ten patients were recruited following the manufacturer’s
indication range, implanted and activated 6 to 8 weeks after implantation. Audiological examination pre-operatively and outcomes at initial activation and 1, 3, 6 and 12 month intervals were assessed. Speech perception tests including the Freiburg monosyllables at 50, 65 and 80 dBSPL, and the Oldenburg Matrix Sentence Test (OLSA) was conducted at each interval.

Results: Preliminary results revealed better speech perception in quiet and noise comparing unaided and aided at initial activation and later on. Several fitting appointments are needed during the first 6 months to achieve a satisfactory speech perception level.

Conclusions: Follow-up audiological results will be presented from the 1, 3, 6, and 12 months interval and outcomes pre-operatively with the best aided condition (e.g. conventional hearing aid) compared to the Carina aided results. Pitfalls and challenges will be discussed.

CARINA MEI OUTCOMES COMPARED TO EXISTING AND PREVIOUS DEVICES
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Keywords: Carina, VSB, MET

Purpose/Aim: At Guy’s and St Thomas’ Hearing Implant Centre we have recently introduced the Cochlear Carina middle ear implant into our portfolio for both adults and eligible paediatric patients. This middle ear implant is a device that is advertised as having a wider fitting range and higher power output than the existing Medel Vibrant Soundbridge middle ear implant. The system is comprised of a totally implantable microphone, processor and rechargeable battery, and an electromagnetic actuator. This gives the advantage of providing an option to utilise an internal microphone giving patients the ability to obtain benefit without any external components. We will discuss our audiological outcomes both with and without the internal microphone system and in comparison to both the Vibrant Soundbridge and the MET implant from which the Carina has been developed.

Materials and Methods: The assessment process consists of a full audiological work up, functional testing and radiological assessment. Paediatric and adult questionnaires were also used. At the end of the assessment, the Multidisciplinary team (MDT) makes the device recommendation, the team’s device selection and decision making process which will include audiological data, radiological data and patient preference will be discussed. Post-implantation, unaided and aided levels were recorded periodically along with repeat functional testing and repeat post-op questionnaires to monitor progress.

Results: Analysis between devices will be discussed with aided levels, speech in quiet and in spatially separated noise, subjective loudness growth and questionnaire outcomes for all of our initial Carina patients in comparison to audiometrically matched Vibrant Soundbridge and MET patients. We will also discuss our patients’ experiences with the Carina device thus far with particular regard to use of the internal microphone and associated factors (e.g. feedback, internal noise, settling/movement of transducer).

Conclusions: As described the Carina appears to provide an attractive option to bridge the hearing implant gap between the audimetric fitting range of the Vibrant Soundbridge and criteria for cochlear implantation. It also offers the potential for patients with milder losses to receive hearing rehabilitation with no external component. We discuss our initial experiences with this device and compare our initial outcomes to existing and previous devices.

VIBRANT SOUNDBRIDGE OUTCOME; KAESC EXPERIENCE
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Keywords: Vibrant Sound Bridge
Purpose/Aim: To evaluate the clinical and audiological outcome of vibrant soundbridge (VSB).

Materials and Methods: it is a review of patients underwent VSB surgery from January to February 2019. We reviewed all the clinical data of patients with post operative surgical result and audiological outcome include aided, unaided pure tone audiometry and aided, unaided speech reception threshold (SRT) as well as speech discrimination score (SDS).

Results: Total of 10 patients (11 ears) were enrolled in this study. All patients had unilateral implant except one patient with bilateral. Five patients with conductive hearing loss. 3 patients with sensorineural hearing loss and 2 patients with mixed hearing loss. 9 of them are male and one female. Postoperative bone conduction threshold showed stable results in comparing with preoperative one. The mean preoperative air conduction hearing test was 71.6 decibel (db) while mean post-operative aided hearing test was 28.3 db. The mean SRT was 65db unaided, which reached 28db aided using VSB. The mean SDS improved from 35% to 92% unaided and aided at 65 db respectively.

Conclusions: We conclude that VSB is a good and reliable solution for those who are not happy with their hearing aids.

OBJECTIVE MONITORING OF ACTIVE MIDDLE EAR IMPLANT COUPLING EFFICIENCY
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Keywords: middle ear implant, FMT, coupling efficiency

Purpose/Aim: The coupling efficiency of the semi-implantable active middle ear implant Vibrant Soundbridge (VSB) (MED-EL, Innsbruck, Austria) with its electromagnetically driven floating mass transducer (FMT) can only be quantified postoperatively in cooperative patients by measuring behavioral vibroplasty in situ thresholds in comparison to bone conduction (BC) thresholds. However, poor coupling efficiency, reflected by differences of 20 dB or more between these thresholds, has been shown to have a negative influence on word recognition scores. In order to avoid revision surgeries and suboptimal audiological outcome, there is a need for a feasible and objective intraoperative method for assessing the absolute coupling efficiency.

Materials and Methods: In an ongoing multicenter study in Germany, auditory brainstem responses (ABRs) are recorded intraoperatively and postoperatively to objectively assess the FMT coupling efficiency. Stimulation via the implant is provided by a modified AP404 audio processor (MED-EL, Innsbruck, Austria). Broadband CE-Chirps are delivered to the audio processor by an insert earphone sound tube connected to a sound tube adapter glued to the processor's microphone aperture. The frequency specific amplification of the audio processor is programmed according to the preoperative BC thresholds of the patient. The intraoperative ABR thresholds are compared to the postoperative coupling efficiency, i.e., the difference between the vibroplasty in situ and the BC thresholds.

Results: The first results show a good correlation between the intraoperative response thresholds and the postoperative coupling efficiency, i.e., the vibroplasty in situ - BC -difference.

Conclusions: The applied method is a promising new tool for the intraoperative assessment of the absolute and quantitative coupling efficiency of the FMT. This may provide an important feedback for the surgeon helping in finding the optimal position of the FMT or the FMT-coupler assembly intraoperatively, thereby ensuring an optimal surgical basis for good postoperative audiological results.

THE ESTEEM® TOTALLY IMPLANTABLE ACTIVE MIDDLE EAR IMPLANT: A LARGE, SINGLE-SURGEON COHORT
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Huntsville, AL, United States

Purpose/Aim: To evaluate hearing outcomes and device safety in a large, single-surgeon experience with the Esteem® totally implantable active middle ear implant (AMEI).
Materials and Methods: Retrospective case series review of 116 patients with moderate to severe sensorineural hearing loss (SNHL) undergoing implantation of the Esteem® AMEI. Pure tone average (PTA) as well as word recognition scores (WRS) at 50dB HL (WRS50) and at phonetically balanced maximum volume (PB-max WRS) were obtained in the implanted ear. Adverse surgical events were also reviewed.

Results: Mean baseline unaided PTA improved from 57.6dB before surgery to 34.1dB postoperatively, signifying a mean gain in PTA of 23.5dB (p=0.0002). PB-max WRS improved slightly from 70.5% to 75.8% (p=0.416), and WRS50 values increased substantially from 14.4% to 70.4% (p<0.0001). Revision surgery was required in 16/116 cases (13.8%) and explantation was performed in 6/116 cases (4.9%). Both revision and explant rates dropped with increasing surgeon experience over time. Severe complications such as cerebrospinal fluid leak, intracranial hemorrhage, meningitis, facial nerve injury, and death were not seen in this series.

Conclusions: This study showed excellent postoperative hearing results with the Esteem® AMEI with regard to PTA and WRS50. Complication rates in this case series were significantly lower with increasing experience of the surgeon and were generally lower overall than other published AMEI reports. The Esteem® device should be considered in appropriate patients with moderate to severe SNHL who have struggled with conventional amplification and are good surgical candidates.

Session Title: Measuring Outcomes

INVESTIGATION OF NOVEL PRIMARY STABILITY TOOLS IN HUMAN CADAVERIC BONES
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Keywords: cadavers, skull, RFA

Purpose/Aim: Bone anchored hearing implants loss due to impeded stability occur more frequently in children, sometimes without apparent causes, and could extrude at any time after placement. The success of bone anchored hearing implants greatly relies on primarily stability achieved from the initial installation of the implant screw. Histomorphometric evaluation and mechanical testing provide valuable information about this implant anchorage. However, these tools cannot be applied in the surgical or clinical setting. Recently, Resonance Frequency Analysis (RFA) and Advanced System for Implant Stability Testing (ASIST) have been proposed as objective and non-invasive ways to measure implant stability.

Materials and Methods: The relationship between primary stability assessed by the RFA and ASIST was correlated with conventional methods study bone-implant interface such as bone-implant contact assessed by Micro-CT, insertion torque value, mechanical pull out testing. The influence of implant design and patient related factors such as skull bone microarchitecture and quality were investigated.

Results: There is minimal effect of changes of implant characteristic such as abutment length on the ASIST coefficient value; however RFA is greatly influenced by abutment length. Compromised bone deleteriously affected the primary stability as assessed by the novel tools and conventional testing methods. Positive correlations between RFA and ASIST measurements and BIC and bio-mechanical testing outcomes were found.

Conclusions: This research presents a laboratory evaluation of the RFA and ASIST to determine the stability of Oticon Medical Ponto bone anchored hearing aid system. The ASIST method is able to isolate the interface properties from the overall system and the measurement is independent of attached components if threshold shifts are used. Absolute RFA values should not be interpreted individually and threshold shifts from baseline should be derived in individual patient in a population over time. After abutment replacement, RFA trends from baseline cannot be interpreted if the abutments differ in length.
WORD RECOGNITION AND WORD RECALL WITH SOFTBAND BONE CONDUCTION DEVICES

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Purpose/Aim: The objective of this study was to determine if directional microphones can improve cognitive performance in typically hearing adults with an induced conductive hearing loss and soft band bone conduction devices. We evaluated differences in (1) speech recognition and (2) word recall between bilateral directional and omnidirectional microphone settings.

Materials and Methods: A conductive hearing loss was artificially induced while participants (n = 35) wore bilateral bone conduction devices on soft bands. Speech recognition and working memory, as measured by a word recall task, were evaluated in two conditions: bilateral omnidirectional and bilateral directional. Seven blocks of seven sentences from the Hearing in Noise Test (HINT) were presented with multitalker babble background noise spatial separated from the signal by 180 degrees (signal-to-noise ratio +2 dB). Participants repeated each entire sentence aloud. At the end of each block (7 sentences), participants wrote down as many of the last words of the sentences as they could recall. A subset of participants (n = 20) achieving at least 80% recognition in both conditions was also analyzed to represent an ecologically valid environment and to ensure the working memory task could be completed appropriately (i.e. participants can only recall what they first recognize). Differences between microphone settings (omnidirectional and directional) were evaluated with paired t-tests (p < 0.05).

Results: Directional microphones provided a significant improvement over omnidirectional microphones for both speech recognition and word recall. The results were consistent for both the full set of participants and the subset of participants with at least 80% recognition.

Conclusions: This study demonstrated that bone conduction hearing aid features such as directional microphones can improve both speech recognition and working memory through a word recall task. It was shown that even in situations where participants can understand the majority of speech, the use of directional microphones may still offer benefits to cognitive performance.

LISTENING EFFORT AT DIFFERENT SIGNAL-TO-NOISE RATIOS FOR BONE-ANCHORED USERS

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Keywords: noise reduction, listening effort, pupillometry

Purpose/Aim: The objective of this study is to evaluate listening effort using object measures of pupillometry over a wide range of signal-to-noise ratios for bone-anchored users.

Materials and Methods: This is a prospective study, where listeners serve as their own control. Listeners with a conductive or mixed hearing loss and with bone-conduction pure tone thresholds lower than 40 dB HL are included in the study. After fitting the patients with Ponto 4, listening effort is estimated through objective physiological testing by measuring pupil dilation with an eye-tracking camera during a speech-in-noise task with target speech presented from the front and 4-talker babble noise presented at the side and back of the participant. Pupil dilation is recorded at fixed signal-to-noise ratios ranging from -8 dB to + 8 dB (in 4-dB steps), for two different device settings. In one setting, the spatially-informed noise-reduction scheme of Ponto 4 is activated, while in the other setting the noise-reduction scheme is deactivated. Self-reported performance with Ponto 4 is also evaluated via a questionnaire.

Results: The outcomes of the study will be presented at the conference.

Conclusions: This is the first study to objectively evaluate listening effort via pupil responses over a wide range of signal-to-noise ratios for bone-anchored hearing systems users. The conclusions of the study will be presented at the conference.
HEAD SIMULATOR, DEVELOPMENT OF A NOVEL BONE CONDUCTION MEASUREMENT INTERFACE

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Keywords: Measurement, evaluation, verification

Purpose/Aim: Recent development in the field of bone conduction is trending towards transcutaneous (active and passive) devices. These devices have new and varying interfaces for connecting to the skull bone which are not compatible with a Skull simulator (e.g. TU-1000). Therefore it is not possible to objectively measure, compare and listen to the system performance. Cadaver measurements are sometimes used to evaluate performance, however drawbacks can include practical handling, difficult acoustic environment and spread of individual cadaver heads etc.

Therefore a “Head Simulator” measurement interface was developed with the aim to physically replicate the human head. The purpose was to be able to objectively measure system performance (output force, acoustic feedback etc.) and listen to the complete system of any bone conduction device in a repeatable and accurate manner in the right acoustic environment.

Materials and Methods: The Head Simulator was developed by building an artificial head and testing different materials to find the right properties for bone, skin, soft tissue, brain and hair. Verification was done by measuring the mechanical impedance, transcranial attenuation, skin attenuation, acoustic feedback performance and comparing the data with real human reference data.

Results: The result is a physical artificial head with similar properties as a human head with multiple measuring vibration sensors build in. When comparing the Head Simulator properties with average clinical human data they show similar results within +/-5 dB from 100 to 10 000 Hz in terms of e.g. mechanical impedance and acoustic feedback response.

Conclusions: The performance of a sound processor measured with the uniquely designed Head Simulator is closer to what a real patient would actually receive (up to 20 dB compared to a Skull simulator) and is therefore a more reliable source of predicting actual clinical performance. The Head Simulator can be used to measure and compare performance of various bone conduction sound processors. One also can use it to simultaneously listen to and compare the sound quality of any fitted bone conduction system.

LOADING TIME SOUND PROCESSOR AFTER BAHI; THE PREFERENCES OF PATIENTS

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Keywords: patients perspective, loading time, BCD

Purpose/Aim: Loading times after Bone-Anchored Hearing Implant (BAHI) surgery have gradually decreased over the past decade. Recently, loading times within one week or even the same day as surgery have been proposed. This study aims to assess the patient’s perspective of optimal loading time after bone-anchored hearing implantation.

Materials and Methods: A prospective, randomized, comparative, patient questionnaire study was performed in a tertiary referral center. All included patients received two questionnaires before surgery: The validated Glasgow Health Status Inventory (GHSI) and a ‘preference’ questionnaire in which the patient was asked to choose their preferred time point for sound processor loading and the rationale behind it. Postoperatively, the preference questionnaire was provided at three time points after surgery: directly postoperative, seven days and three weeks. Independent on preference, all patients in the study were loaded three weeks after surgery, which is our standard practice. Primary outcome was preferred time point of loading before surgery. Secondary outcome was change in preferred time point after surgery.

Results: Sixty patients were included. Preoperatively, the majority of patients (70%) preferred sound processor loading within one week after surgery, whereby 43% preferred loading directly postoperatively. Reasons to choose loading at the same day as surgery were quick hearing rehabilitation and practical considerations. These preferences did not correlate
with the total GHSI-score nor duration of hearing loss. Directly after surgery, no change in preference was observed. However, at seven days and at three weeks after surgery, significantly more patients preferred loading at a later time point. At 1 week, 50% of the patients preferred loading within 1 week and at 3 weeks only 40% of the patients.

Conclusions: Pre-operatively, a majority of patients would prefer receiving the sound processor within the week after surgery. The number of patients preferring loading within one week declined after surgery. However, postoperatively, still approximately 50% preferred earlier loading than the current standard of three weeks.

OUTCOME MEASURES FOR CONDUCTIVE AND MIXED HEARING LOSS TREATMENT

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Keywords: Outcome, Treatment, Patient

Purpose/Aim: The number of potential options for rehabilitation of patients with conductive or mixed hearing loss is continually expanding. To be able to inform patients and other stakeholders there is a need to identify and develop patient?centred outcomes for treatment of hearing loss.

Materials and Methods: A systematic review of the medical literature was performed, reviewing treatment outcomes for adult subjects for conductive and mixed hearing loss. The outcome measures were grouped into the identified core areas and then grouped into domains using methodology published previously (Tysome et al 2015)

Results: The literature search resulted in the identification of 1,434 studies. These papers were reviewed and outcome measures in each of the 4 core areas were identified. Once done these outcomes were grouped into domains and each core area evaluated separately. In the physical core area 39 domains were identified related to treatment success or to complications. In the hearing core area 829 hearing outcomes were reported which were grouped into 9 domains. The economic core area identified 3 domains.

Conclusions: There is a vast number of different outcome measures that have been used to evaluate the treatment of conductive and mixed hearing loss.

AURONET is an international group dedicated to improving the outcomes of patients with hearing loss through the development of a core set of patient-centred outcome measures that can be used in individual practices and serve as a standard of reporting in clinical trials. Having established four core areas of Hearing, Economic, Physical and Psychosocial, in this talk we will present data from our recently completed systematic reviews in each domain and critically evaluate the current situation in each. We will then describe the next steps in this exciting project.

BONE-CONDUCTION SOUND TRANSMISSION COMPARISON BETWEEN SOFTBAND AND AN ADHESIVE PLASTER

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Keywords: softband, adhesive plaster, skin drive
**Purpose/Aim:** The objective of this study is to compare the sound transmission of a bone anchored sound processor placed on an adhesive plaster as compared to when used on a softband.

**Materials and Methods:** This is a prospective measurement, where participants serve as their own control. Six normal hearing listeners participated. First, their bone-conduction (BC) thresholds were measured via BC-71 audiometry to serve as a control measure for the other BC thresholds measurements. BC thresholds were hereafter measured in-situ via a Ponto placed on either a softband or a prototype adhesive plaster attached behind the ear. The participants wore a Ponto sound processor on the adhesive plaster for a trial period of four days. The BC thresholds were measured every day during the trial period with the adhesive plaster skin drive solution.

**Results:** The BC thresholds measured via a sound processor mounted on a softband showed that sounds are attenuated primarily in the high frequencies above 2 kHz. The BC thresholds measured via the adhesive plaster were significant lower than the thresholds on a softband in the frequency range up to 2 kHz. In particular, thresholds were 20 dB lower with the adhesive plaster than with the softband in the low frequency range up to 1 kHz. The thresholds measured via the adhesive plaster did not vary over time.

**Conclusions:** The outcomes of this investigation show that BC sound transmission via an adhesive plaster is additionally attenuated as compared to sound transmitted via a softband in the frequency range up to 2 kHz due to the lack of pressure towards the skull. The adhesive plaster from Oticon Medical has never been released for sale.

**COMPARISON OF REMOTE MICROPHONE TECHNOLOGY IN BCD**

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**Purpose/Aim:** Determine whether a wireless audio-streaming accessory (Cochlear™ Corporation, Mini Microphone 2+) results in improved listening in noise compared to a digital adaptive remote microphone (Sonova, Roger™) in adults with simulated hearing loss using a bone conduction hearing device.

**Materials and Methods:** Bilateral conductive hearing loss was simulated in normal hearing adults (> 18 years old) using bilateral ear plugs. Speech perception in noise using the Cochlear Corp bone conduction hearing device (BCD) evaluated in nine conditions including BCD processor alone, BCD + wireless audio streaming, and BCD + wireless audio-streaming + digital adaptive remote technology. Speech was presented from the front at 0 degrees azimuth at –10dB SNR in diffuse noise. The remote microphone was positioned six inches away from the center of the cone of the loudspeaker presenting the sentences at 0 degrees azimuth (American Academy of Audiology Remote Microphone Guidelines, 2008) and then the remote microphone was spatially separated from the noise.

**Results & Conclusion:** Speech perception improved significantly for BCD + wireless audio-streaming both within the noise field and when spatially separated. Direct connect via wireless audio-streaming was superior to performance using the digital adaptive remote microphone accessory in all conditions. The use and benefit of different types of remote microphone technology in individuals with hearing aids and cochlear implants has been well studied. At present there are no studies comparing different types of remote microphone technology in BCD users despite the fact that these individuals experience significant difficulties in unfavorable listening environments that can impact their quality of life. Preliminary data suggests that when the digital adaptive technology is coupled to the wireless accessory to the BCD processor, signal transparency is negatively affected.

**INITIAL OUTCOMES WITH MED-EL ADHEAR IN PEDIATRIC PATIENTS**

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**Keywords:** pediatrics, ADHEAR

**Purpose/Aim:** Cincinnati Children’s Hospital Medical Center (CCHMC) has an established team of audiologists who specialize in the assessment and management of bone conduction devices (BCD) in pediatric patients for the treatment of conductive hearing loss, mixed hearing loss and single sided deafness (SSD). The introduction of the MED-EL ADHEAR has resulted in a rapid increase in interest from patients and parents as well as an increase in referrals from ENT
physicians for this non-surgical alternative. Many of these are patients with unilateral hearing loss who have been previously unsuccessful or inconsistent with hearing device use, are uninterested in surgical options, and have chosen not to pursue amplification.

**Materials and Methods:** The current assessment and management practices at CCHMC for this population will be reviewed. Evaluation, fitting and counseling considerations specific to the ADHEAR device will be discussed.

**Results:** Initial impressions and patient outcomes with the Med El ADHEAR device will be presented. Patient trends and supportive cases will be shared along with audiologist perspectives and experiences, including advantages and limitations of the technology.

**Conclusions:** The Med El ADHEAR is a viable option for select patient populations and fills a void in the treatment possibilities for some etiologies. This presentation will summarize the initial impressions and outcomes with the ADHEAR device at CCHMC and generate a discussion around the use of this technology in the pediatric population.

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**PERFORMANCE OF TWO DIFFERENT NON-IMPLANTED BONE CONDUCTION HEARING SYSTEM**

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**Keywords:** Adhere, Baha 5, Softband

**Purpose/Aim:** To compare the performance of two non-implanted bone conduction hearing systems, namely the adhesively attached Adhear device (Medel, Inc.), and the Baha 5 (Cochlear Inc.) worn on a softband in subjects with a simulated bilateral and purely conductive hearing loss.

**Materials and Methods:** Tests were performed with 15 normal hearing subjects. Their ears were occluded using a new occlusion method, simulating a bilateral conductive hearing loss of 49 dB (average in the frequency range 500 to 4000 Hz). Sound field thresholds, speech reception thresholds in quiet and in noise, and sound localization were measured in unaided conditions and with both devices used unilaterally and bilaterally.

**Results:** All test results were significantly better in any of the aided conditions than in the unaided condition. Sound field thresholds improved by 22.1 to 23.4 dB (p <.001), speech reception thresholds in quiet by 21.5 to 22.7 dB (p <.001) and speech understanding in noise by 3.6 to 4.8 dB (p <.001). When the bone conduction systems were used bilaterally rather than unilaterally, sound localization was improved by +28° to 34° and speech understanding in noise coming from the side of the first device was improved by +3.9 to 4.4 dB. The differences between Adhear and Baha on softbands were not statistically significant in any of the tests.

**Conclusions:** Adhear and Baha 5 on softbands show significant improvements in speech understanding in quiet and in noise in subjects with normal inner ear function. No significant difference was found between the two systems in any of the measurements. The bilateral use of either device improved (but did not normalize) sound localization and speech understanding in noise in certain situations.

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**THE BONE CONDUCTION IMPLANT – REVIEW AND ONE YEAR FOLLOW UP**

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**Keywords:** transcutaneous active, bone conduction, implants

**Purpose/Aim:** The Bone Conduction Implant (BCI) system uses an implanted transducer that allows the skin to be intact. A review of similar bone conduction devices will be given along with the one-year endpoint results of the clinical study.
Evaluating the safety and effectiveness of the BCI.

Materials and Methods: The present study is a consecutive prospective case series where sixteen patients (9 female and 7 male) with average age 40 years (range 18-74) have been included after fulfilling the inclusion criteria. Thirteen patients were operated in Gothenburg and three in Stockholm. The patients were fitted with the externally worn audio processor 4-6 weeks after surgery, and follow-up visits were conducted 1, 3, 6 and 12 months after fitting. Main outcome measures were intraoperative and postoperative safety in terms of complications and adverse events, as well as outcome measures related to the effectiveness of the device in terms of objective measured transmission condition, audiological performance, and patient experience.

Results: It was found that the procedure for installing the BCI is safe and the transmission condition was stable over the follow-up time. During the 1-year follow-up no serious adverse events or severe adverse device effects occurred. The BCI significantly improves hearing sensitivity, speech in noise at conversational levels, and self-assessment in comparison with the unaided condition. Also, the patients had similar or better results with the BCI compared to a conventional bone conduction reference device on a softband.

Conclusions: In summary, it was found that the BCI can provide a safe and effective hearing rehabilitation for patients with mild-to-moderate conductive or mixed hearing impairments.

The Bone Conduction Implant

AN EVALUATION OF THE BENEFITS OF NEW BILATERAL BAHA SOFTWARE
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Keywords: Bilateral, binaural, software

Purpose/Aim: Users of all types of hearing aids typically struggle to hear well in noisy situations. This is in part due to an inability to discriminate between sounds as effectively as those with normal hearing levels. Hearing aid manufacturers employ a range of strategies and accessories to improve the signal to noise ratio in order to provide a better wearing experience. Until recently, fifth generation Cochlear BAHAs had the ability to wirelessly link the controls and output of bilateral hearing aids. The latest generation of programming software incorporates the ability to allow the adaptive directionality of the processor microphones to adjust independently to surrounding noise levels.

Materials and Methods: Twenty Bilateral BAHA5 users were randomly selected from the Freeman Hospital database and invited to a review appointment in order to reprogram their bone anchored hearing aids using newly released Cochlear software.
The updated software specifically addresses the way in which the directionality of the microphones of a bilateral pair of bone anchored hearing aids react in noisy environments with the aim of improving the audibility of speech in a range of situations.

Subjects attended the Freeman Hospital Audiology Department for a short appointment during which they completed the SSQ12 questionnaire to assess their current level of functionality with their bilateral bone anchored hearing aids, as programmed by using the previous generation of Cochlear software. Their processors were then reprogrammed to incorporate the updated features of the new software.

At a second visit, four weeks later, the changes were evaluated by repeating the SSQ12 for comparison. Subjects were given the opportunity to share their impressions of the changed settings.

**Results:** By comparing the scores from the first and second SSQ12 questionnaires, it can be shown whether the differences in programming have benefitted the trial subjects in daily use.

**Conclusions:** The NHS is under pressure to make best use of available resources. The findings of this trial will enable the BAHA team at Freeman to make decisions on whether the benefits of the updated BAHA settings warrant the extra appointments involved in adjusting the settings of the remaining ?? bilateral BAHA users on the database.

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**Session Title: Medical Considerations**

**RANDOMISED CONTROLLED TRIAL MIPS VERSUS LINEAR INCISION: 22 MONTHS RESULTS**

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1 University Medical Center Utrecht 2 Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden 3 Oticon Medical Ab, Askim, Sweden 4 Medisch Centrum Leeuwarden, Leeuwarden 5 Ziekenhuisgroep Twente 6 Isala, Zwolle 7 Maastricht University Medical Center, Maastricht, 8 Maastricht University 1 Department of Otorhinolaryngology, Head and Neck Surgery 2 Department of Biomaterials, Institute of Clinical Sciences, 8 Department of Methodology and Statistics, School for Public Health and Primary Care (Caphri) Utrecht, Netherlands

**Keywords:** BAHS, bone-anchored hearing, MIPS

**Purpose/Aim:** This study aims to compare the clinical outcomes of the Minimally Invasive Ponto Surgery (MIPS) technique to those of the linear incision technique with soft-tissue preservation for bone-anchored hearing systems (BAHS).

**Materials and Methods:** This is a sponsor initiated, multi-centre, randomised, controlled trial (NL50072.068.14) performed in the Netherlands Adult patients scheduled for unilateral BAHS surgery were included. All participants received a 4-mm Ponto Wide implant with pre-mounted abutment (Oticon Medical AB, Askim, Sweden) placed using single stage surgery using either the MIPS or the linear incision with soft tissue preservation surgical techniques. Data was obtained during baseline, surgery, 9 days, twelve weeks, twelve months and twenty-two months follow-up. Outcomes include Holgers Index scorings, incidence of skin inflammation (Holgers Index ? 2), rate of skin dehiscence, pain scores (directly around the abutment, radiating pain, headache), loss of skin sensibility, soft-tissue overgrowth, skin sagging, implant extrusion, cosmetic outcomes (researcher and patients scorings), Implant Stability Quotient (ISQ) measurements, Quality of Life questionnaires (Health Utilities Index Mark 3, Abbreviated Profile of Hearing Aid Benefit and ICEpop CAPability measure for Adults) and (serious adverse) events.

**Results:** Sixty-four patients were randomised 1:1 to the MIPS-group (test) or linear incision technique with soft tissue preservation group (control). Twelve weeks results were published in 2018 (Calon, Johansson et. al., Otol Neurotol. 2018 39(7)). No significant differences were observed between incidence of skin inflammation at twelve weeks follow-up. The long-term twenty-two months results will be analysed according to a Per-Protocol analysis and Intention-to-treat analysis. These results are expected to become available in the second quarter of 2019. Here, we will present the long-term results of this large randomized controlled trial with twenty-two months follow-up.

**Conclusions:** The long-term clinical outcomes of this multi-centre randomised controlled trial comparing the MIPS technique with the linear incision technique with soft tissue preservation for BAHS will be presented for the first time.
SSD/ASYMMETRIC HEARING LOSS MANAGEMENT: A TERTIARY HOSPITAL AUDIT

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The Royal National Throat, Nose & Ear Hospital, University College London Hospitals Nhs Foundation Trust
Auditory Implants
London, United Kingdom

Keywords: SSD, Bone Conduction Devices, CROS Aids

Purpose/Aim: This presentation will review the management and treatment decisions of all SSD/Asymmetrical hearing loss patients who were referred to the RNTNE Hospital for assessment of a Bone Conduction device. Treatment of this condition is constrained by the National Institute of Clinical Excellence guidelines, and we examine the clinical impact these guidelines have on our service delivery. The outcome of this patient audit is to help counsel patients appropriately regarding likely outcomes.

Materials and Methods: A retrospective audit was carried out from 2016 - 2018 of all patients referred to the Auditory Implant Centre at RNTNE with SSD or Asymmetric HL where a bone conduction device could possibly be used as a CROS device.

Results: The proportion of patients who proceed to implantation, choose to use a CROS aid or decline any intervention will be discussed. Examination of aetiology and duration of deafness will be explored to see if themes emerge.

Conclusions: This audit will help inform patients about likely outcomes from their assessment and trial once they are referred to us. It will also help us look at the cost implications of the NICE guidance, and the demand for clinical services during the assessment period compared with the mixed/conductive hearing loss group.

PERI-ABUTMENT GENE EXPRESSION OF THE BONE-ANCHORED HEARING SYSTEM

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Keywords: tissue response, bone-anchored hearing, gene-expression

Purpose/Aim: The purpose of this study was to examine the gene expression of cells in different compartments around the bone-anchored hearing system (BAHS) with either electropolished or machined abutment. Further, the study aimed to correlate the molecular profile with clinical and bacterial findings.

Materials and Methods: The patients received Ponto Wide implant, pre-mounted with either machined or electropolished abutments and installed using a minimally invasive approach (Oticon Medical AB, Askim, Sweden). The gene expression levels of ten different cytokines and biological mediators, related to inflammation, infection, tissue metabolism, wound healing and angiogenesis, were determined at two different compartments: the soft tissue and the peri-abutment fluid space. The soft tissue close to the abutment was retrieved using a biopsy punch (baseline, 3 and 12 months), whereas cells in the peri-abutment fluid space was obtained using paper-points (3 and 12 months). The cellular RNA of the different compartments was extracted and analysed using quantitative polymerase chain reaction (qPCR). The clinical and microbiological data have been reported previously (Trobos M., Johansson M.L., et al. (2018) Eur Arch
Otorhinolaryngol. 275, 1395-1408).

Results: Twelve patients received either a machined (n=7) or an electropolished (n=5) abutment. Two implants in the electropolished group were lost during the follow-up period between 3 and 12 months. The mRNA expression of IL-8, IL-1?, IL-10, FOXO1, VEGF, COL1A1, TIMP-1, MMP-9, TLR-2 and TLR-4 in the different compartments, at different time-points and for the two abutment types will be presented. Correlations between the gene expression and the clinical parameters as well as the microbiological findings will be discussed.

Conclusions: The gene expression in the soft tissue and peri-abutment fluid following implantation of BAHS with abutments of different topology will be presented.

\[ \text{THE MECHANICAL IMPEDANCE OF DIRECT DRIVE BONE CONDUCTION IMPLANTS} \]

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Keywords: mechanical impedance, bone conduction, implants

Purpose/Aim: The mechanical impedance at the attachment point of direct drive bone conduction implants is of great importance for the design and function of such devices. Knowledge of this impedance is also crucial in the design of Skullsimulators which are used to objectively verify the performance such devices in manufacturing, service and fitting procedures.

Materials and Methods: The present study is a consecutive prospective case series where 47 patients (26 female and 21 male) using percutaneous bone conduction devices (Ponto system or Baha system) with average age 53 years (range 11-71 year). Seven patients had been treated in Gothenburg, Sweden and 40 patients in Edmonton, Canada. A conventional impedance head (B&K 8001) was used where the mass above the force gauge was canceled but the snap coupling of the Ponto and Baha systems were included. A swept sine from 100 to 10k Hz was used to drive a balanced transducer that had an emphasized low frequency response.

Results: It was found that the skull impedance had an anti-resonance at around 150 Hz (median peak of 4900 mechanical ohms) below which it is mass controlled corresponding to an apparent mass of 4.2 kg at 100 Hz. Above the anti-resonance the impedance is stiffness controlled by a compliance of roughly 500n m/N at 1 kHz. At the frequencies above 5 kHz the impedance becomes mass controlled again which corresponds to the mass of the snap coupling. The results were slightly affected by age and number of major ear surgeries, but no significant difference was found related to gender or skull abnormalities. The compliance of the two different snap couplings were measured and found to be much stiffer than the patients skull impedances and thus assumed to have no clinical importance. In a preliminary investigation of the mechanical impedance of some attachments for active transcortaneous implants, made in a cadaver study, no big differences were seen relative to the present results.

Conclusions: The mechanical impedance of percutaneous implants measured in this study was found to confirm previous limited studies and can be used for the design and evaluation of direct drive bone conduction implants.
PILOT STUDY - MASTOIDECTOMY IMPACT ON BONE CONDUCTED COCHLEAR STIMULATION

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Keywords: Bone Conduction, Sound Transmission, Mastoidectomy

Purpose/Aim: For bone conduction devices sound transmission improves to the ipsilateral cochlea if the transducer is positioned closer to the cochlea compared to the BAHA position 55 mm behind the ear canal opening. This can be important for transcutaneous bone conduction devices where the loss of energy due to signal transmission over the skin, can be gained back if the transducer is positioned close to the ear canal. In the case of a mastoidectomy or a radical cavity the transducer must be positioned in a more posterior position, which can influence the stimulation of the cochlea. The aim of the study was to evaluate if a mastoidectomy has an impact on the ipsilateral bone conducted sound transmission to the cochlea.

Materials and Methods: In five cadaver heads, the vibration velocity of the cochlear promontory was measured using a laser Doppler vibrometer. Bone conduction vibration stimulation was applied at a titanium fixture 55 mm behind the ear canal opening for three situations; intact mastoid, after a mastoidectomy and after a radical cavity.
Results: After both a mastoidectomy and a radical cavity there was a tendency of increased sound transmission of up to 9 dB to the ipsilateral cochlear promontory compared to an intact mastoid bone, especially in the high frequency range. No difference was detected in the contralateral measurement or between a mastoidectomy and a radical cavity in the ipsilateral measurements.

Conclusions: Compared to an intact mastoid, a mastoidectomy does not seem to have a negative influence on bone conducted sound transmission to the ipsilateral cochlear.

MICROBIOME ON THE BONE-ANCHORED HEARING SYSTEM: A PROSPECTIVE STUDY

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Keywords: BAHS, bone-anchored hearing, microbiology

Purpose/Aim: The overall purpose of this study was to gain insight into the microbiome associated with the bone-anchored hearing system (BAHS). The study aims to (i) evaluate changes in bacterial colonisation of the skin adjacent to the abutment after BAHS surgery and (ii) to identify the microbiome associated with adverse skin reactions.

Materials and Methods: This study is part of a randomised, controlled, clinical trial (NL50072.068.14). All subjects received a Ponto system (Oticon Medical AB, Askim Sweden). Data were collected at baseline, surgery, 9-days, 12-weeks and 12-months follow-up, and during cases of adverse skin reactions. Bacterial swabs were obtained at the implant site and contralateral site prior to surgery. At 12-weeks follow-up and during cases of adverse skin reactions (Holgers index score ≥ 2) swabs were obtained around the abutment and at surrounding skin. The microbiota was analysed using a validated profiling technique, which provides information at the phylum and species levels (IS-PRO™, IS-Diagnostics, Amsterdam, The Netherlands). Statistics were employed for the total bacterial counts, the Shannon Diversity Index (SDI) and sample similarity. To identify the microbiota associated with adverse skin reactions, Partial Least Squares Discriminant Analysis (PLS-DA) was employed.

Results: Streptococcus pneumoniae/mitis was significantly more detected in patients after implantation compared with baseline. In contrast, Propionibacterium acnes was significantly less detected after implantation. In the case of inflammation, Staphylococcus epidermidis and Staphylococcus aureus were the most commonly found bacteria, comprising 17% and 19% of total bacterial load respectively. The SDI was significantly higher after implantation for the phyla Firmicutes, Actinobacteria, Fusobacteria and Verrucomicrobia, but not for other phyla or for all bacteria combined. The SDI index was similar for patients with and without adverse skin reactions. Patients who developed adverse soft tissue reactions after implantation could be identified at baseline using PLS-DA with an accuracy of 91.7%. In addition, PLS-DA could classify post-surgical skin swabs associated with adverse skin reactions with an accuracy of 97.7%.

Conclusions: This study provides evidence for a microbiota associated with BAHS. Staphylococcus aureus and Staphylococcus epidermidis should be considered as relevant bacterial species associated to BAHS. The results indicate that patients susceptible to adverse skin reactions may be identified already before implantation.
LASER EPIILATION AS TREATMENT FOR RECURRENT INFECTIONS AROUND BCI ABUTMENT

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Keywords: laser epilation, BCD, Holgers

Purpose/Aim: To describe the laser epilation of hair around a BCHI abutment using the long-pulsed, 800-nm Light SheerTM diode laser (Lumenis, Inc.) as a treatment for recurrent soft tissue reactions secondary to the in growth of hairs around the implant site.

Materials and Methods: One of the most frequent complications of percutaneous bone conduction hearing implant (BCHI) surgery is dermatitis around the titanium skin-penetrating abutment. This paper describes a principle and an example of successful laser epilation of the hair around the BCHI abutment as an alternative treatment for infections, especially if due to hair ingrowth.

(published Laser Epilation as a Treatment for Recurrent Infections around Bone Conduction Implant Abutment; K Samoy, M Goeteyn, B Lerut ; Ann Otolaryngol Rhinol 2016)

Results: Laser therapy resulted in prevention of recurrent infections as a sequel of an effective hair follicle reduction in our case. The patient was very satisfied with the outcome and no side effects could be observed.

Conclusions: Diode laser therapy appears to be a successful therapeutic option for patients suffering from recurrent infections around their BCHI abutment due to the in growth of hair. This treatment can be proposed as a new alternative for current standard therapies.
ACTIVE TRANSCUTANEOUS BONE-CONDUCTION IMPLANT: MIDDLE FOSSA PLACEMENT TECHNIQUE IN CHILDREN
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Keywords: Active transcutaneous bone conduction implant, External auditory canal atresia, Middle fossa technique

Purpose/Aim: The aim of this study is to present the middle fossa technique (MFT) as an alternative for patients who cannot undergo traditional surgery for active transcutaneous bone conduction implants (ATBCI) due to their altered anatomy or desire for future aesthetic reconstruction.

Materials and Methods: A case series descriptive study was designed. The MFT was developed. Preoperative and postoperative information from 33 patients with external auditory canal atresia (EACA) and implanted with ATBCI was reviewed.

Results: A total of 33 children with bilateral EACA received implants in the middle cranial fossa. Their average age was 12. Of these patients, ten had an associated congenital disorder: Goldenhar Syndrome, Treacher Collins Syndrome or the Pierre Robin Sequence. The average follow-up was at 17 months (ranging from between 2– and 51 mo) and there were no major complications. Four patients showed skin erythema at the processor site after turn on, which was solved by lowering the magnet strength. One patient had a scalp hematoma that required puncture drainage. The hearing thresholds went down on average from 66.5 to 25.2dB 1 month after turn on. Speech recognition improved respectively from 29.4% without and 78.9% with a bone conduction hearing aid to 96.4%.

Conclusions: MFT placement of the ATBCI was proven to be safe and effective and a viable option for treating pediatric patients with EACA who cannot receive implants at the sinodural angle or in the retrosigmoidal position because of their altered anatomy and/or desire for future aesthetic reconstruction.
AUTOLOGOUS VERSUS PROSTHETIC RECONSTRUCTION – PATIENT, PROFESSIONAL AND LAYMEN PERCEPTION

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Purpose/Aim: The introduction of osseointegrated implants outside the oral cavity marked an important step in the prosthetic reconstruction of craniofacial defects. Since then, prosthetic reconstruction of craniofacial defects has become a viable and secure alternative to autologous reconstruction. The choice for surgical, prosthetic or combined treatment depends on the characteristics of the defect (size, location and etiology), motivation and condition of the patient and interdisciplinary cooperation. This study aimed at evaluating the differences in perceiving subjective aesthetic outcome after autologous or prosthetic reconstruction of auricular and nasal defects, among laymen, patients and various medical professionals. Additionally, the authors intended for determining the influence of anatomical landmarks on the overall appreciation of auricular and nasal reconstructions.

Materials and Methods: All patients who have been surgically or prosthodontically treated for auricular of nasal defects between 1997 and 2016, with a follow-up of six months, were selected. All patients were invited to take standardized photographs. A constructed questionnaire was used to assess the subjective satisfaction with the aesthetic result using SurveyMonkey on three different domains: Overall appearance, general and anatomical structures. Laymen, patients and professionals were randomly selected for participation in completing the questionnaires. Each observer received an e-mail with a link to the digital survey comprising the standardized structured questionnaires and instructions.

Results: In total, 77 patients (65%) were included of whom 48 patients with reconstructed nose defects (24 autologous and 24 prosthetic) and 29 with reconstructed ear defects (12 autologous and 17 prosthetic). For both nasal and auricular reconstruction, significant differences were seen generally in favor of prosthetic rehabilitation. A similar trend is seen for all anatomical details. No single anatomical subunit was identified to have a significant impact on the overall appreciation of prosthetic or autologous auricular and nasal reconstruction.

Conclusions: Prosthetic reconstructions of auricular and nasal defects tend to be advantageous in subjective aesthetic outcome in the view of professionals, in particular the maxillofacial surgeons. However, patients themselves, judged the prosthetic and autologous nose constructions as equal, and showed a preference for the prosthetic ear reconstruction on one domain.

Session Title: MPO

TRANSDUCER ATTACHMENT IMPACT ON DIRECT DRIVE BONE CONDUCTION STIMULATION

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Keywords: attachment, LDV, ECSP

Purpose/Aim: Direct drive bone conduction devices (BCDs) stimulate the skull bone directly, either with an implanted transducer (active transcutaneous), or through a skin penetrating abutment (percutaneous). The attachment of a direct drive BCD to the skull bone can differ significantly between devices, and possibly influence the vibrations’ transmission to the cochlea. In this study, four different attachments (see Figure) are considered: (A) small-sized flat surface, (B) extended flat surface, (C) bar with a screw at both ends, and (D) standard bone anchored hearing aid screw. A, B, and C represent three active transcutaneous options, while D represents a percutaneous application. The aim of this study was to investigate how different transcutaneous attachments (A, B, and C) affect the vibration transmission to the cochlea and to compare transcranial attenuation (TA) between the attachments.

Materials and Methods: Measurements were performed on four human cadaver heads, measuring cochlear promontory
velocity with an LDV (laser Doppler vibrometer) and sound pressure in the ear canal (ECSP) with an inserted microphone. The stimulation signal was a swept sine 0.1-10 kHz.

**Results:** The comparison of ipsilateral transmission between transcutaneous adaptors A, B, and C was in agreement with previous findings, confirming that: (1) Adaptor C seems to provide the most effective transmission for frequencies around 6 kHz but somewhat lower transmission in the mid frequency range, and (2) a smaller flat contact area to the bone seems to provide advantages compared to a more extended one. Analogous, but less distinct, trends were seen contralaterally. The observed TA was similar for adaptors A, B, and C at the mastoid position, ranging -10-0 dB below 500 Hz, and 10-20 dB above. A lower TA was seen above 500 Hz for adaptor D at the parietal position.

**Conclusions:** The transmission to both cochleae seems to be slightly affected by size of contact area and attachment type, while the TA was mainly affected by the position of the transducer. Based on the measured TA and the absolute contralateral responses, the attachments A-C seem to be equally suitable for SSD patients’ rehabilitation as the D solution, while also providing a more side-specific stimulus.

**EFFECTS OF MAXIMUM POWER OUTPUT ON SPEECH UNDERSTANDING WITH BAHÀ**

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**Keywords:** Baha, MPO

**Purpose/Aim:** One of the main characterizing parameters for different types of bone conduction sound processors is their maximum power output or MPO. The objective of this research is to assess speech understanding in quiet and in noise in users of Bone anchored hearing devices with mixed hearing loss as a function of different MPO levels.

**Materials and Methods:** In this ongoing study, so far eight adult Baha users, ages 59 to 79 years with mixed hearing losses (average bone conduction threshold for the frequency range 500 to 4000 Hz, 35 dB, range 20 to 46 dB) have been tested. Four different MPO-levels were compared: 119 dB (named level I hereafter and corresponding to a Baha 5 SuperPower), 113 dB (level II, corresponding approximately to a Baha 5 Power), 107 dB (level III, approx. Baha 5) and 101 dB rel. 1 µN (level IV). Speech understanding in quiet with German monosyllabic words and numbers and in noise, using the German matrix test. Subjective sound quality was rated using eight different scales, including e.g., loudness and overall quality.

**Results:** In quiet, speech understanding was not significantly different as a function of the different MPO levels. In contrast, in noise speech understanding decreased as a function of sensorineural hearing loss and dynamic range given by the MPO level. The result so far shows an average decrease in speech understanding in noise as a function of MPO-level of -4.6 dB (I), -4.1 dB (II), -3.7 dB (III) and -2.0 dB (IV) SNR. The difference is statistically different when comparing
level IV with the other 3 levels (p<.05).

**Conclusions:** Speech understanding in quiet is not strongly affected as a function of different MPO levels. In noise, however, lower MPO levels and higher levels of sensorineural hearing loss lead to significantly lower speech understanding.

**LISTENING EFFORT WITH BAHS: EFFECT OF MAXIMUM FORCE OUTPUT**

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**Keywords:** maximumforceoutput,listeningeffort,pupillometry

**Purpose/Aim:** The objective of this study was to evaluate the effect of higher maximum force output (MFO) and more advanced MFO signal processing on listening effort in bone anchored users. The hypothesis was that users would allocate less cognitive resources to process speech in noise when using a sound processor with a higher MFO and a multichannel MFO algorithm due to fewer saturation artifacts in the signal.

**Materials and Methods:** Listening effort was estimated by measuring pupil dilation with an eye-tracking camera during a speech-in-noise task. Twenty-one participants performed the task with three different sound processors from Oticon Medical AB (Askim, Sweden): Ponto Pro (PP), Ponto 3 (P3), and Ponto 3 Super Power (P3SP). The three devices differ in their MFO level (PP: low MFO; P3: slightly higher MFO than PP; P3SP: higher MFO than P3 and PP) and MFO algorithm (PP: single channel; P3 and P3SP: multichannel). Two conditions were performed: in Condition 1, the speech level was adjusted for each participant to saturate the PP and the noise was consequently adjusted to lead to 95% correct intelligibility; in Condition 2 the overall level was lowered to reduce saturation artifacts. The resulting signal-to-noise ratio was ecologically valid (mean SNR of 8.6 dB).

**Results:** In Condition 1, the peak pupil dilation obtained with the P3SP was significantly lower than the peak pupil dilation obtained with the PP, indicating a reduced listening effort with the P3SP. In Condition 2, the peak pupil dilation was not significantly different for the three processors. Pupil responses were also analyzed via growth curve analysis (GCA) to estimate the overall pupil dilation while processing and retaining the sentence in working memory. The GCA revealed that the overall pupil dilation was significantly lower with both the P3SP and the P3 relative to the PP in both conditions. In Condition 1, the overall pupil dilation was also significantly lower with the P3SP relative to the P3.

**Conclusions:** The outcomes of this study indicate that listening effort in bone anchored patients can be significantly reduced by the effects of higher MFO and more advanced MFO signal processing.
LOUDNESS FUNCTION IN SUBJECTS WITH PURE CONDUCTIVE HEARING LOSS.

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Purpose/Aim: A study conducted by Stenfelt and Zeitooni (2013) showed differences, mainly for low frequencies, in the loudness function between bone conducted (BC) and air conducted (AC) sound in normal hearing subjects. For BC sound, the loudness function was steeper than for AC sound. The method used in that study was Categorical Loudness Scaling (CLS).

Loudness function is an important factor in prescription methods for hearing aids. Bone conducted devices (BCDs) which transmit the sound through the bone are largely used by people with conductive hearing losses and knowledge about the loudness function in this group is needed.

The aim of this study was to compare the loudness function for AC and BC sounds in two groups of subjects: 1) with a pure conductive hearing loss and 2) normal hearing.

Materials and Methods: The study sample consisted of individuals with pure conductive hearing loss (N=18) and normal hearing (N=20). A loudness function measurement was employed unilaterally, for both AC sound and BC sound, using the same methodology as in Stenfelt and Zeitooni (2013): CLS. The subjects were asked to indicate the loudness of a given stimuli on a response scale ranging from Inaudible to Too loud. According to the ISO standard for CLS, four frequencies with narrow band noise were evaluated: 0.5 kHz, 1 kHz, 2 kHz and 4 kHz.

Results: Results corroborate the earlier findings of a steeper loudness function for bone conducted sound. Furthermore, results show statistically significant differences between the two groups. The group with conductive loss demonstrated a smaller dynamic range in total and steeper loudness function for lower stimulation levels than the normal hearing group, both for AC and BC sound.

Conclusions: The results indicate a higher sensitivity in the group with conductive hearing loss compared to normal hearing subjects. These findings may be important to consider in the future work of developing prescription rules for BCDs and in the clinical work of fitting the devices.

HIGHER MFO: PERFORMANCE AND PREFERENC IN DAILY LIFE

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Keywords: Bone anchored hearing system, maximum force output, mixed hearing loss
Purpose/Aim: The objectives of this study was to investigate how higher Maximum Force Output (MFO) in a sound processor for Bone Anchored Hearing system (BAHS) affects the perceived benefit and experience of sounds as well as hearing outcomes in subjects with mixed hearing loss.

Materials and Methods: In this prospective cross-over study (ABA-design), nineteen experienced users of bone anchored hearing system participated. All participants had a mixed hearing loss in the fitting range of a standard BAHS (unaided BC pure tone average threshold of 20-40 dB HL). Two sound processors with different maximum force output were used in the study, device A: Oticon Medical Ponto 3 (standard BAHS) and device B: Oticon Medical Ponto 3 Super Power (SP BAHS). Outcome measurements were speech in noise test at different signal to noise ratios, aided thresholds, and questionnaires (Speech Spatial and Quality of hearing scale; SSQ-12, SSQ-C and a self-design questionnaire).

Results: Speech intelligibility test showed significant improvement at the levels of 78- and 75-dB SPL using device B. SSQ-C showed a significant larger perceived benefit with device B concerning localization, distance and movement of the sound source. At the end of the study eleven participants chose to keep device A and eight participants chose to keep device B for further use.

Conclusions: Higher MFO in bone anchored hearing sound processors allow improvement of speech intelligibility in sound demanding environments in subjects with mixed hearing loss. Higher MFO are perceived as beneficial to receive spatial information. When perceived audiological benefits are the same, cosmetic factors such as size and appearance will affect the choice of sound processor.

Saturday, December 14

General Session

Invited Speaker
Augmented Reality in Surgery and Medical Education
Michael E. Ivan MD, MBS
Chief of Service Cranial & Neurooncology JSCH
Co-Director of Neurosurgery JSCH
Director of Research UM Brain Tumor Initiative
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Timur M. Urakov MD
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Virtual, Augmented and Mixed Reality is exciting and versatile and we have only just begun to understand its true impact in medicine. The use of Augmented Reality (AR) is penetrating every major field including the Neurosurgery. The presentation will focus on AR's uses for medical and patient education, preoperative strategic planning, and enhancement of Cranial and Spine surgery. Current limitations and future directives will also be discussed..
Session Title: The Great Debate

Congenital Conductive hearing loss in Syndromic Children
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Congenital conductive hearing loss requires individualised management. There are a number of treatment modalities available including non-intervention, non-surgical hearing solutions, passive and active surgical solutions. When this hearing loss is part of a wider syndrome, there are additional considerations and challenges that need to be factored into the management choices. Syndromes associated with congenital conductive hearing loss include hemifacial microsomia/ facial microsomia/ Goldenhaar’s/ oculo-auriculo-vertebral syndrome (OAVS), mandibulofacial dysostosis (Treacher Collins syndrome), craniosynostoses, branchio-oto-renal syndrome amongst others. Syndromic children have involvement of other systems besides hearing and this influences the management choices for their hearing loss. I will present the experience at Alder Hey Childrens hospital and discuss these considerations.

OUTCOMES OF COMBINING HEARING IMPLANTS WITH AUTOLOGOUS AURICULAR RECONSTRUCTION
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Keywords: auricular reconstruction, microtia, hearing implants

Purpose/Aim: To describe how we combine hearing implants (BAHA Attract, Bonebridge or Vibrant Soundbridge) with autologous auricular reconstruction in children with Congenital Aural Atresia. To explain the clinical, audiological and radiological work-up and technical aspects of the procedure. To report the audiological and surgical outcomes

Materials and Methods: Demographics, indication, operative details, surgical and audiological outcomes including the Children’s Home Inventory for Listening Difficulties (CHILD) questionnaire were collected on all children undergoing hearing implantation with / or as part of a planned autologous auricular reconstruction.

Results: 8 Vibrant Soundbridges, 12 BAHA Attracts and 2 Bonebridges were implanted in children aged 5 – 15 (average 6) between December 2014 and March 2019. Implantation combined with: first stage auricular reconstruction = 2; final stage = 3; other ear procedure = 3; beforehand = 14. Single complication of skin necrosis following application of audio processor. No drop in bone conduction hearing following implantation. Average CHILD improvement from 4.6 to 6.8 (child scoring) and 4.7 to 6.6 (parent scoring).

Conclusions: Combined implantation with the first stage of reconstruction abandoned as the Temporo-parietal vascular flap required to cover the newly constructed ear meant inadequate cover of the implant. Now implant either before auricular reconstruction (sited with plastic surgical input to avoid the eventual site of ear and damage to its potential blood supply) or with the final stage. We have demonstrated no significant deterioration in the inner ear function and improved hearing with the CHILD questionnaire. Numbers too small to demonstrate benefit of one implant over another.

THIRTEEN YEARS EXPERIENCE FROM A SPECIALIST CLINIC FOR MICROTI/A/TRESIA
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St Thomas' Hearing Implant Centre
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Keywords: microtia, atresia
Purpose/Aim: The Guy's and St Thomas' multi-disciplinary microtia/atresia specialist clinic was established in 2006. UK care standards for the management of microtia/atresia patients were published in March 2015. We present the auditory implantation outcomes, audiological results and patient reported outcomes for our series of patients.

Materials and Methods: All patients with microtia/atresia that received a hearing implant between September 2004 and November 2018 were included in the study. A retrospective case note and database review of implant surgeries, complications and pre- and post-operative audiological outcomes was undertaken. Patients were invited to participate in a cross sectional questionnaire study to enable collation and analysis of patient reported outcomes.

Results: Forty five hearing implant recipients with microtia, atresia or congenital external auditory canal stenosis were identified from the database. This included 35 children and 10 adults, six of whom were affected bilaterally. The mean age at implantation for the paediatric patients was 7 years 4 months. The implanted devices are; 25 Oticon Ponto; 3 Cochlear Baha Connect; 12 Cochlear Baha Attract; 1 MED-EL Bonebridge; 11 MED-EL Vibrant Soundbridge. There have been four percutaneous implant failures. There are currently two non-users.

Conclusions: With an increasing number of implantable hearing technologies available every patient should undergo thorough assessment of their auditory rehabilitation needs in light of other medical conditions and co-morbidities. Skull thickness and anatomical access corridors are assessed to identify which devices are potentially suitable. Multi-disciplinary assessment includes consideration of future reconstructive or prosthetic options. Ear specific stimulation with Vibrant Soundbridge is our intention for suitable candidates.

PARENTS’ EXPERIENCES FOLLOWING THE BIRTH OF A CHILD WITH MICROTIA/ATRESIA

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Keywords: microtia/atresia, children

Purpose/Aim: Children with microtia/atresia are a low incident population within a low incident population. While considerable attention and research exists, or is ongoing, regarding technology, screening/diagnosis, best practices and outcomes for children with sensorineural hearing loss, considerably less attention is given to the needs of children with microtia/atresia and their families, aside from surgery related topics. As surgical interventions are not available to these children until older childhood and may not even be appropriate for a child’s unique needs, parents, doctors, interventionists, and policy makers need qualitative and quantitative data to inform best practices in management, intervention and amplification decisions to insure these children do not experience avoidable developmental delays. In order for researchers to identify priorities for studies and for practitioners to provide information and appropriate supports to new parents, the experiences of recent parents provide critical insight into these areas. The purpose of this study was to identify and describe the experiences of parents following the birth of a child with microtia/atresia (aural atresia).

Materials and Methods: Participants were recruited via social media and professional network and included English speaking parents of children with microtia/atresia, ages of 6 months-6 years at the time of the study. Participants provided demographic information, pregnancy/birth history, and information about their child, such as age of confirmation of hearing loss, use of amplification, and Early Intervention enrollment by completing a survey. Participants completed semi-structured, one hour, qualitative interviews with members of the research team. Responses were transcribed and coded for thematic analysis to identify common recurring themes.

Results: This study is in process and will be completed in August of 2019. Results will include participant characteristics and demographic details, including relevant descriptive statistics of quantitative information shared by participants via the survey. Results of the thematic analysis of responses to the interview, focusing on experiences, challenges, and needs identified and described by parents following the birth of a child with microtia/atresia will be included.

Conclusions: This study is in process and will be completed in August of 2019. In consideration of the results of this study, directions for future research and supports for parents will be addressed.
Session Title: Future Directions

VIRTUAL SURGICAL PLANNING USING COCHLEAR™ VISTAFIX® SYSTEM FOR MICROTIA RECONSTRUCTION

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Keywords: Microtia, CAD-CAM, Virtual Surgical Planning

Purpose/Aim: Microtia is a congenital malformation of the ear, which occurs approximately 1:6,000 live births in the general population, classically this was treated with complex and unreliable surgical techniques that yielded fair outcome at best or prosthetic rehabilitation that did not meet our patients’ expectations. Virtual Surgical Planning has revolutionized this filed making treatment protocols more predictable, reliable and cost effective for both the patients and the health care systems. The aim of this presentation is to illustrate the digital work flow of reconstructing microtia using Virtual Surgical Planning with Cochlear™ Vistafix® implants.

Materials and Methods: Using Computer Assisted Design and Manufacturing technology to correct the malformations of microtia, Our team developed a digital work-flow utilizing Materialize™ Mimics® which is image processing software for 3D design and modeling to to bypass the conventional and unpredictable ways that are used to surgically correct these complex deformity with suboptimal outcomes. Cochlear™ Vistafix® implants were used in all cases for prosthetic anchorage.

Results: Implementation of advanced digital technologies does offer a superior esthetic and functional outcome to patients with previously failed reconstruction.

Conclusions: Excellent esthetic results are key in providing patients with the confidence that their correction will go undetected. The added value of computer assisted surgical planning and manufacturing has pushed the bounders of our ability to deliver exceptional outcomes that usually excesses our patient expectations. Less number of needed surgeries, guided surgical splints and near identical re-production of missing ears is all but few of what we can offer patients nowadays.
EFFECTS OF PLACEMENT AND SURGICAL METHOD OF THE SENTIO TRANSDUCER

Ghoncheh, Mohammad *, Stenfelt, Stefan***; Maas, Patrick**; Maier, Hannes*
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Keywords: BoneConductionImplant, ObjectiveMeasurements, AcousticCoupling

Purpose/Aim: Transcutaneous bone conduction implants have the advantage that the site of stimulation can be designed independent from the position of the sound processor with the microphone on the head. Hence, alternative sites such as close to the ear canal below the pinna are possible. The objective of this study was to evaluate the effect of implant position and surgical method on the acoustic coupling of a new transcutaneous bone conduction implant in human cadaveric full heads.

Materials and Methods: In human cadaver heads the bone conduction implant Sentio Ti was sequentially implanted at different surgically relevant positions in the mastoid. Implantation was performed either on the intact - only slightly flattened skull surface - or by creating a 3mm deep drilled bone bed. To determine the output of the implanted device Laser Doppler Vibrometry (LDV) measurements on the ipsi- and contralateral cochlear promontory and on the bone close to the implant were performed. Additionally, sound pressures on the forehead were obtained for exploration of this method as an easy and cost-effective alternative to LDV.

Results: Placement of stimulation site close to the ear canal on the mastoid led to higher velocity responses on the ipsilateral promontory compared to the commonly used retro-auricular position for the abutment of percutaneous devices. Moreover, drilling a bone bed for the implantable vibrator was beneficial on the acoustical coupling leading to increased vibrational amplitudes on the ipsilateral promontory at frequencies above 1 kHz.

Conclusions: The preliminary results indicate that the maximum power output (MPO) of bone conducted stimulation can be improved using stimulation sites closer to the ear that are not possible with percutaneous devices. Although surgically attractive due to its simplicity, surface mounting the transducer result in lower MPO than when the bone is flattened. The experiments are intended to provide suggestions on implantation site and surgical method for placing a transcutaneous bone conduction implant for optimum outcomes. The result can also provide indications for patient selection.

OUTCOMES OF THE NEW OSIA SYSTEM COMPARE TO BAHAAATTRACT

Nevoux, Jerome *, Pronost, Nolwenn - Boulet, Marc - Papon, Jean-Francois. Chu Bicetre Ent Le Kremlin-Bicetre, France

Keywords: Bone anchorage, QOL, hearing results

Purpose/Aim: Bone conduction implants based on abutment-driven acoustic transmission result in good hearing outcomes; however, skin complications impact the quality of life (QOL) and possibly the viability of the device for many patients. The transcutaneous magnetic Baha? Attract technology was developed with the goal of minimizing skin complications but has auditory benefit limited because of soft tissue absorption. The last version is an active implant, OSIA?, which should resolve all the remaining problems.

Objectives: To analyze surgical, auditory, and QOL outcomes for patients implanted with the OSIA.

Materials and Methods: Participants: Eight patients implanted with the OSIA? all with mixed hearing loss and previously implanted with the Baha? Attract. Main outcome measures: Post-operative follow-up involved visual analysis of soft tissue adaptation and sound processor magnet strength measurement. The audiometric outcomes were evaluated in quiet and noise, and the QOL was assessed using three different questionnaires.

Results: At the first fitting, the hearing threshold significantly improved compared to unaided situation (65 to 36 dB HL respectively, p<0.001) as did speech in noise ratio (+5.5 to 2.3 respectively, p<0.01). All patients reported a louder and clearer perception of sound since the first activation probably related to the impressive improvement of the hearing threshold on the high frequency.
After 3 months of use, the speech recognition threshold in quiet significantly improved compared to unaided situation (65 to 25 dB HL respectively, p<0.001) as did speech in noise ratio (+5.5 to 1.2 respectively, p<0.01). All QOL, APHAB, SSQ and HUI-3 scores improved.

Conclusions: The OSIA? technology results in significant hearing gain and improves QOL. The transition from the Baha? Attract to the OSIA? is an option if hearing degrades.

ACTIVE OSSEOEINTEGRATED STEADY-STATE IMPLANT SYSTEM FOR TREATMENT OF SSD
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Keywords: Active osseointegrated steady-state implant system, SSD, unilateral deafness

Purpose/Aim: The active osseointegrated steady-state implant system uses a piezoelectric actuator placed on the bone surface and fixated via an osseointegrating implant. The system is a new treatment option indicated for patients with mixed hearing loss (MHL), conductive hearing loss (CHL) or single-sided sensorineural deafness (SSD). There is no previous literature describing the use of this technology in patients with SSD. Audiological outcomes in the initial patients with SSD implanted with the active osseointegrated steady-state implant system will be presented.

Materials and Methods: This prospective, international, multicenter clinical investigation was conducted at five centers in Europe, Australia and the United States. Adult subjects with SSD, CHL or MHL were implanted with the active osseointegrated steady-state implant system. Audiological evaluations included audiometric thresholds and speech recognition in noise and quiet preoperatively and at four weeks, three months, and six months post-operatively. Results were compared with unaided hearing and pre-operative softband tests with a Baha power sound processor. Daily length of use was recorded. Device comfort was reported using a visual analogue scale. Statistical analysis was performed on the intention to treat population.

Results: Fifty-one subjects were included in the study; fourteen subjects implanted at four centers had SSD. For the SSD subgroup, there were statistically significant improvements at 3 months compared to preoperative unaided hearing for all audiological tests: audiometric thresholds (change in PTA: -24.6dB, SD6.6dB; p<0.0001), speech in noise (change in SNR: -13.0 dB, SD6.1dB; p<0.0001), and quiet (Change in % correct words at 65dB: 55.6 percent points, SD21.7%; p<0.0001). Comparison to preoperative performance with a softband showed statistically significant improvements in speech recognition in noise and in audiometric thresholds at high frequencies. The mean daily use of the sound processor was 10.5 hours (SD 4.3 hours). At three months, a satisfactory comfort level was reported overall (mean 81%, SD17%, range 18-100%). Final 12-month data will be available at the time of presentation.

Conclusions: The active transcutaneous bone conduction hearing system offers significant clinical benefit to patients with SSD and constitutes a new safe and reliable treatment option for these individuals.
OSIA, A NEW ACTIVE TRANSCUTANEOUS BONE CONDUCTION DEVICE: PRELIMINARY RESULTS
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Purpose/Aim: Cochlear Osia is a new transcutaneous active bone conduction device, which is divided into two components. The internal, subcutaneous and osseointegrated part that will be the active part ("actuator"); and the external part, the processor that will be connected transcutaneously by means of a magnet to the internal part. The main goals is to verify the effectiveness and performance of the new Cochlear Osia active osseointegrated hearing implant in patients with moderate to severe mixed hearing loss. Then, we compare audiologically and surgically the Osia implant with the users of Baha Connect + Baha 5 Power, to see if Osia is equivalent to this sound processor.

Materials and Methods: A clinical evaluation of Cochlear Osia was performed with 10 subjects to evaluate the surgical intervention, the audiological results and the subjective satisfaction of the patient. The inclusion criteria were new candidates without previous bone conduction implant with chronic otitis media with bone conduction thresholds between 45 dB - 55 dB and which showed good results with the preoperative test with SoundArc and Baha 5 Power.

The patient underwent a battery of audiological tests:
- Free field tonal audiometry
- Silent speech discrimination at 50, 65 and 80 dB.
- Discrimination of speech in noise (SNR 0; +5; +10 dB)
- Discrimination of adaptive speech in noise: Matrix test (Oldenburger measurement application)
- GBI and APHAB quality of life questionnaire.

Results: The preliminary results obtained predict auditory performance at a tonal and verbal level similar to that provided by its percutaneous implant, no incidences at the surgical level and with good satisfaction in the quality of life questionnaires.

We are currently performing the tests at 6 months after device's activation, for which, we do not have the final results of all patients. But we observe very encouraging results for patients with moderate mixed hearing loss with bone conduction thresholds between 45 and 55 dB.

Conclusions: Cochlear Osia is a new transcutaneous active bone conduction device that provides good hearing performance in patients with mixed hearing loss with bone conduction thresholds between 45 and 55 dB.

SURGICAL AND FUNCTIONAL OUTCOMES OF THE NEW COCHLEAR OSIA IMPLANT
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Keywords: Active bone conduction implants, Osia, Piezoelectric

Purpose/Aim: Bone conduction hearing devices are well established for patients where conventional hearing aids are not tolerated or contraindicated. There is a shift from percutaneous to transcutaneous options for reduced aftercare but the gain might be lower with a compromise in higher frequencies.

The innovative active transcutaneous Cochlear Osia system overcomes these weaknesses by using a piezoelectric transducer mounted on the well established Bi300 fixture providing a single point of contact.

We aimed to evaluate the surgical and functional outcomes of patients with the new Cochlear Osia implant system.

Materials and Methods: Patients with moderate conductive and mixed loss were selected after informed consent. All patients had pure tone audiometry and speech testing. The reasons for choosing an active transcutaneous device, initial reactions and views on aesthetic considerations were noted as well.

A bone conduction device (BAHA 5) on a headband was trialled for 2 weeks and patients completed a diary to record their
experiences.

The “Sheffield S” incision and a standardised soft tissue approach was used followed by insertion of fixture and mounting of the transducer. Bone polishing was undertaken in 7 cases. Skin thinning was not needed.

Results: Twelve patients were implanted. The male female ratio was 7:5. The patient population consisted of a mixture of moderate conductive and mixed loss. Average follow up was 2.5 months.

There were no minor soft tissue complications. One patient had a stich abscess three months after the surgery. This had to be evacuated under an anaesthetic. There were no long term sequelae.

The Osia requires (1) less monitoring and reviews compared to other transcutaneous devices (2) has a higher and wider range of amplification – covering the higher frequencies and bone conduction up to 55dB (3) there is no feedback (4) isn’t conspicuous.

Conclusions: The new Cochlear Osia active transcutaneous implant is well tolerated by patients. It is well suited for rehabilitation of moderate conductive or mixed hearing losses. The surgery is safe and the device is stable and the processor is very well liked by all patients.

THE OSIA SYSTEM – RESULTS FROM AN INTERNATIONAL, MULTICENTER CLINICAL INVESTIGATION

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Keywords: Osia System, bone conduction

Purpose/Aim: The Osia System is a new active transcutaneous bone conduction hearing implant indicated for patients with mixed (MHL) or conductive (CHL) hearing loss or single-sided sensorineural deafness (SSD). The system uses an implantable piezoelectric actuator that is fixated to the bone surface via an osseointegrating implant. The objective of this first clinical investigation of the new system was to evaluate audiological performance, patient-reported outcomes (PROs) and safety in an adult population.

Materials and Methods: This prospective, international, multicenter clinical investigation was conducted at five centers in Europe, USA and Australia. Adult subjects with CHL, MHL up to 55 dB SNHL, or SSD were implanted with the Osia System. Audiological evaluations included audiometric thresholds, speech recognition in noise and quiet; results were compared with unaided hearing and preoperative tests with a Baha power sound processor on softband. PRO measures included HUI3, APHAB and SSQ. Daily use, surgical and safety parameters were analyzed. Primary performance was evaluated after 3 months and primary safety after 6 months of follow-up. The total study duration was 12 months.

Results: Fifty-one subjects were included (37 CHL/MHL, 14 SSD, 49 unilateral, 2 bilateral). Statistically significant improvements compared to unaided hearing were recorded for all audiological tests at 3 months: audiometric thresholds (change in PTA4: -24.9dB, SD9.5dB), speech in noise (change in SNR: -13.3 dB, SD8.1 dB) and quiet (change in % correct words at 65dB: 59.8 percent points, SD27.1%). Comparisons to Baha on softband showed significant improvements, the largest difference being observed for speech in noise and audiometric thresholds at high frequencies. Statistically significant improvements were observed on all questionnaires, including the comprehensive health state attribute of HUI3. Average daily use was high (Mean 10.5 hours/day, SD 4.3). The primary safety evaluation concluded that postoperative healing was satisfactory, and few complications were reported. One implant was removed before activation due to post-surgical infection. Final 12-month data will be available at the time of presentation

Conclusions: The results show that the Osia System is safe and provides significantly improved hearing performance compared to unaided hearing and Baha on softband, as well as improvements in PROs in patients with CHL, MHL and SSD.
OSIA - A NEW ACTIVE OSSEOINTEGRATED IMPLANT SYSTEM IN SSD

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Keywords: Osia, SSD, osseointegration

Purpose/Aim: CochlearTM Osia? System is an active osseointegrated implant system intended for patients with conductive and mixed hearing loss but can be also used in cases of single-sided deafness (SSD) for the contralateral routing of signal (CROS). The Osia? implant is placed under the intact skin behind the ear with the piezoelectric actuator attached to an osseointegrated BI300 implant on the mastoid. The external processor is magnetically attached to the head. As the Osia? is recently CE certified, and new on the market, with limited patient outcome data for SSD available. The objective of this study was the evaluation of audiological results and patient satisfaction for the Osia system in SSD patients.

Materials and Methods: Three patients (18 years of age or older) with single-sided deafness and bone conduction thresholds PTA4 ≤ 25 dB HL on the contralateral side not suitable for CI were implanted with an Osia to benefit from CROS hearing. Retrospective analysis of clinical outcome data - audiological measurements and subjective benefit - for SSD patients was conducted. Audiological measurements performed included word recognition score (in %) in quiet using the Freiburg monosyllable test. Speech intelligibility was determined with the Oldenburg sentence test (OLSA) in quiet (S90Osia; in %) and in fixed 65 dB SPL noise (S0N90contra and S90OsiaN90contra; in dB SNR) with an adaptive speech level. Unaided and aided sound field audiograms (S0) with the contralateral ear muffled and plugged served to determine the performance of the devices. All tests were performed unaided and aided with the Osia System. The subjective benefit with the Osia system in different listening situations/everyday situations was determined by using two questionnaires: Abbreviated Profile of Hearing Aid Benefit (APHAB) and the Bern Benefit in Single Sided Deafness (BBSSD.)

Results: Preliminary results indicate an improvement in speech perception in quiet, listening performance in everyday situations and patient satisfaction.

Conclusions: Provided that SSD patients are open for CROS hearing, they can benefit from the Osia system by reduced head shadow effects and better speech recognition.

General Session

THE DEVELOPMENT OF BONE CONDUCTION TECHNOLOGY IN CONSUMER ELECTRONICS

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Shenzhen, China

We will introduce the application of bone conduction technology in different fields briefly. Then we will talk about our success in the application of bone conduction, including technical, product and business achievements. Finally, we would discuss our future development planning.
<table>
<thead>
<tr>
<th>Table#</th>
<th>First Name</th>
<th>Last Name</th>
<th>Abstract Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adams</td>
<td>Tracey</td>
<td>Early Clinical Experience Of The Cochlear™ Osia® System In Europe</td>
</tr>
<tr>
<td>2</td>
<td>Agterberg</td>
<td>Martijn</td>
<td>Multi-Center-Clinical-Results With The Carina®; Benefit Of Listening With Two Devices</td>
</tr>
<tr>
<td>3</td>
<td>Arndt</td>
<td>Susan</td>
<td>Binaural Benefit With The New Active Bone-Conduction System Osia</td>
</tr>
<tr>
<td>4</td>
<td>Bahmad</td>
<td>Fayez</td>
<td>Hearing And Tinnitus Rehabilitation Through Bone-Conducted Sound Stimulation</td>
</tr>
<tr>
<td>5</td>
<td>Barauna</td>
<td>Iulo</td>
<td>Hearing Results And Quality Of Life Of Patients With Carina System In Brazil</td>
</tr>
<tr>
<td>6</td>
<td>Barnaby</td>
<td>Jacob</td>
<td>Transcutaneous Bahas In Children- A Step In The Right Direction</td>
</tr>
<tr>
<td>7</td>
<td>Bere</td>
<td>Zsofia</td>
<td>Preliminary Study Of Osia In Childhood</td>
</tr>
<tr>
<td>8</td>
<td>Berthelsen</td>
<td>Debbie</td>
<td>Nurseled Outpatient Clinic For Patients With Bone Anchored Hearing System(Bahs)</td>
</tr>
<tr>
<td>9</td>
<td>Bezdjian</td>
<td>Aren</td>
<td>Inter-Observer Validity Assessment Of Skin Tolerability Scales</td>
</tr>
<tr>
<td>10</td>
<td>Bezdjian</td>
<td>Aren</td>
<td>Smoking As A Risk Factor For Spontaneous Implant Extrusion</td>
</tr>
<tr>
<td>11</td>
<td>Bezdjian</td>
<td>Aren</td>
<td>Processor Coupling Timing For Pediatric Recipients Using Resonance Frequency Analysis</td>
</tr>
<tr>
<td>12</td>
<td>Bianchi</td>
<td>Federica</td>
<td>Effect Of Noise Reduction On Listening Effort For Bone-Anchored Users</td>
</tr>
<tr>
<td>13</td>
<td>Bonilla</td>
<td>Alfonso</td>
<td>Ssd And Osseointegrated Implants Long Term Follow-Up</td>
</tr>
<tr>
<td>14</td>
<td>Bonilla</td>
<td>Alfonso</td>
<td>Percutaneous Implants Minimally Invasive Surgery: Our Punch Technique Results</td>
</tr>
<tr>
<td>15</td>
<td>Bouzegta</td>
<td>Rajae</td>
<td>Hearing Outcomes And Daily Use With An Active Transcutaneous Bci</td>
</tr>
<tr>
<td>16</td>
<td>Bouzegta</td>
<td>Rajae</td>
<td>Hearing Outcomes And Datalog Using A Passive Transcutaneous Bci</td>
</tr>
<tr>
<td>17</td>
<td>Boyle</td>
<td>Connor</td>
<td>Predictive Capacity Of Questionnaires For Successful Implantation In Aural Atresia</td>
</tr>
<tr>
<td>18</td>
<td>Brassington</td>
<td>William</td>
<td>Benefits Of Fitting Bilateral Bahs: Impact On Auditory Working Memory</td>
</tr>
<tr>
<td>19</td>
<td>Brown</td>
<td>Christine</td>
<td>Uhl In Children: Parent Perspectives On Bone Conduction Device Selection</td>
</tr>
<tr>
<td>20</td>
<td>Cagnacci</td>
<td>Byanka</td>
<td>Bilateral Baha Fitting: Auditory And Quality Of Life Benefits</td>
</tr>
<tr>
<td>21</td>
<td>Caspers</td>
<td>Coosje</td>
<td>Long-Term Quality Of Life With A Percutaneous Bcd</td>
</tr>
<tr>
<td>22</td>
<td>Catenacci</td>
<td>Catherine</td>
<td>Audiological Outcomes Of The Osia System™, A New Generation Of Osseointegrated Implants. Follow-Up To 6 Months</td>
</tr>
<tr>
<td>Table#</td>
<td>First Name</td>
<td>Last Name</td>
<td>Abstract Title</td>
</tr>
<tr>
<td>-------</td>
<td>------------</td>
<td>--------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>23</td>
<td>Choi</td>
<td>Byung Yoon</td>
<td>Functional Outcome Comparison Among Various Bone Conduction Implantable Hearing Aids</td>
</tr>
<tr>
<td>24</td>
<td>Christiansen</td>
<td>Simon Krogholt</td>
<td>Technical Evaluation Of A Speech Enhancement System For Bone Conduction</td>
</tr>
<tr>
<td>25</td>
<td>Coelho</td>
<td>Daniel</td>
<td>Do Antibiotics Improve Skin Reactivity Following Auditory Osseointegrated Implant Placement?</td>
</tr>
<tr>
<td>26</td>
<td>De Ataide</td>
<td>Andre</td>
<td>A Decade Of Baha Brazil: Demographic Profile Of Osseointegrated Implants</td>
</tr>
<tr>
<td>27</td>
<td>de Boer</td>
<td>Annemiek</td>
<td>Ovma For Dutch National Implant Registration, Recording In Patient File</td>
</tr>
<tr>
<td>28</td>
<td>Deveze</td>
<td>Arnaud</td>
<td>Adaptive Feedback Cancelling Algorithm For The Carina®: Experimental Results</td>
</tr>
<tr>
<td>29</td>
<td>D'hondt</td>
<td>Christiane</td>
<td>Directivity Index Of A Fully-Implantable Microphone</td>
</tr>
<tr>
<td>30</td>
<td>Dobrev</td>
<td>Ivo</td>
<td>Experimental And Numerical Evaluation Of The Skull’S Bone Conduction Response</td>
</tr>
<tr>
<td>31</td>
<td>Eshraghi</td>
<td>Adrien</td>
<td>Otoprotection Using L-N-Acetylcysteine And Dexamethasone Combination In An In-Vitro Model</td>
</tr>
<tr>
<td>32</td>
<td>Fierens</td>
<td>Guy</td>
<td>Feasibility Study For Measuring Unintended Acoustic Stimulation During MRI</td>
</tr>
<tr>
<td>33</td>
<td>Fredén Jansson</td>
<td>Karl-Johan</td>
<td>Vestibular Evoked Myogenic Potentials Using The B250 Transducer</td>
</tr>
<tr>
<td>34</td>
<td>Fredén Jansson</td>
<td>Karl-Johan</td>
<td>Bc Stimulated Vemp In Patients With Vestibular Schwannoma Using B250</td>
</tr>
<tr>
<td>35</td>
<td>Galanti</td>
<td>Valeria</td>
<td>The Ponto Trial Companion App: A Multicentric Study</td>
</tr>
<tr>
<td>36</td>
<td>Gamm</td>
<td>Ute Alice</td>
<td>Optimum Loading Of The Carina Middle Ear Implant Actuator</td>
</tr>
<tr>
<td>37</td>
<td>Garrada</td>
<td>Mohamed</td>
<td>Auditory And Speech Performance In Patients Following Transcutaneous Baha® Implantation</td>
</tr>
<tr>
<td>38</td>
<td>Gawdecki</td>
<td>Wojciech</td>
<td>Comparison Of Benefits Of Osia And Baha Attract System.</td>
</tr>
<tr>
<td>39</td>
<td>Gawliczek</td>
<td>Tom</td>
<td>Audiological Performance Of A New Nonimplantable Wearing Option For Baha.</td>
</tr>
<tr>
<td>40</td>
<td>Ghoncheh</td>
<td>Mohammad</td>
<td>Output Evaluation Of A Bone Conduction Implant In Human Cadavers</td>
</tr>
<tr>
<td>41</td>
<td>Gill</td>
<td>Charn</td>
<td>“Adhear” Use In Traumatic Tympanic Membrane Perforation From Blast Injuries</td>
</tr>
<tr>
<td>42</td>
<td>Gomez</td>
<td>Laura</td>
<td>Baha Use In Elderly Population. Correlations With Social And Cognitive</td>
</tr>
<tr>
<td>43</td>
<td>Goycoolea</td>
<td>Marcos</td>
<td>Surgical Approach And Results Of The Osia System, ™ A New Generation Of Osseointegrated Implants</td>
</tr>
<tr>
<td>44</td>
<td>Harris</td>
<td>Stuart</td>
<td>Which Intervention Offers The Best Hearing Ability For Glue Ear?</td>
</tr>
<tr>
<td>Table#</td>
<td>First Name</td>
<td>Last Name</td>
<td>Abstract Title</td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
<td>---------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>45</td>
<td>Hodgson</td>
<td>Sarah</td>
<td>Impact Of An Ehealth Solution In The Bone-Anchored Assessment Process</td>
</tr>
<tr>
<td>46</td>
<td>Holgersson</td>
<td>Erik</td>
<td>Designing And Testing A Small, Reliable And Powerful Transducer</td>
</tr>
<tr>
<td>47</td>
<td>Holmberg</td>
<td>Marcus</td>
<td>Experiences With The Minimal Invasive Ponto Surgery Surgical Technique</td>
</tr>
<tr>
<td>48</td>
<td>Hougaard</td>
<td>Dan Dupont</td>
<td>Do Patients Benefit From Upgrading To Ponto 4 Sound Processor?</td>
</tr>
<tr>
<td>49</td>
<td>Hua</td>
<td>Håkan</td>
<td>Clinical Success Rates In Restoring Hearing Among Patients With Com</td>
</tr>
<tr>
<td>50</td>
<td>Jacobsen</td>
<td>Chris</td>
<td>Hearing Outcomes Within A Danish Cohort Of Baha Patients.</td>
</tr>
<tr>
<td>51</td>
<td>Jang</td>
<td>ChulHo</td>
<td>Accelerated Osteointegration Of The Titanium-Implant Coated Bmp-2 For Baha</td>
</tr>
<tr>
<td>52</td>
<td>Jaramillo</td>
<td>Rafael</td>
<td>Bilateral Sequential Bone Implantation: Evidence Of Clinical Benefits</td>
</tr>
<tr>
<td>53</td>
<td>Jaramillo</td>
<td>Rafael</td>
<td>Multi-Centric Experience With The Baha System: Pre-Implantation Demographic Profile</td>
</tr>
<tr>
<td>54</td>
<td>Jardim</td>
<td>Isabela</td>
<td>Bone Conduction Device: User´S Profile And Short Term Outcomes</td>
</tr>
<tr>
<td>55</td>
<td>Johansson</td>
<td>Martin L.</td>
<td>The Microbiological Profile Of The Bone-Anchored Hearing System</td>
</tr>
<tr>
<td>56</td>
<td>Johansson</td>
<td>Martin L.</td>
<td>Comparative Experimental Study On A Drilling System For Baha</td>
</tr>
<tr>
<td>57</td>
<td>Johansson</td>
<td>Martin L.</td>
<td>Effect Of Drill Parameters On Heat Generation During Osteotomy Preparation</td>
</tr>
<tr>
<td>58</td>
<td>Johansson</td>
<td>Martin L.</td>
<td>Multimodal Analysis Of The Tissue Response To A Baha Implant</td>
</tr>
<tr>
<td>59</td>
<td>Johansson</td>
<td>Martin L.</td>
<td>Snapshot Assessment Of Well-Established Baha Placed Using Mips</td>
</tr>
<tr>
<td>60</td>
<td>Katiri</td>
<td>Roulla</td>
<td>International Consensus On Outcome Measures For Single Sided Deafness Interventions</td>
</tr>
<tr>
<td>61</td>
<td>Kim</td>
<td>Young Yoon</td>
<td>Safety Of Baha Implantation Performed Simultaneously With Com Surgery</td>
</tr>
<tr>
<td>62</td>
<td>Koitschev</td>
<td>Assen</td>
<td>Bone Conduction Or Middle Ear Implant? A Decision Making Algorhythm</td>
</tr>
<tr>
<td>63</td>
<td>Kok</td>
<td>Herman</td>
<td>Clinical Experiences With A Superpower Sound Processor</td>
</tr>
<tr>
<td>64</td>
<td>Kompis</td>
<td>Martin</td>
<td>Voluntary Middle Ear Impedance Increase With Mild Conductive Hearing Loss</td>
</tr>
<tr>
<td>65</td>
<td>Kong</td>
<td>Tae Hoon</td>
<td>The Audiological Benefits And Performace Improvements Of Baha® Attract Implantation.</td>
</tr>
<tr>
<td>66</td>
<td>Kruyt</td>
<td>Ivo</td>
<td>5-Year Clinical Outcomes Of Two Surgical Techniques And Two Bahis</td>
</tr>
<tr>
<td>67</td>
<td>Kruyt</td>
<td>Ivo</td>
<td>Economic Evaluation Of Percutaneous Titanium Implants For Bone Conduction Hearing</td>
</tr>
<tr>
<td>Table#</td>
<td>First Name</td>
<td>Last Name</td>
<td>Abstract Title</td>
</tr>
<tr>
<td>-------</td>
<td>------------</td>
<td>-----------</td>
<td>----------------</td>
</tr>
<tr>
<td>68</td>
<td>Lee</td>
<td>Jihyeon</td>
<td>The Benefit Of Bluetooth Devices In Speech Recognition With Baha®</td>
</tr>
<tr>
<td>69</td>
<td>Lee</td>
<td>Kyu-Yup</td>
<td>Design Of Electromagnetic Transducer For Implantable Bone Conduction Hearing Devices</td>
</tr>
<tr>
<td>70</td>
<td>Lenarz</td>
<td>Thomas</td>
<td>A Novel Transcutaneous Bone Conduction Device</td>
</tr>
<tr>
<td>71</td>
<td>Lerut</td>
<td>Bob</td>
<td>Transcutaneous Bcd And Magnetic Resonance Imaging</td>
</tr>
<tr>
<td>72</td>
<td>Lochner</td>
<td>Jonas</td>
<td>Verifying Outcomes With An Adhesive Bone Conduction Device</td>
</tr>
<tr>
<td>73</td>
<td>Magele</td>
<td>Astrid</td>
<td>Active Transcutaneous Bone Conduction Implants: A Systematic Literature Review And Meta-Analysis</td>
</tr>
<tr>
<td>74</td>
<td>Maier</td>
<td>Hannes</td>
<td>Long Term Stability Of Middle Ear Transducers T1 And T2</td>
</tr>
<tr>
<td>75</td>
<td>Marley</td>
<td>Suzanne</td>
<td>Review Of Patients Who Declined A Bchi After A Trial</td>
</tr>
<tr>
<td>76</td>
<td>Matthews</td>
<td>Timothy</td>
<td>Superior Placement Of The Bonebridge Implants In Adults: Long-Term Outcomes.</td>
</tr>
<tr>
<td>77</td>
<td>Mauro</td>
<td>Laurie</td>
<td>Treatment For Children With Conductive And/Or Mixed Unilateral Hearing Loss: Audiologist Decision And Counseling Strategies</td>
</tr>
<tr>
<td>78</td>
<td>Mileshina</td>
<td>Neylya</td>
<td>Bone Conduction Implants Survival</td>
</tr>
<tr>
<td>79</td>
<td>Moore</td>
<td>Lindsay</td>
<td>The Cleating Stitch: An Adjunctive Technique For Percutaneous Osseointegration Screws</td>
</tr>
<tr>
<td>80</td>
<td>Morris</td>
<td>David Peter</td>
<td>Bhd For Unilateral Sensorineural Loss. Halifax Cohort 10 Years On.</td>
</tr>
<tr>
<td>81</td>
<td>Moyer</td>
<td>Catherine</td>
<td>Aided Cortical Auditory Evoked Potentials With Bone Conduction Fittings</td>
</tr>
<tr>
<td>82</td>
<td>Moyer</td>
<td>Catherine</td>
<td>Fitting Insights: Baha Soundarc On A Diverse Pediatric Population</td>
</tr>
<tr>
<td>83</td>
<td>Mrowka</td>
<td>Maciej</td>
<td>Skin Reaction In Patients Using Transcutaneous Titanium Implants.</td>
</tr>
<tr>
<td>84</td>
<td>Mrowka</td>
<td>Maciej</td>
<td>Baha In Various Acquired And Congenital Ear Malformations In Children.</td>
</tr>
<tr>
<td>85</td>
<td>Mrowka</td>
<td>Maciej</td>
<td>Baha System In Patient With Paget’S Disease - Case Study.</td>
</tr>
<tr>
<td>86</td>
<td>Murri</td>
<td>Alessandra</td>
<td>Binaural Hearing Restoration With A Bilateral Fully Implantable Device</td>
</tr>
<tr>
<td>87</td>
<td>Neumann</td>
<td>Katrin</td>
<td>The Adhear System Effectively Treats Conductive Hearing Loss In Children</td>
</tr>
<tr>
<td>88</td>
<td>Ontivero</td>
<td>Paula</td>
<td>Aesthetic Lineal Incision In Baha® Attract Surgery</td>
</tr>
<tr>
<td>89</td>
<td>Ordoñez</td>
<td>Leonardo</td>
<td>Transition From Percutaneous To Transcutaneous Bone Conduction Hearing Aid: Outcomes</td>
</tr>
<tr>
<td>Table#</td>
<td>First Name</td>
<td>Last Name</td>
<td>Abstract Title</td>
</tr>
<tr>
<td>-------</td>
<td>----------------</td>
<td>-------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>90</td>
<td>Park</td>
<td>Si-hun</td>
<td>Better Understanding Of Bone-Conducted Thresholds Using Pta, Abr, And Bodirect</td>
</tr>
<tr>
<td>91</td>
<td>Pedrero-Escalas</td>
<td>Maria-Fernanda</td>
<td>Adhear Vs Baha Attract In Pediatric Congenital Aural Atresia</td>
</tr>
<tr>
<td>92</td>
<td>Pedrero-Escalas</td>
<td>Maria-Fernanda</td>
<td>Outcome After 15 Years Of Osseointegrated Implants In Children</td>
</tr>
<tr>
<td>93</td>
<td>Peixoto</td>
<td>Maria Conceicao</td>
<td>Totally Implantable Middle Ear Device</td>
</tr>
<tr>
<td>94</td>
<td>Peixoto</td>
<td>Maria Conceicao</td>
<td>Patient Outcomes With The Adaptive Feedback Canceller</td>
</tr>
<tr>
<td>95</td>
<td>Peixoto</td>
<td>Maria Conceicao</td>
<td>Preliminary Data On Qol And Hearing Function For Carina® Recipients</td>
</tr>
<tr>
<td>96</td>
<td>Powell</td>
<td>Harry</td>
<td>Outcomes From A 15 Year Old Cochlear Carina Recipient</td>
</tr>
<tr>
<td>97</td>
<td>Proctor</td>
<td>Vicki</td>
<td>Audiological Outcomes Of The New Cochlear Osia Implant</td>
</tr>
<tr>
<td>98</td>
<td>Ray</td>
<td>Jaydip</td>
<td>Sheffield Experience Of The Cochlear Carina Fully Implantable Hearing Device</td>
</tr>
<tr>
<td>99</td>
<td>Rebol</td>
<td>Janez</td>
<td>Historical Roots And Research Trends In Bone Conduction Devices</td>
</tr>
<tr>
<td>100</td>
<td>Rebol</td>
<td>Janez</td>
<td>Patient Satisfaction Of Percutaneous And Transcutaneous Bone Conduction Devices</td>
</tr>
<tr>
<td>101</td>
<td>Rende</td>
<td>Sharon</td>
<td>Experience With The Super Power Devices</td>
</tr>
<tr>
<td>102</td>
<td>Rosenbom</td>
<td>Tove</td>
<td>Effect Of Noise Reduction On Speech Intelligibility And Self-Reported Performance</td>
</tr>
<tr>
<td>103</td>
<td>Salcher</td>
<td>Rolf</td>
<td>Surgical Experience With An Active Os Implant In Ssd</td>
</tr>
<tr>
<td>104</td>
<td>Sardiwalla</td>
<td>Yaeesh</td>
<td>Cost Comparison And Long-Term Follow-Up Of Minimally Invasive Punch Technique</td>
</tr>
<tr>
<td>105</td>
<td>Savage Jones</td>
<td>Howard</td>
<td>Mips: A Prospective Study On Surgical Programme Evolution</td>
</tr>
<tr>
<td>106</td>
<td>Savage Jones</td>
<td>Howard</td>
<td>Tullamore Classification: Fixture Site Skin Reactions Comparing Mips/Lss/Str Techniques</td>
</tr>
<tr>
<td>107</td>
<td>Savage Jones</td>
<td>Howard</td>
<td>Tullamore Classification: Pbahs Fixture Site Skin Reaction Reevaluation</td>
</tr>
<tr>
<td>108</td>
<td>Savage Jones</td>
<td>Howard</td>
<td>Pbahs In The Management Of Meniere’S Syndrome</td>
</tr>
<tr>
<td>109</td>
<td>Scotta</td>
<td>Gianluca</td>
<td>Is There A Future For Percutaneous Bone Conduction Implants</td>
</tr>
<tr>
<td>110</td>
<td>Seo</td>
<td>Young Joon</td>
<td>Baha Attract Implantation Using A Small Incision: A Surgical Technique.</td>
</tr>
<tr>
<td>111</td>
<td>Shahal</td>
<td>David</td>
<td>Development/Establishment Of In-Vitro Model To Understand The Effect Of Electrical-Stimulation</td>
</tr>
<tr>
<td>112</td>
<td>Siegbahn</td>
<td>Malin</td>
<td>Central Auditory Pathways In Unilaterally Hearing Rats</td>
</tr>
<tr>
<td>Table#</td>
<td>First Name</td>
<td>Last Name</td>
<td>Abstract Title</td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
<td>--------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>113</td>
<td>Silva</td>
<td>Maria Angela</td>
<td>Soundarc: A Non - Surgical Pediatric Option</td>
</tr>
<tr>
<td>114</td>
<td>Silva</td>
<td>Maria Angela</td>
<td>Benefits In Noise Discrimination With Baha 5 In Unilateral Dysgenesis.</td>
</tr>
<tr>
<td>115</td>
<td>Singam</td>
<td>Shyam</td>
<td>Ten Year Review Of Bahi Surgery Without Soft Tissue Reduction</td>
</tr>
<tr>
<td>116</td>
<td>Skarzynski</td>
<td>Piotr H.</td>
<td>Bonebridge – Audiological And Surgical Results In World Hearing Center</td>
</tr>
<tr>
<td>117</td>
<td>Skarzynski</td>
<td>Piotr H.</td>
<td>Adhear In Patients With Conductive Hearing Loss – Various Issues</td>
</tr>
<tr>
<td>118</td>
<td>Skarzynski</td>
<td>Piotr H.</td>
<td>Evaluation Of Baha Attract Efficacy In Terms Of Hearing Performance</td>
</tr>
<tr>
<td>119</td>
<td>Skarzynski</td>
<td>Piotr H.</td>
<td>Evaluation Of Mips With Ponto System At World Hearing Center</td>
</tr>
<tr>
<td>120</td>
<td>Skarzynski</td>
<td>Piotr H.</td>
<td>Audiological And Quality Of Life Benefits After Bonebridge Implantation</td>
</tr>
<tr>
<td>121</td>
<td>Snik</td>
<td>A.F.M</td>
<td>Is Treatment Of Unilateral Congenital Conductive Hearing Loss Effective?</td>
</tr>
<tr>
<td>122</td>
<td>Soulby</td>
<td>Andrew</td>
<td>Outcome Measure Driven Audiological Considerations For Bci/Mei Hearing Implants</td>
</tr>
<tr>
<td>123</td>
<td>Toner</td>
<td>Joseph</td>
<td>Bonebridge In Single Sided Deafness (Ssd)</td>
</tr>
<tr>
<td>124</td>
<td>Varga</td>
<td>Lukas</td>
<td>Functional Outcomes In Bonebridge Recipients: Single Center Experiences From Slovakia</td>
</tr>
<tr>
<td>125</td>
<td>Verhaert</td>
<td>Nicolas</td>
<td>Power Stapes With The Carina® System: Clinical And Surgical Experience</td>
</tr>
<tr>
<td>127</td>
<td>Waldmann</td>
<td>Bernd</td>
<td>Cochlear Reserve With The Carina® Active Middle Ear Implant</td>
</tr>
<tr>
<td>128</td>
<td>Waldmann</td>
<td>Bernd</td>
<td>Measuring Aided Thresholds With Active Middle Ear Implants</td>
</tr>
<tr>
<td>129</td>
<td>Wenzel</td>
<td>Claudia</td>
<td>A Novel Bone Conduction Implant: Minimization Of Pre-Operative Planning</td>
</tr>
<tr>
<td>130</td>
<td>Wesarg</td>
<td>Thomas</td>
<td>Speech Perception For Different Noise Types With Osia</td>
</tr>
<tr>
<td>131</td>
<td>Wollet</td>
<td>Annemarie</td>
<td>Earlier Intervtion For Medically Fragile Pediatric Inpatient Population With Bcd</td>
</tr>
<tr>
<td>132</td>
<td>Wright</td>
<td>Megan</td>
<td>Bone Anchored Hearing Aid Implant Registration</td>
</tr>
<tr>
<td>133</td>
<td>Cancelled</td>
<td>Cancelled</td>
<td>Cancelled</td>
</tr>
<tr>
<td>134</td>
<td>Xie</td>
<td>Youzhou</td>
<td>Audiological Outcomes Of Implanted Sophono In Congenital Microtia</td>
</tr>
<tr>
<td>135</td>
<td>Xie</td>
<td>Youzhou</td>
<td>Hearing Performance Of Baha Attract In Patients With Bilateral Microtia</td>
</tr>
</tbody>
</table>
Poster Presentation Abstracts
1

EARLY CLINICAL EXPERIENCE OF THE COCHLEAR™ OSIA® SYSTEM IN EUROPE

Adams, Tracey*; Liu, Dian; Bordonhos, Ana; Lee, Grace; Mauch, Herbert

Cochlear
Clinical Affairs & Research
Basel, Switzerland

Keywords: osia, early experience

Purpose/Aim: To study the acceptance of the Cochlear™ Osia® System by practicing surgeons and audiologists.

Materials and Methods: The Osia System is an active transcutaneous bone conduction system. 76 Osia Systems were made available in 7 European clinics in an early clinical release. Throughout this period, clinical surveys were collected to monitor the clinicians’ experiences.

Results: Preliminary data consisted of 33 implantations of the Osia System. Patients ranged from 8 to 78 years of age. New unilateral implantations took 71 minutes on average, with an additional 41 minutes on average for bilateral cases or transitions from the Baha® Attract System. Most surgeries (79%) were rated to be more difficult than for the Baha Attract System, although not much more difficult. This can likely be attributed to the higher number of surgical procedure steps. Incision techniques varied from surgeon to surgeon. Skin thickness was 6 mm or less in most of the cases and therefore, soft tissue thinning was only performed in 9% of the implantations. Overall, in 73% of the surgeries, surgeons agreed or were neutral on the ease of handling and insertion of the Osia OSI100 Implant. If not for the Osia System, in more than half of the patients (64%) a Baha Attract System would have been chosen instead.

Initial fittings were conducted on 13 patients. The average sessions lasted 55 minutes, with the actual programming taking 20 minutes. The duration was the same or shorter compared to fitting a similar patient with a Baha Attract System (77%). In 85% of the initial fittings, audiologists agreed that the Osia Sound Processor was easy to fit. Most of the patients or families were satisfied with the Osia System after the session in terms of sound processor, sound quality, loudness and speech understanding.

Conclusions: Early experiences indicated a high acceptance of the Osia System by practicing surgeons and audiologists and a high satisfaction of recipients or their families. Surgeries were more complex than for the Baha Attract System and were shorter than cochlear implant surgeries, usually in the range of 90 minutes.

2

MULTI-CENTER-CLINICAL-RESULTS WITH THE CARINA®; BENEFIT OF LISTENING WITH TWO DEVICES

Agtelberg, Martijn *; Cris P. Lanting1, Nicolas Verhaert3,4, Emmanuel A.M1, Jef J. Mulder1
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Keywords: Carina, thresholds, speech understanding

Purpose/Aim: The Carina system is a fully implantable middle ear implant system that can be used with a button (i.e. an external microphone), and with a fully implantable internal microphone. We will present the first clinical results, and the potential of providing two of these relative complex implants to bilaterally hearing impaired patients instead of implanting just one Carina.

The aim of our multi-center study is to improve the counselling of patients and to better understand the limitations in the different listening conditions as well as the limitation of listening with just one hearing implant.

Materials and Methods: One-year follow-up (6 weeks, 6 months and 1 year) of clinical (surgery, post-operative pain) and audiological data (pre- and post-operative audiometric thresholds, word recognition in quiet, aided thresholds) of the first subjects implanted in Leuven (Belgium) or Nijmegen (The Netherlands), are presented.

In Belgium and the Netherlands reimbursement for this implant system is limited and therefore only unilateral treatment with the Carina is considered.
Results: Patient implanted with the Carina system demonstrate promising hearing thresholds and speech understanding with both the button (i.e. external microphone) and the fully implanted microphone. Some patients indicate a preference for the button because of better speech understanding and less noise, other prefer the invisible option. The Carina system is an effective treatment for patients with moderate to severe sensorineural or mixed hearing loss. Possible noise problems, especially with the internal microphone, are probably related to a partial intact cochlea (i.e. pure conductive hearing loss).

Unilaterally implanted patients with bilateral hearing loss benefit more from a second device compared to patients receiving an implant while having a contralateral normal hearing ear. We demonstrate this by comparing sound localization and speech understanding in patients fitted bilaterally with the Codacs (n=1), Bonebridge (n=2), VSB (n=3), percutaneous bone-conduction device (n=11), and Bonebridge/VSB (n=1).

Conclusions: Preliminary data indicates that bilateral implanted patients lateralize, instead of localize, sounds. True binaural fusion seems not possible. Still, the benefit of bilateral treatment as compared to unilateral treatment is significant.

3
BINAURAL BENEFIT WITH THE NEW ACTIVE BONE-CONDUCTION SYSTEM OSIA
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Department of Otorhinolaryngology - Head and Neck Surgery Freiburg, Germany
Freiburg, Germany

Purpose/Aim: Subjects with bilateral conductive hearing loss (CHL), or mixed hearing loss (MHL) show difficulties in speech understanding, particularly in noisy listening situations. Unilateral or bilateral treatment with bone-conduction implants (BCI) has been shown to successfully improve hearing capabilities in these subjects. The aim of this study is to assess the binaural benefit in speech recognition obtained with bilateral implantation of the new active bone-conduction system Osia in adult patients with bilateral CHL or MHL. The Osia enables direct bone conduction stimulation via an osseointegrated implant with a piezoelectric transducer controlled by an external sound processor.

Materials and Methods: To date, two adult bilaterally implanted Osia patients with bilateral MHL have been included. Speech reception thresholds in noise (SRT) were assessed using a modified version of the Oldenburg sentence test (OISa) in three listening conditions: right Osia, left Osia, and bilateral Osia. The speech stimuli were OISa sentences which were presented from the front at an adaptive level. Speech-modulated background noise was presented at 65 dB SPL from three loudspeakers (90°, 180°, 270°) simultaneously and uncorrelated.

Results: The two bilateral Osia patients showed differing outcomes. There was no binaural benefit in patient 1 who obtained SRTs of -9.3, -9.85, or -9.5 dB SNR with right, left, or bilateral Osia, respectively. In contrast, patient 2 achieved SRTs of -11.05, -9.05, or -12.65 dB, with right, left, or bilateral Osia, respectively, i.e. a binaural benefit in speech reception of 1.6 dB.

Conclusions: Preliminary results show that the binaural benefit obtained with bilateral Osia seems to differ across patients and that there might be a relation between this benefit and bone-conduction thresholds and their interaural asymmetry. Further research is needed in order to derive reliable conclusions for individual counseling of Osia candidates regarding unilateral versus bilateral implantation.

4
HEARING AND TINNITUS REHABILITATION THROUGH BONE-CONDUCTED SOUND STIMULATION
Bahmad, Fayez *, Cardoso, Carol
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Otology Department
Brasilia, DF, Brazil

Keywords: Tinnitus, hearing loss, bone anchored hearing aid

Purpose/Aim: Objective: Assessing the auditory rehabilitation process in bone anchored hearing aid users through audiological, speech perception and tinnitus aspects
Materials and Methods: Methods: Individuals with hearing loss were assessed before and after implantation. Participants were subjected to pure tone audiometry in free field, functional gain audiometry, speech perception tests, Tinnitus Handicap Inventory (THI) in open format and to Visual Analog Scale (VAS).

Results: Results: It was found that the participants benefited from the use of bone anchored hearing aid. The difference in participants’ performance before and after bone anchored hearing aid surgery was significant in terms of hearing acuity. There was no statistically significant difference in the speech perception tests. Tinnitus assessment showed that 80% of the participants scored slight tinnitus severity in THI after using bone anchored hearing aid. Eighty percent of the participants classified their tinnitus as absent to mild in the Visual Analog Scale (VAS) after the surgery.

Conclusions: Conclusion: Based on the results of the current study, we can conclude that the participants improved both the auditory perception and the tinnitus handicap.

5
HEARING RESULTS AND QUALITY OF LIFE OF PATIENTS WITH CARINA SYSTEM IN BRAZIL
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Keywords: Carina, Audiological outcomes, quality of life

Purpose/Aim: The lack of evidence based clinical studies of totally implantable hearing systems has been a great challenge to measure safety, effectiveness and establish criteria to compare functional results with the current gold standard treatment of hearing loss, the hearing aids. The aim of this study is to present and analyze the hearing results and quality of life of the 5 patients (6 ears) submitted to surgery of fully implantable hearing system CARINA in Brazil

Materials and Methods: During the period from January to December of 2012 were selected 5 patients (6 ears/1 patient bilateral) for implantation of Totally Implantable Prosthesis CARINA. Patients were submitted to tonal audiometry and speech tests. To hearing analysis we have applied audiometric tests with and without hearing aids. All tests were performed in separate ears and with contralateral ear occlusion (OCO)

Results: The mean age of the study group was 42.10 years (15-66) The audiological data obtained in the pre-operative time without HA were: mean air conduction thresholds at frequencies of 0.5kHz-4kHz with OCO: 48.75dB; Monosyllabic WRS at 60dBNA: 42.67%; test in noise with SNR+5dBNA: 46.67%. The results obtained with sound amplification were: average thresholds by air conduction at frequencies of 0.5kHz-4kHz with OCO: 25.63dB; WRS at 60dBNA with OCO: 90.67%; test in noise with +5 dBSNRNA: 88.33%. Functional gain obtained after hearing test was 29.38dB. All patients experienced improvement in the audiometric results in both tests in quiet and noisy environments as: average thresholds by air conduction with OCO: 1 Month: 43.33dB and 24th Month: 34.58dB. The WRS improved: 1 Month: 73.00% and 24th Month: 84.33%. Finally, tests in noisy environment with +5dBSNRNA: 1 Month: 76% and 24th Month: 78%. The test results of quality of life were QL1=64.33 points; QL2=20.01 points; QL3=11.04 points and the QL4=9.0 points.

Conclusions: The CARINA was effective in hearing stimulation of five patients in our series. Meanwhile, the functional gain and the WRS was lower compared with those achieved with HA. Finally, all patients had significant improvement in quality of life scale when measured by HHIA, superior to those achieved with preoperative use of HA.

6
TRANSCUTANEOUS BAHA S IN CHILDREN-
A STEP IN THE RIGHT DIRECTION
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Ent and Undergraduate Medical Department
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Keywords: Transcutaneous, BAHA, Children

Purpose/Aim: It is well recognised that the use of percutaneous BAHA systems is restricted in children due to recurrent skin inflammation and concerns about cosmesis. The Cochlear™ Baha® Attract system was designed to overcome these
problems by offering an intact-skin alternative. This study analysed surgical experience and compliance with the Attract system in children at our centre.

**Materials and Methods:** A retrospective descriptive review.

**Results:** Nineteen children (mean = 9 years at surgery, range= 3-17 years) were identified with 4 to 60 months follow-up. 2/19 were subsequently lost to long-term follow-up. Regarding co-morbidity, 5/19 children had a recognised syndrome (1 CHARGE, 1 Treacher-Collins, 3 Downs Syndrome). 17/19 children had unilateral and 2/19 bilateral insertions. Only 2/19 underwent 2-stage surgery. 2/19 were transitioned from Baha® Connect to Baha® Attract due to recurrent skin infections and failed osseointegration, and 1/19 were transitioned in the opposite direction. No intra-operative complications were reported. In the immediate post-operative period (2 weeks) there was one haematoma (conservatively managed with pressure dressing) and one skin inflammation (conservatively managed with topical Bactroban). Magnet strength information was available for 13/19 patients. Five patients decreased their magnet strength following the initial audiprocessor loading as the soft tissue swelling settled, mean 14 weeks (range 5-30weeks). Three (3/19) patients received two magnet strengths to alternate depending on daily activities (e.g. dancing) or to manage potential skin reactions. Skin discomfort was reported as the main reasons for reduced compliance. 2/17 children were non-users, both were syndromic. The surgical incision reduced in length and changed orientation in response to surgical experience during the study period.

**Conclusions:** Until, the next generation of active transcutaneous BAHA devices becomes available the Cochlear™ Baha® Attract system remains an option, especially for those children and young people whose utilisation of percutaneous Baha has been restricted due to recurrent skin inflammation. It is important to discuss with children and parents that increased wearability must be measured against reduced hearing gain. It should be noted that inappropriate magnet strength impacts audiprocessor retention, comfort and ultimately compliance.

7

**PRELIMINARY STUDY OF OSIA IN CHILDHOOD**

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**Keywords:** Osia1, Pediatric2

**Purpose/Aim:** The aim of the study was to test the audiological performance and benefit of the new, active bone conductive hearing aid i.e. Osia (Cochlear®) system on pediatric patients.

**Materials and Methods:** Implantees were selected based on the following criteria: age below 18, conductive or mixed type hearing loss - within the audiology indication range of BAHA.

Preoperative CT scan was performed. Temporal bone thickness was measured carefully at implant site. Necessary size and optimal position of the implant was assigned based on the bone thickness measurements and anatomical situation. Each patient was screened audiologically: pure tone and speech audiometry was performed preoperatively with and without BAHa Softband and postoperatively with Osia. Quality of Life (QoL) test was also filled. Pre- and postoperative audiological outcome and QoL results were compared. Results were analyzed statistically.

**Results:** In some cases, based on preoperative CT results, retrosigmoid implantation and 3 mm implant size was necessary for safety purposes. However, this modified retrosigmoid implant position did not change the protocol of surgery. Average surgical time was ~90± 10min. No soft tissue reduction was performed. No postoperative wound healing complication was detected. Postoperative pain, or discomfort was acceptable. Numbness reduced with time. Sound
processor fitting started after the 6th postoperative week. No discomfort, pain or numbness occurred during the sound processor-wearing period. Osia system accomplished significant improvement in pure tone and speech audiometry results compared to the Softband test. Air-bone gap could be closed or reduced below 20 dB in all test frequencies.

**Conclusions:** Osia surgery requires thorough preoperative CT analysis and preoperative planning in childhood, however, surgical steps are still easy and straightforward in such cases. The system provides good hearing performance and comfortable wearing with acceptable esthetic outcome.

8

**NURSELED OUTPATIENT CLINIC FOR PATIENTS WITH BONE ANCHORED HEARING SYSTEM (BAHS)**

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**Purpose/Aim:**
Patients with BAHS needs continuity and the possibility to discuss physical, mental and social issues after BAHS surgery. This might be achieved if the patient see the same nurses in a nurseled outpatient clinic postoperatively.

**Materials and Methods:** The nurseled clinic opened in March 2014. Three nurses was trained in BAHS care by an ear surgeon. Written instructions for the patient care was produced to ensure a unilateral practice.
Patients are seen 10 days postoperatively and anually for 5 years thereafter. The nurse checks for signs of infektion, skinlevel, stability and correct placement of the abutment. The nurse talks to the patient about how to get the most out of the BAHS.
An ear surgeon is always available if needed.
The clinic has undergone ongoing improvements according to patients response and to nurses experiences.

**Results:** The nurseled clinic has been running for 5 years and the patients express satisfaction with the clinic. Emerencuy appointments are available on the same day in case of problems and telephone contact is widely used.

**Conclusions:**
It has been possible to develop and run a nurseled clinic with independent BAHS care for both children and adults. Experience shows that patients appreciate the continuity and trust with the three nurses.

9

**INTER-OBSERVER VALIDITY ASSESSMENT OF SKIN TOLERABILITY SCALES**

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**Keywords:** Skin reaction, Holger's, classification

**Purpose/Aim:** Percutaneous bone anchored hearing implants (BAHI) imply a continuous breach in the skin surrounding the temporoparietal skull bone region. To compensate for this breach, immunological mechanisms in the subcutaneous tissue surrounding the implant become more active. A grading system to standardize the reporting of such soft tissue reactions was introduced by Holgers et al in 1988. Since then, improvement of surgical techniques and innovations of implant design have led to less invasive surgeries, resulting in fewer adverse skin reactions. Several reports and clinical experience mention that the Holgers classification is outdated. Thus, new skin tolerability scales have been proposed, but their accuracy, in comparison to the Holgers classification, have yet to be well established. The primary objective of this study was to determine and to compare the variability amongst scorers for three skin tolerability scales used in post-operative assessment of bone anchored hearing implants.
Materials and Methods: A group of ENT surgeons, residents, and health professionals who have experience with bone anchored hearing implant surgery graded twelve BAHI skin reaction images using three scales: the Holgers classification, the IPS scale, and the Tullamore scale. To determine the variability and to compare outcomes of these skin tolerability scales, Cohen’s kappa value for inter-observer agreement was calculated for each image and for the complete dataset. Moreover, the level of clinical experience of scorers was considered, as its effect on inter-observer agreement was evaluated.

Results: The Cohen’s kappa value was low for all three skin tolerability scales. No significant difference demonstrating less variability of a scale over another was detected. Experience with bone anchored hearing implants did not affect variability scores.

Conclusions: Adherence to the three classification scales is generally poor for all three skin tolerability scales amongst scorers. Nonetheless, the endorsement of these scales is recommended for BAHI follow up care. Improved classification scales are needed to adequately address skin reactions and the recommended therapeutic and follow up regimen per reaction score.

10

SMOKING AS A RISK FACTOR FOR SPONTANEOUS IMPLANT EXTRUSION

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Keywords: Smoking, cigarette, extrusion

Purpose/Aim: Numerous studies have identified smoking as a risk factor for osteoporosis and bone fracture and other studies have reported higher revision rates of orthopedics hip and knee replacements as well as dental implants in smokers compared to nonsmokers. There are limited reports examining the effect of smoking on bone anchored hearing implant survival (BAHI).

Materials and Methods: We report a case of two BAHI extrusions occurring in a heavy smoker patient. The literature was reviewed to investigate the association between BAHI loss and smoking and the possible underlying mechanisms that may account for auditory osseointegrated implant loss and smoking.

Results: The patient experienced delayed healing and increased pain around the abutment site. After the first extrusion, a revision surgery was conducted. Both surgeries were unproblematic. After both primary and revision surgery, the implant extruded 2 days and 1 week, respectively, after coupling of the sound processor. The timing of the implant loss suggests that the bone implant interface did not achieve adequate primary stability through the surgeries and osseointegration never occurred.

Conclusions: Contributors to bone strength such as bone mineral density and microstructure are deleteriously affected by smoking. Smoking has been associated with significantly increased risk for fracture. Smoking may lower bone mass via direct effects on bone cells or indirectly affecting calcium absorption and vitamin D metabolism, adrenal and gonadal hormone levels, and/or free radical levels. Smoking adversely affects hormones and enzymes involved in bone regulation, and has inhibitory effects on osteogenesis and on angiogenesis. At the cellular level, nicotine reduces the proliferation of red blood cells, macrophages, and fibroblasts and increases micro clot formation in blood vessels through increased platelet adhesiveness. This case report and review of literature serve to demonstrate the risks associated with bone anchored hearing implant loss and smoking. Consideration should be given when implanting BAHIs in heavy smokers.
PROCESSOR COUPLING TIMING FOR PEDIATRIC RECIPIENTS USING RESONANCE FREQUENCY ANALYSIS

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Purpose/Aim: Surgical installation of the bone anchored hearing implant (BAHI) screw and abutment is typically followed by a latency period before coupling of the sound processor. It is thought that this latency period may enhance osseointegration and subsequent implant stability by limiting micromotion at the bone-implant interface following implantation. Limited clinical data is available to support the duration or efficacy of such a latency period. A prospective cohort study was conducted to investigate the use of peri-operative Resonance Frequency Analysis (RFA) in indicating the optimal latency period prior to processor coupling.

Materials and Methods: All patients undergoing BAHI surgery at our pediatric implant center were included. All implantations were performed in a single-stage surgical procedure by the same surgeon. Patients were included if an intra-operative baseline RFA measurement and at least two follow up measurements were obtained. The follow up period lasted 15 weeks after implantation. RFA threshold shifts (difference from baseline within patient) were used to analyze and interpret stability outcomes.

Results: In total, 29 BAHI were placed in 13 pediatric (mean age: 10.6, range: 5 – 17 years) and 16 adult (mean age: 45.9, range: 18 – 70) patients. The most common surgical approach for BAHI surgery in our cohort was the MIPS technique in 20 patients (5 pediatric) followed by implantation through linear incision in 9 patients (8 pediatric). There is an increase in stability quotient after implantation seen similarly in both cohorts. After 7 weeks of implantation, stability assessments regress to intra-operative scores in adults. However, a significant increase in stability quotients were found at the 3 to 6 weeks in the pediatric cohort.

Conclusions: Currently there is no standardized objective measurement of in vivo implant stability or consensus on the duration of the latency period, prior to processor coupling. Our clinical data show that 1) for pediatric patients, a 6-week latency period prior to coupling the sound processor is warranted. 2) For adults, processor coupling could likely be performed as soon as skin around the abutment site has healed. The non-invasive RFA method for measuring implant stability has clinical relevance and could be an important tool added to BAHI surgery.

EFFECT OF NOISE REDUCTION ON LISTENING EFFORT FOR BONE-ANCHORED USERS

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Keywords: noisereduction, listeningeffort, pupillometry

Purpose/Aim: The objective of this study is to evaluate the effect of the new noise-reduction scheme of Ponto 4 on listening effort for bone-anchored users.

Materials and Methods: The noise-reduction scheme evaluated in this study consists of a fast-acting combination of a minimum variance distortion-less response beamformer and a single-channel Wiener post-filter. This combined system is implemented in Ponto 4 as a feature called OpenSound NavigatorTM (OSN). Listeners with a conductive or mixed hearing loss, or with single-sided deafness are included in this study. The patients with mixed hearing losses have bone-conduction pure tone thresholds lower than or equal to 40 dB HL. After being fitted with Ponto 4, listening effort is estimated by measuring pupil dilation with an eye-tracking camera during a speech-in-noise task with target speech presented from the front and a 4-talker babble noise presented at the side and back of the participant. Listening effort and speech intelligibility performance are evaluated in two conditions: OSN active and OSN inactive. The speech and the noise are set at a fixed level to yield a positive and ecologically-valid signal-to-noise ratio.

Results: The outcomes of the study will be presented at the conference.
Conclusions: The behavioral and objective outcomes of this study provide evidence of the effect of OSN, as implemented in Ponto 4, on speech intelligibility and listening effort for bone anchored hearing systems users. The conclusions of the study will be presented at the conference.

SSD AND OSSEINTEGRATED IMPLANTS LONG TERM FOLLOW-UP
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Keywords: SSD, OSSEOINTEGRATED IMPLANTS.

Purpose/Aim: Evaluate subjective outcome in our patients with SSD after a minimum of 36 months follow-up. Evaluate our results of device use in these patients.

Materials and Methods: We present 19 patients with SSD and osseointegrated implants operated between Sept.2010 and Sept. 2016. We’ve studied data from surgery type, device type, complications during surgery and quality of life survey. We’ve used Berna Survey to evaluate the benefits obtained in our patients, that survey is a 10 questions test about everyday listening situations. We’ve done these questions to our patients with more than 36 months of follow-up.

Results: Our preliminary results show that more than 90% of our patients are daily users of the device and for more than 8 hours a day. This use doesn’t reduce over time and they use it in almost every listening situation as obtained after Berna survey.

Conclusions: Berna Survey is a useful tool to evaluate the long time benefit obtained. Osseointegrated implants, in our scenario, are a good option for SSD patients audiological rehabilitation.

PERCUTANEOUS IMPLANTS MINIMALLY INVASIVE SURGERY: OUR PUNCH TECHNIQUE RESULTS
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Keywords: Punch Technique, Percutaneous implants, surgery

Purpose/Aim: Study our punch technique results after 5 years of experience. Show our punch technique video.

Materials and Methods: We present 45 percutaneous implants patients operated with punch technique in our Hospital, since Nov. 2013 until Nov. 2018. We’ve studied our patients data, surgery time, intraoperative complications, implant used, skin thickness, and extrusion rate. We present our punch technique video.

Results: We have 45 patients operated with punch technique: 42 primary Punch Technique and 3 secondary. In 41 patients we’ve used a 4 mms implant and in 4 patients we’ve used the 3 mms implant. We have 3 migrations to Attract system. We have no intraoperative complications. Our surgery time was divided in 10 patients groups: first 10 patients we had a surgery mean time of 20 minutes, second 10-patients group mean surgery time was 16,3 min., the third was 11 min., and the last 10 patients group mean time was 6,5 min. We’ve had an extrusion rate of 4,44% (2 patients).

Conclusions: The Punch Technique is our gold standard surgery technique when we’re planning to operate a
HEARING OUTCOMES AND DAILY USE WITH AN ACTIVE TRANSCUTANEOUS BCI

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Keywords: datalogging, self-reported Use, outcomes

Purpose/Aim: The aim of the study was to evaluate the audiological outcomes and to compare the objective data logging vs self-reported daily use at 6 months follow-up in patients implanted with an active transcutaneous BCI.

Materials and Methods: Eleven patients (six female and five male), with a mean age at implantation of 56 (range 24-74) years, were tested during their six-month follow-up appointment. Preoperative unaided and postoperative aided Pure Tone Average (PTA1-4kHz), Speech in Quiet (SPIQ) and Speech in Noise (SPIN) were measured. Data logging was read at the time of visit and compared to the patient’s self-reported use. Five patients had a conductive - mixed hearing loss and six single-sided deafness (SSD).

Results: At six-month follow-up a mean functional improvement of 52.4 dB HL (PTA1-4kHz) was measured. A significant improvement for SPIQ was found between the unaided preoperative condition and the aided preoperative condition on softband (52.37% to 92.32% at 65 dB SPL) and between the postoperative aided condition (52.37% to 97.02%). Furthermore SPIN improved significantly between the preoperative unaided condition (4.75 dB SNR) and the postoperative aided softband condition (-0.83 dB SNR) and postoperative aided condition (-2.74 dB SNR). No significant difference was found between the preoperative softband condition and postoperatively with the BONEBRIDGE™ system. All patients report an average wearing time of 13.0 hours per day (range 8.0 – 16.0) and indicate that they use their sound processor on average 6.9 days per week (range 6-7). This corresponds to the registered hours of use via data logging which recorded 13.1 hours per day (range 10.0 – 15.0).

Conclusions: The BONEBRIDGE™ active transcutaneous implant system produces a significant improvement in SPIQ and SPIN in patients with a conductive-mixed hearing loss or SSD. Comparison of data logging and self-reported use demonstrate that the sound processor is worn all day and on a daily basis.

HEARING OUTCOMES AND DATALOG USING A PASSIVE TRANSCUTANEOUS BCI

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Keywords: Hearing outcomes, datalogging, self-reported Use

Purpose/Aim: The aim of the study was to analyse the hearing outcomes and subjective benefit in patients with single-sided deafness (SSD), conductive or mixed hearing loss implanted with a transcutaneous BCD.

Materials and Methods: A retrospective study was performed in 30 patients implanted with a transcutaneous bone conduction system (Cochlear Baha® Attract™) at the Antwerp University Hospital between 2015 and 2018. Different outcome measures were performed pre- and postoperatively: pure tone audiometry (PTA), speech perception in quiet (SPIQ), speech perception in noise (SPIN), self-reported use and data logging. Subjective benefit was reported using the Audio Processor Satisfaction Questionnaire (APSQ).

Results: The mean age at implantation was 56 (range 21-79) years. Half of the patients had mixed hearing loss, 26%
conductive hearing loss and 24% SSD. A mean average functional improvement of 33 dB HL (1 – 4 kHz) was measured. A significant improvement between the preoperative unaided and postoperative aided SPIQ condition of 46.27% (tested at 65dB SPL) was found. SPIN improved with 9.2 dB SNR. The results between the preoperative aided softband condition and the postoperative aided condition were comparable emphasizing the importance of a softband trial before implantation. For daily use of the sound processor data logging and the patient’s self-reported use was compared. Patients indicated that they wore their Baha® sound processor on average 10.2 hours per day (SSD group) and 8.0 hours per day (conductive-mixed group), while data logging showed a rather low wearing time with on average 4.5 hours per day (SSD group) and 4.8 hours per day (conductive-mixed group). In both subgroups this difference was found to be significant.

Conclusions: The Baha® Attract™ system is an effective solution for Baha indications in patients with a conductive-mixed hearing loss or SSD. The results obtained during the preoperative softband trial are a valid indication of the expected improvement with the sound processor on the implant. Patients indicate that they are generally satisfied with their sound processor, but the data logging shows a relatively low wearing time than reported by the patients.

17

PREDICTIVE CAPACITY OF QUESTIONNAIRES FOR SUCCESSFUL IMPLANTATION IN AURAL ATRESIA

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Keywords: aural, atresia, questionnaires

Purpose/Aim: To perform an initial assessment of CHILD and Speech, Spatial and Qualities of Hearing (SSQ) questionnaire results in patients with unilateral congenital aural atresia (CAA), both pre-operatively and postoperatively, and to assess if these results have any predictive capacity for patient selection in the planning of auditory implantation.

Materials and Methods: A retrospective review of patients with unilateral aural atresia registered on the Scottish National Microtia Database, from 5 to 18 years old, with data correlated from both their preoperative and postoperative CHILD questionnaire and Speech, Spatial and Qualities of Hearing (SSQ) questionnaire outcomes.

Results: 73 patients with unilateral CAA were identified, with a median age of 10 years. 42 patients were male and 31 were female. The average preoperative SSQ score from parents was 6.624 (± 0.782, 95% CI) and from children was 6.968 (± 0.628). The average preoperative CHILD score from parents was 5.697 (± 0.736), and from children was 6.216 (± 0.755). These scores were subdivided into two groups; patients who wanted an implant and those who didn’t. The average preoperative SSQ score was noticeably higher in patients who did not want an implant (7.70 [± 0.987]) compared to those who did (6.27 [± 1.140]), p=0.06. The average preoperative CHILD score was also higher in patients who did not want an implant (7.25 [± 0.791]) compared to those who did (6.93 [± 0.202]), although not to the same extent (p=0.48).

86% of children who did proceed to have an implant were confirmed to still be using it 12 months after surgery.

Conclusions: Hearing questionnaires used pre-operatively show that patients who have had subsequent auditory implantation had lower scores overall than patients who did not have an operation, and that patients who continued to use devices more than 3 months after their operation were also more likely to have had lower preoperative scores. The majority of children who had surgery continued to use the implant one year later. Further questionnaire results and increased patient numbers are needed to determine the extent of both clinical and statistical significance of this predictive capacity.

18

BENEFITS OF FITTING BILATERAL BAHS: IMPACT ON AUDITORY WORKING MEMORY

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Page 131
Keywords: working memory, bilateral fitting, BAHS

Purpose/Aim: The purpose of this study is to investigate the benefits of bilateral implantation in adult bone-anchored users in terms of spatial resolution abilities (minimum audible angle), as well as in terms of auditory working memory. Additionally, the aim is to investigate the performance that is perceived daily by the bilateral users.

Materials and Methods: This is a cross-over study, where listeners serve as their own control. Listeners with a bilateral conductive or mixed hearing loss are included in the study. Inclusion criteria are symmetrical bone-conduction pure tone thresholds with PTA lower or equal to 65 dB HL on both ears. After optimally fitting the patients unilaterally and bilaterally with Ponto 3 SuperPower, spatial resolution is estimated by measuring the minimum audible angle (MAA) in two conditions: both sound processors active (bilateral condition) and only one sound processor active (unilateral condition). At the second visit, a memory recall test, the Sentence-final Word Identification and Recall (SWIR) test is performed in both conditions (unilateral and bilateral). Self-reported performance with the patient's device is also evaluated via a questionnaire.

Results: The outcomes of the study will be presented at the conference.

Conclusions: This is the first study to evaluate the benefit of bilateral fitting in terms of auditory working memory for bone-anchored hearing systems users. The conclusions of the study will be presented at the conference.

19

UHL IN CHILDREN: PARENT PERSPECTIVES ON BONE CONDUCTION DEVICE SELECTION

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Keywords: parent perspective, device selection, unilateral hearing loss

Purpose/Aim: Mulla, Wright and Archbold (2013) examined the views and experiences of families whose children used bone conduction hearing devices. While they found parents viewed the bone conduction hearing device to be very helpful for their child, moving through the course of care was very complex. This work aims to understand current experiences of parents in North America and explore their perspectives on the pathway for using bone conduction technology for permanent unilateral conductive or mixed hearing loss with their children.

Materials and Methods: An online survey will be distributed to over 200 parents in North America to gather information on parent device selection for their children with permanent unilateral conductive or mixed hearing loss. The survey consists of twenty-eight questions, with multiple choice and one open-ended item. During the presentation, the findings of the survey and their potential impact will be explained.

Results: Approximately one hundred responses from parent survey items will be compared, evaluated and described. Item categories include those relating to experiences of the pathway of care, hearing device intervention, treatment, and post-treatment. Open-ended survey items will be examined to understand potential gaps for parents when considering bone conduction devices for their children with permanent unilateral conductive or mixed hearing loss.

Conclusions: This work is currently underway. Conclusions are not available at the time of the abstract submission.

20

BILATERAL BAH A FITTING: AUDITORY AND QUALITY OF LIFE BENEFITS

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Keywords: Bone Anchored Hearing Aid, Conductive Hearing Loss, Deafness

Purpose/Aim: To evaluate the auditory benefits (speech perception and binaural summation of loudness) and quality of life with the use of Bone-Anchored Hearing Aid (BAHA) in both ears.

Materials and Methods: Evaluation of five users of the BAHA implant system bilaterally. Patients will be submitted to "The Hearing in Noise Test" (HINT) for speech-to-noise measurements and binaural summation of loudness test. The "The Speech, Spatial and Qualities of Hearing Scale" (SSQ) questionnaire will also be applied. All tests will be performed under uni and bilateral listening situations (one device off and both devices on).

Results: The results of speech-in-noise tests and binaural summation of loudness test will be described, comparing uni and bilateral listening situations. Benefit scores and user satisfaction will also be detailed, under the same conditions, with the SSQ test.

Conclusions: It is expected that speech perception in the noise evaluated by the HINT test is superior in bilateral use of BAHA and that the phenomenon of binaural summation of loudness can be observed. In addition, we believe that SSQ scores will demonstrate improved quality of life for all patients.

LONG-TERM QUALITY OF LIFE WITH A PERCUTANEOUS BCD

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Keywords: long-term, HRQoL, GHSI

Purpose/Aim: In previous studies, it was demonstrated that hearing-related quality of life (HRQoL) in patients indicated for a bone-conduction device (BCD) improved after BCD-implantation. Unfortunately, little is known about long-term HRQoL, change in quality of life over time, and differences in HRQoL between different indications. Therefore, this study aimed to evaluate long-term HRQoL across and for separate indications in a large group of patients with a BCD.

Materials and Methods: In two previously conducted clinical trials, HRQoL data before and after implantation of a bone conduction device was prospectively collected in 85 patients. In these patients, the Glasgow Health Status Inventory (GHSI) was assessed before implantation, at 6 months after implantation and at 36 months after implantation. The Glasgow Benefit Inventory was conducted at 3 and 12 months postoperatively. Scores on these questionnaires, as well as demographic data and clinical variables, were used for data-analysis in the current study. Primary outcome measures were GHSI scores at 36 months compared to before surgery and the GBI scores at 12 months, for all patients. Secondary assessment consisted of correlation analysis between the HRQoL scores and clinical variables such as sound processor use, adverse events and postoperative complications. For further analysis, patients were divided into three subgroup, based on indication: (1) acquired bilateral conductive/mixed hearing loss, (2) unilateral conductive/mixed hearing loss, (3) single-sided deafness. The 36-month GHSI scores, 12-month GBI scores and change in GHSI and GBI scores over time, were compared between these subgroups.

Results: Data-analysis is currently being performed.

Conclusions: Results will be available and presented during the conference.

AUDIOLOGICAL OUTCOMES OF THE OSIA SYSTEM™, A NEW GENERATION OF OSSEOINTEGRATED IMPLANTS. FOLLOW-UP TO 6 MONTHS

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Keywords: Audiometry, Benefits, Active implant

Purpose/Aim: To prospectively evaluate the audiological results of this new active bone vibrator in 10 patients with conductive hearing loss. Compare the results with the Baha Softband in the same patients. To compare the gain, the results of the speech tests and compare the performance, the satisfaction and the impact on the quality of life of the patients

Materials and Methods: Pre evaluation was done with Baha 5 and softband. Postoperative evaluations will be done. Functional gain will be measured at 2 and 6 months as well as speech recognition using HINT. In these same periods, the SSQ, APHAB, and Glasgow Inventory questionnaires will be completed

Results: The pre-operative tests done with Baha 5 and the softband presented the following average results: Functional gain of 31.27 dB, threshold of perception of speech in noise -0.71 dB, Recognition of speech in noise at the S/N ratio = 0 dB with a 69.10 % of correct answers and the S/N ratio = +5dB with 91.24% correct answers. The patients are 4 weeks post-operative and there are still no data available. The surgery and healing were without incident. To date, all patients use the device without local problems

Conclusions: All patients are very satisfied with the quality of the hearing obtained. The complete audiological results (described in Method) at 2 and 6 months and the pre and post-operative comparisons will be presented at the meeting

23

FUNCTIONAL OUTCOME COMPARISON AMONG VARIOUS BONE CONDUCTION IMPLANTABLE HEARING AIDS

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Purpose/Aim: We aimed to evaluate the audiological outcome of different BCHIs in patients with mixed hearing loss (MHL) and unilateral hearing loss (UHL), and compared hearing gains with BCHIs between them.

Materials and Methods: A retrospective review of audiological outcome and a compliance of BCHIs was performed in 21 patients with MHL and 18 patients with UHL. All of the participants underwent implantation of Baha connect, Baha attract, or Bonebridge. We compared the functional gain and effective gain between the devices.

Results: The averaged functional gain of BAHA connect with BP 110 (n=7), Baha attract with BP 110 (n=4), and Bonebridge (n=10) was 33.1±17.7, 24.7±13.0, and 35.2±12.6 dB in MHL, respectively, and the difference of the functional gain between the devices was not significant (p=0.477). The averaged effective gain of Bonebridge (n=10) was higher (-2.8±11.8 dB) than Baha attract (n=4, -10.3±9.5 dB), and the difference was marginally significant (p=0.054). In UHL patients, the averaged functional gain of Bonebridge (n=15) and Baha attract (n=3) was not significantly different between two devices (21.4±8.1, 20.9±7.1, respectively) (p=0.678). The averaged effective gain of Bonebridge was significantly higher than that of Baha attract (-11.9±3.4, -19.6±2.9, respectively) (p=0.005), and the difference between the two devices was mostly prominent at 3 kHz (p=0.016). Among 21 patients with MHL, 17 patients used BCHD consistently (81%), whereas, the usage rate of BCHD in UHL was only 56 % (n=10/18). In UHL patients, constant user group showed higher functional gain than non-constant user group (24.2±4.3 vs 17.7±9.7, p=0.068), and the difference was significant at 3kHz frequencies (37.5±8.6 vs 19.4±12.9 at 3kHz, p=0.004).

Conclusions: Bonebridge showed higher effective gain in patients with MHL and UHL. The usage rate of BCHI was significantly lower in UHL than MHL, and the patients who showed higher functional gain used BCHIs more consistently.

24

TECHNICAL EVALUATION OF A SPEECH ENHANCEMENT SYSTEM FOR BONE CONDUCTION

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**Keywords:** Signal Processing, Noise Reduction, Bone Conduction

**Purpose/Aim:** Hearing assistive devices typically feature various signal processing strategies to enhance the listening situation of the users. The Ponto 4 bone conduction device utilizes the Velox S platform from Oticon’s conventional hearing aids, enabling the OpenSound Navigator speech enhancement system. OpenSound Navigator replaces conventional directionality and noise reduction systems. Both technologies still exist in an advanced version, but they are used in a very different way. A Noise Removal module, a fast-acting single-channel noise reduction, is placed after a Balance module which implements a minimum-variance distortion-less response (MVDR) beamformer. Importantly, both modules receive a spatially-informed noise estimation realized by a multi-microphone noise estimator. The objective of this study is to technically evaluate the performance of the OpenSound Navigator on a bone conduction device, which substantially differs from a conventional hearing aid in placement and sound transmission.

**Materials and Methods:** The Ponto 4 sound processor was tested on an artificial head placed in a loudspeaker setup with spatially separated speech and noise. The Balance and the Noise Removal modules were evaluated by individually enabling and disabling them, and the amount of noise removed was quantified. Furthermore, the speech preservation was evaluated in terms of level reduction and modulation ratio relative to a signal with no speech enhancement processing.

**Results:** The results show that OpenSound navigator is able to reduce the noise, with minimal effect on the target speech. The performance is comparable to the performance observed on a conventional hearing aid using the OpenSound Navigator.

**Conclusions:** Despite the differences in position and sound transmission relative to a conventional hearing aid, the OpenSound Navigator is able to enhance the listening situation by reducing noise while preserving target speech.

25

**DO ANTIBIOTICS IMPROVE SKIN REACTIVITY FOLLOWING AUDITORY OSSEIOINTEGRATED IMPLANT PLACEMENT?**

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**Keywords:** bone anchored hearing aid, osseointegrated auditory implant, antibiotics

**Purpose/Aim:** At the end of this presentation, participants should be able to understand the role of postoperative antibiotics following percutaneous auditory osseointegrated implant placement.

**Materials and Methods:** A total of 44 patients who underwent percutaneous auditory osseointegrated implant placement were divided into those who received five days of postoperative antibiotics (AB) and those who received no antibiotics (NAB). All surgery was performed using the same surgical technique (Minimally Invasive Ponto Surgery). Variables recorded included patient demographics, Holgers skin reaction score, complications, and need for further intervention.

**Results:** A total of 23 patients received prophylactic postoperative antibiotics (AB) while 21 patients did not (NAB). At the first postoperative visit (AB 12.7 days vs. NAB 12.3 days, p = 0.9) there were no differences in average Holgers Score (AB 0.3 ± 0.7 vs. 0.2 ± 0.5, p =0.27). There were also no statistical differences in Holgers Score (AB 0.05 ± 0.2 vs. NAB 0.1 ± 0.3, p = 0.25) at most recent followup visit (AB Mean 97.5 days vs. NAB 102.8 days, p = 0.84).

**Conclusions:** The use of postoperative antibiotics does not appear to confer significant benefit to skin reactivity in patients receiving percutaneous osseointegrated auditory implants. Such findings support the theory that skin reactivity, when it does occur, may not be an infectious-mediated process.
A DECADE OF BAHÀ BRAZIL: DEMOGRAPHIC PROFILE OF OSSEOINTEGRATED IMPLANTS

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Keywords: Bone-anchored hearing aid, Baha, Hearing loss

Purpose/Aim: The Baha® system is already an established method for the treatment of conductive / mixed hearing loss and also for the treatment of single-sided deafness. Currently, few studies with Baha® presents data with large casuistics. Thus, studies with representative numbers of participants and aiming to collect long-term results continue to be of great value to the scientific community as they can provide important information for new indications, guidance, counseling and rehabilitation of future patients.

The study aims to describe and investigate the demographic profile of patients implanted with Baha® in the last 10 years, predominantly in the state of Paraná, assisted / operated by one otologic surgeon. The demographic profile to be traced will also be extended to surgical and clinical information for all patients.

Materials and Methods: This article presents an observational, retrospective and descriptive study. The study will be based on the analysis of medical records of patients implanted with Baha® (unilaterally or bilaterally) in the last decade, predominantly in the state of Paraná, operated / assisted by one otologic surgeon, author of this article, Ataide, A.L. There will be no exclusion criteria, since all the information, including the lack thereof, will be the subject of the study. The data to be collected will be demographic (age at the time of surgery, sex), audiological criteria of indication and causes, surgical aspects (surgical technique, implant and abutment size, laterality, complications) and follow-up (adherence to use, processor upgrade).

Results: The analysis of the variables studied covers data collected from 2009 to 2019, whose registration schedule will be extended until September 2019. The data will be compiled, submitted to statistical advice and conclusions drawn. According to preliminary data, 120 patients were implanted, 14 of them received bilateral prosthesis, 67 of which were female and 53 were male. Among the indications, conductive / mixed causes and single-sided deafness present similar prevalences, being the reason of the same ones detailed in the study.

Conclusions: The program began in 2009 and analyzes to date indicate broadly positive auditory rehabilitation results with Baha®, associated with a high degree of satisfaction and a small number of complications.

OVMA FOR DUTCH NATIONAL IMPLANT REGISTRATION, RECORDING IN PATIENT FILE

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Keywords: OVMA, registration

Purpose/Aim: A uniform registration of otological implants at the OR's in university hospitals in the Netherlands. This is for the DOQ and the LIR (Dutch registration systems for the ENT), in order to evaluate and further optimize otological operative care. Thereby, all patients can be identified immediately in the event of a calamity.

Materials and Methods: To achieve this this, the OVMA scan system was introduced in the Radboud UMC using green stickers with a data-matrix. When the implant is used in the OR, the green sticker is scanned and the information is automatically transferred to the electronic patient file (EPIC) and the Dutch registration systems for the ENT. A pilot will start in all Dutch academic hospitals to collect data.

Results: By scanning, a link between the implant and the patient who received the implant is assessed within the patient file and automatically forwarded encrypted to the mandatory LIR, as well as the DOQ registration.
Conclusions: A “bleepable” registration for all databases: EPIC, LIR and DOQ. Less administration and a lower risk of incorrect input. With this method, better inventory management is achieved.

28

ADAPTIVE FEEDBACK CANCELLING ALGORITHM FOR THE CARINA®: EXPERIMENTAL RESULTS
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Keywords: middle ear implant, feedback, microphone

Purpose/Aim: An adaptive feedback cancelling (AFC) algorithm was developed for use with the CochlearTM Carina® system and tested both in an acoustic-LDV analysis platform as in a multicenter trial to determine its effectiveness in reducing feedback, distortion and audible artifacts, to improve sound quality as perceived by recipients.

Materials and Methods: First, multiple testings were achieved across the following conditions: skin thickness, position of microphone, fixation of transducer with the Fixed Feedback canceller (FFC) and the new algorithm (AFC). Then, a prospective study was conducted at 3 centers. Patients implanted with the Carina System for at least one year were included. The study comprised two phases over 31 months. The AFC was injected in the implant processor instead of the previous FFC. Subjects were asked to rate their preferences for either feedback canceller. Differences between the two conditions were assessed in PTA and for speech score.

Results: The experimental exploratory study confirmed the ability for the AFC to overcome the dampening of the output accordingly. For the clinical analysis, 14 patients were enrolled. Ten patients completed the study, with three withdrawals and one explant from infection. Among study subjects, 93% expressed a preference, and 72% a strong preference, for the adaptive feedback canceller (AFC) over the fixed feedback canceller (FFC). Aided thresholds were similar or better from 2 kHz to 6 kHz for AFC as compared with FFC, an improvement attributed to better system stability. Word recognition scores were similar for AFC and FFC across presentation levels from 60 to 80 dB SPL. At 55 dB SPL, AFC showed a clinically significant improvement of 20%. The introduction of AFC has allowed a sequence of time-consuming positional measurements to be eliminated from the fitting procedure, making the process simpler and easier for clinician and patient.

Conclusions: The AFC appears to be more stable under complex and changing conditions, as shown by objective measures of performance, and is perceived by a large majority of users to be more comfortable and natural-sounding. The AFC is found to have achieved its design goals, and will be incorporated in future versions of the Cochlear Carina™ Fitting Software.

29

DIRECTIVITY INDEX OF A FULLY-IMPLANTABLE MICROPHONE
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Keywords: fully-implantable middle ear implant, implantable microphone, microphone directional response

Purpose/Aim: The implantable microphone is one of the key components of a fully-implantable middle ear implant. The microphone investigated in our study is a subcutaneous, omni-directional microphone, which is surgically implanted in the mastoid bone behind the ear. The most frequently used microphone position is on the posterior interior mastoid line, but due to previous surgeries or surgeon’s preference, it might also be positioned in other locations behind the ear. This may lead to variability in the directional response of the microphone. The aim of this study was to investigate the directional
response of the microphone in various microphone positions on the mastoid in different heads (see A-D in figure).

Materials and Methods: The microphone of the Cochlear Carina Fully-Implantable Middle Ear Implant was positioned in four different positions on the mastoid in vitro and in vivo. First it was placed on two different artificial heads (Cochlear Haddock and Cortex MK2) and a human cadaveric whole head. The heads were placed in the middle of a horizontal arch with loudspeakers having a distance of 15° from each other. A broadband noise (MLS) with a duration of 1.5 s was played consecutively via the loudspeakers and recorded by the microphone and a reference microphone. Additionally, the directional response of the microphone implanted in three subjects was measured in the same way as described above using custom research software. The articulation index-weighted directivity index (AI-DI) was calculated for each microphone position on all heads.

Results: As expected for an omni-directional microphone, the AI-DI was negative for all microphone positions. Preliminary results show differences in the AI-DI for the various microphone positions and indicate the mastoid tip as best microphone position for listening to frontal sounds.

Conclusions: As the implantable microphone is a crucial component of the investigated system, it is important to know the directional response of the microphone in different microphone positions. The results suggest that the mastoid tip is an optimal position for the microphone for best hearing performance.

EXPERIMENTAL AND NUMERICAL EVALUATION OF THE SKULL’S BONE CONDUCTION RESPONSE

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Keywords: bone conduction, Finite element modeling, 3D Laser Doppler Vibrometry

Purpose/Aim: Evaluation of sound propagation in osseous and non-osseous skull contents, via combination experimental and numerical methods.

Materials and Methods: Experiments were conducted on two sets of five Thiel embalmed whole head cadaver specimens. The electromagnetic actuator from a commercial BCHA (Baha® Power) was used to provide stepped sine stimulus in the range of 0.1-10 kHz, percutaneously at the BAHA location. The head response was monitored as: 1) skull surface motion; 2) promontory motion; 3) intracranial pressure (ICP). The skull surface response (at the of the ipsi-, top and contra areas) was sequentially measured at ~200 points (~ 15-20mm pitch) via a three-dimensional laser Doppler vibrometer (3D LDV) system, navigated by a robotic positioner. In addition, the 3D motion of the ipsi- and contralateral promontory were also measured. The intracranial pressure (ICP) was measured at the central, anterior, posterior, ipsilateral and contralateral temporal regions of the cranial space. Experimental data were compared with predictions from a finite element model (FEM) of the human head (LiUHead).

Results: Low frequency (<500Hz) motion of the skull surface differs between the experimental and numerical data sets probably due to different boundary conditions. Higher frequencies (>2kHz) show qualitative similarities, however, there are topological differences in the vibration pattern, potentially due to local inhomogeneities of the cadaver head, which are not matched with the model. Both the measured and predicted ICP distribution within the CSF showed the lowest response in the central region of the cranial space.

Conclusions: Both numerical and FEM methods suggest that sound is transmitted from the ipsilateral side through the occipital and temporal sections of the skull (skull base) first, which in turn activates the corresponding CSF sections at the fluid-solid boundary. Further refinement of the boundary conditions and the local variation in material properties of the skull need to be matched more closely with the FEM.

31

OTOPROTECTION USING L-N-ACETYLCYSTEINE AND DEXAMETHASONE COMBINATION IN AN IN-VITRO MODEL

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Purpose/Aim: Hearing Loss is one of the most common neuro sensory disorder affecting humans. Auditory rehabilitation is provided to hearing impaired individuals through surgery or various types of devices, middle or inner ear implants. However, ear surgery may cause Inner ear trauma by various mechanisms(i.e. noise trauma, vibration trauma, direct mechanical trauma during Stapectomy or inner ear damages during CI), all of them potentially causing damages to sensory cells of the inner ear. There is a need of otoprotective strategy to prevent sensory cell damage and improve clinical outcomes of these cases. In earlier studies L-N-acetylcysteine(L-NAC, and dexamethasone(Dex)have been shown independently to protect the HCs loss against different types of inner ear trauma. The goal of this study is to determine appropriate dosages and test the efficacy of a combination of these molecules.

Materials and Methods: OC explants were dissected from P-3 rats. Explants were divided into control(untreated and inner ear trauma controls)and experimental groups (inner ear trauma+L-NAC(different concentrations);inner ear
trauma+Dex (different concentrations); inner ear trauma+L-NAC+Dex). In inner ear trauma Groups, a 0.28-mm diameter monofilament fishing line was introduced through the small cochleostomy located next to the round window area, allowing for an insertion of between 110° and 150°; explants were cultured in media containing L-NAC alone, or Dex alone or in combination. After incubation, the explants were fixed, stained with FITC-phalloidin, imaged by fluorescence microscopy, and viable HCs were counted.

Results: There was decrease of total hair cell count in the inner ear trauma explants compared with control group. We observed that combination of L-NAC and Dex provides better otoprotection against inner ear trauma than used individual suggesting synergistic interaction. The combination therapy of L-NAC and Dex may be beneficial in other type of inner ear trauma that can result in hair cell loss.

Conclusions: Inner ear trauma involves oxidative stress and lipid peroxidation early on after the implantation. L-NAC and Dex are effective alone in protecting the sensory cells in vitro at high doses. A combination containing L-NAC, and Dex at much lower doses of each compound, is effective in protecting sensory cells. These compounds can be combined with synergistic effect allowing a decrease of potential side effects of each compound.

32

FEASIBILITY STUDY FOR MEASURING UNINTENDED ACOUSTIC STIMULATION DURING MRI

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Keywords: MRI safety, acoustic implants, unintended stimulation

Purpose/Aim: The use of magnetic resonance imaging (MRI) has grown steadily over the past years. In parallel, an increasing number of people suffering from disabling hearing loss are being implanted with implantable hearing solutions. As these devices contain conductive and/or magnetic materials, there could be a mutual interference with electromagnetic fields present during scanning. Besides the effect of the device on image quality, this could lead to patient harm. To minimize patient risk, manufacturers need to perform several tests to demonstrate device behavior during MRI scanning. Although many risks have been described in industry standards, device specific hazards are often overlooked. The presented feasibility study aims at measuring the risk of unintended output of acoustic hearing implants, a known phenomenon which needs to be quantified as it might potentially harm the patient.

Materials and Methods: A proof-of-concept test setup has been developed in which induced vibrations can be measured during MRI scanning using a commercial laser Doppler vibrometer system (OFV-534, Polytec GmbH, Waldbronn, Germany). The system’s laser beam is directed into an optical fiber which guides the laser beam into the MRI suite whilst keeping the measurement equipment in the control room. At the distal end of the fiber, the laser beam is aimed at the tip of a middle ear actuator (Cochlear Ltd., Sydney, Australia) positioned inside the scanner bore. By changing the actuator position and orientation inside the scanner and altering the scanner pulse sequences, typical and worst-case scenarios regarding unintentional output can be determined.

Results: In a laboratory environment, the measurement setup allows measuring vibrations provided their amplitude is larger than 0.2-9.2 μm/s depending on the signal frequency. Under the assumption that these vibrations are transferred directly to the stapes footplate, these values can be converted to estimated sound pressure levels of 48-86 dB SPL. Currently, experiments are ongoing inside an MRI suite to measure MRI-induced vibrations, including the measurement of the different scanner pulses. A correlation analysis will be performed to determine the influence of different electromagnetic fields on the magnitude of this unintended output.

Conclusions: Preliminary measurements indicate that the system can measure unintended acoustic output.
VESTIBULAR EVOKEK MYOGENTIC POTENTIALS USING THE B250 TRANSDUCER

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Keywords: BC, VEMP, B250

Purpose/Aim: A prototype bone conduction (BC) transducer, called B250, has been developed to improve investigations of vestibular evoked myogenic potentials (VEMPs). The aim is to compare clinical VEMP investigations using the B250 to air conduction (AC) stimulation with earphones. By using BC stimulation with the B250, it is hypothesized that VEMP investigations can be simplified and more accurate. Also, the risks related to high sound levels using AC stimulation should be avoided.

Materials and Methods: The B250 transducer has been evaluated for oVEMP (ocular) and cVEMP (cervical) on 30 healthy subjects between 18 and 40 years old (15f, 15m). For comparison reasons, they were also tested using the B81 (Radioear Corporation, US), the Minishaker 4810 (Brüel & Kjaer A/S, Denmark) and AC stimulation. The Eclipse EP25 platform (Interacoustics A/S, Denmark) was used for signal generation and VEMP recordings. BC stimulation was applied to both the forehead and the mastoid and compared for the different transducers. The stimulation signals were repeated 4 ms long tone bursts at 500 Hz for AC and 250 Hz for BC, respectively.

Results: Ipsilateral mastoid stimulation at 250 Hz using B250 gave more consistent responses compared to forehead stimulation in terms of peak latency, and the required stimulation sound level was about 40 dB lower than with AC stimulation. Both the B250 and the BK4810 were able to generate 25 dB higher output than the B81 at 250 Hz, but the BK4810 had to be driven by an additional power amplifier. The B250 could be attached on the mastoid using a P3333 (Brüel & Kjaer) steel-spring headband, while the BK4810, which is about 30 times larger, had to be hand-held on the forehead.

Conclusions: Preliminary results show that B250 simplifies the VEMP method and gives more accurate responses than conventional transducers. Furthermore, the B250 can evoke clinical viable responses at much lower stimulation intensity as compared to AC stimulation.

BC STIMULATED VEMP IN PATIENTS WITH VESTIBULAR SCHWANNOMA USING B250

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Keywords: B250, VEMP, Schwannoma

Purpose/Aim: Patients with vestibular schwannoma has a benign tumor on either the inferior or superior vestibular nerve. Localization of the tumor origin has recently been found possible by vestibular evoked myogenic potential (VEMPs) but is limited to patients without conductive hearing loss and require high sound level if air conduction (AC) stimulation is used. A prototype bone conduction (BC) transducer, called B250, has been developed to improve investigations of VEMP and is hypothesized to improve also the localization of tumor origin, which will be investigated in this study.

Materials and Methods: Data from pure-tone and speech audiometry, video head impulse testing, AC and BC stimulated cVEMP (cervical) and oVEMP (ocular) will be analyzed in 10 patients diagnosed with vestibular schwannoma prior to surgery. Investigational VEMP parameters will be peak latencies, asymmetry ratios and AC and BC thresholds. The results will be compared with data from a control group of healthy subjects as well as the patient’s healthy ear.

Results: The study was recently initiated, and final results will be presented at the conference. However, preliminary
results on healthy subjects have shown that the B250 gives more accurate responses and can evoke clinical viable responses at 40 dB lower stimulation intensity as compared to AC stimulation, and possibly this method will improve the localization in patients who are suffering from conductive hearing loss.

Conclusions: Hopefully we will show that the B250 has the potential to improve the use of VEMP in patients with vestibular schwannoma, and that more patients can benefit from the method as compared to using AC stimulation.

THE PONTO TRIAL COMPANION APP: A MULTICENTRIC STUDY
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Keywords: eHealth, Patient engagement, Counseling

Purpose/Aim: This multicentric and multinational study aims to evaluate the impact of using the Ponto Trial Companion app during the trial of a bone-anchored device across countries. Besides providing support for the patient in terms of increased engagement, the app is also designed to support the audiologist – in terms of better insights into the trial and as guidance during counseling. The study also aims to investigate if the app reception among professionals and patients varies according to the country and its clinical practices.

Materials and Methods: The Ponto Trial Companion is an app that allows patients to rate (using scores of between 1 and 5) and comment on the sound experience in a given listening situation. The app can also support the patient by providing information on the treatment. At the end of the trial, the app allows patients to share a report featuring these observations with the audiologist. The report can be used by the audiologist at the follow-up visit as a counseling tool. Several clinics from 5 different countries participated in the study. The audiologists were asked to use the app with as many patients as possible and with a minimum of four patients undergoing a trial with a bone-anchored device. After having used the app, professionals were asked to complete a 17-item questionnaire to clarify their experience with the app and the impact they thought it had on their patients. Additionally, qualitative interviews were conducted in some of the participating clinics to understand how clinical practice affects the reception of the app and its impact.

Results: The complete outcomes of this study will be presented at the conference.

Conclusions: Using eHealth solutions such as the Ponto Trial Companion may provide support to both patients and professionals. The audiologists’ experience with the app as a supporting and counseling tool, as well as the app’s reception in different countries, will be discussed at the conference.
OPTIMUM LOADING OF THE CARINA MIDDLE EAR IMPLANT ACTUATOR

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Keywords: Carina, active middle ear implant

Purpose/Aim: Instructions for the implantation of the Cochlear™ Carina™ active middle ear implant include the use of a transducer loading assistant (TLA) that measures the electrical impedance of the actuator at its resonance frequency. Upon contact with the incus, the actuator impedance drops and for best coupling results the manufacturer recommends to advance the actuator further forward by a quarter turn of the adjustment screw (63µm). It has not been investigated yet which static loading forces are applied to the incus following these instructions. Furthermore, it is unknown which consequences higher or lower forces have on coupling efficiency. In this study we performed an extensive investigation of loading forces on actuator performance such as coupling efficiency and sound transmission in a loaded state. Also we investigated electric actuator impedance measurements as loading guidance.

Materials and Methods: Measurements were performed on 9 fresh frozen temporal bones compliant with ASTM guidelines. The actuator was coupled to a force sensor attached to a micromanipulator and advanced towards the incus body in steps of 20 µm. Actuator output was measured at each step through Laser Doppler vibrometry of stapes motion between 100 Hz and 10 kHz. The actuator output was expressed as equivalent free field sound pressure levels at 1 Vrms actuator input. Stapes motion in response to sound was measured to investigate conductive losses. Furthermore actuator impedance over the whole frequency spectrum was measured for each loading force.

Results: Loading forces below 1 mN did not lead to effective coupling and maximum coupling efficiency was observed at forces above 10 mN. No decrease in actuator output was observed for high loading forces (10-100 mN). Conductive losses were observed for 2 of 9 TBs for static loading forces up to 100 mN. Electrical impedance measurements showed a rapid decrease of the actuator resonance peak upon contact to the incus which completely vanished at 5-10 mN loading forces.

Conclusions: Above a minimum coupling force of 10 mN, the actuator couples to the incus with high efficiency. Direct electrical impedance measurements via the transducer loading assistant are a useful measure to indicate effective coupling.

37

AUDITORY AND SPEECH PERFORMANCE IN PATIENTS FOLLOWING TRANSCUTANEOUS BAHAS® IMPLANTATION

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Purpose/Aim: The aim of the study was to prospectively evaluate the clinical audiological outcomes as well as patient satisfaction of transcutaneous bone anchored, hearing aid surgery.

Materials and Methods: This is a retrospective clinical study. A total of 13 patients who underwent the Cochlear™ Baha® Attract surgery were analysed for audiological outcomes, surgical complications, and device-related postoperative follow-up. Speech recognition performance and hearing aided thresholds with and without device conditions were evaluated.

Results: The surgical procedure and healing were uneventful. Statistically significant improvements in audibility and speech understanding recorded for the test device compared with pre-operative unaided hearing. The overall mean for the gain in frequencies 0.5 to 4 kHz were 31 dB. On average, the speech discrimination scores improved by 36% post-operatively. Good soft tissue outcomes were reported, without major soft tissue related complications. At the end of the investigation, all patients continued to use and benefit from the device.

Conclusions: The transcutaneous bone conduction device provides good outcomes in patients with a conductive, mixed,
COMPARISON OF BENEFITS OF OSIA AND BAHA ATTRACT SYSTEM

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Keywords: OSIA, Baha Attract, benefits

Purpose/Aim: To study the initial experience with implantation and fitting a new powerful piezo-based active bone conduction system – OSIA (Cochlear Ltd) in patients with mixed unilateral or bilateral hearing loss and to compare the surgery, audiological benefits and quality of patients’ life after implantation of this system with Baha Attract system.

Materials and Methods: Material consists of 16 adult patients (18 years or older) with mixed hearing loss in the ear to be implanted. Bone conduction thresholds with pure tone average (PTA4; mean of 0.5, 1, 2 and 4 kHz) should be 25 - 50 dB. The participants will be randomly divided into two groups. The first group of 8 patients will receive the implant OSI100 with Osia Sound Processor, the second group of 8 patients will receive the auditory implant Baha Attract with Baha 5 Power Sound Processor.

The course of surgery and healing will be evaluated. Postoperatively the following audiometry test will be performed with the device in both groups: free field pure tone audiometry in quiet, free field speech audiometry in quiet and free field speech audiometry in noise. Subjects will also complete APHAB (Abbreviated Profile of Hearing Aid Benefit) and SSQ (Speech, Spatial and Qualities of Hearing Scale) questionnaires.

Results: The results of this study will be presented during the OSSEO 2019 meeting.

Conclusions: The conclusions will be made based on the results of the study.

AUDIOLOGICAL PERFORMANCE OF A NEW NONIMPLANTABLE WEARING OPTION FOR Baha

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Keywords: Baha

Purpose/Aim: To assess the audiological performance of Baha (Cochlear, Sweden) attached to (i) a Softband and (ii) to a novel non-invasive wearing device (SoundArc) in adults with simulated conductive hearing loss.

Materials and Methods: Fifteen normal hearing subjects participated in this study. Both ears were occluded to simulate a bilateral conductive hearing loss (unaided sound field PTA of 49 dB HL). The following outcomes were assessed in the unaided, unilateral and bilateral treatment conditions: sound field thresholds, speech reception thresholds in quiet (German words and numbers) and in noise (German Matrix Test). In addition, sound localization was measured in the unilateral and bilateral conditions (12 speakers in full horizontal circle, resolution of 30°).

Results: All outcome measures were significantly better in the aided conditions with Softband and SoundArc: sound field thresholds (improvement by 24 dB, p <.001), speech reception thresholds (SRTs) in quiet (improvement by 20 dB p <.001) and in noise (improvement by 4 dB, p <.001). Sound localization was improved in the bilateral treatment conditions. The differences in outcomes with both solutions (Softband vs. SoundArc) were statistically insignificant.

Conclusions: Both non-invasive bone conduction systems (Baha on Softband or SoundArc) provide comparable audiological benefits for adults with conductive hearing loss.
OUTPUT EVALUATION OF A BONE CONDUCTION IMPLANT IN HUMAN CADAVERS
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Keywords: BoneConductionImplant, ObjectiveMeasurements, OutputEvaluation

Purpose/Aim: Bone conduction hearing devices are used to treat patients with conductive and mixed hearing losses. The objective of this study was to evaluate the output performance of the new transcutaneous bone conduction implant system Sentio from Oticon Medical AB (Askim, Sweden) in human cadaver heads.

Materials and Methods: For reference, the output performance was evaluated on a skull simulator and an artificial mastoid. The Sentio and a percutaneous bone conduction device (Ponto 3, Oticon Medical, Askim, Sweden) were implanted in human cadaveric heads. Both devices were placed on the intended placements of implantation. Laser Doppler Vibrometry (LDV) measurements were performed to determine the vibration response on the ipsi- and contralateral cochlear promontory and to assess maximum power output of the transcutaneous and the percutaneous devices. Furthermore, the feasibility of intracochlear pressure measurements in response to the bone conduction stimulus was investigated.

Results: The results show the output performance of the new transcutaneous bone conduction implant system (Sentio) on the cochlear promontory. The preliminary LDV measurements at the promontory suggested similar output vibration amplitudes at frequencies above 500 Hz for both devices (Sentio and the percutaneous Ponto 3).

Conclusions: Our preliminary results suggest that the vibration response for the new bone conduction implant Sentio is similar to existing bone conduction devices on the market.

41

“ADHEAR” USE IN TRAUMATIC TYMPANIC MEMBRANE PERFORATION FROM BLAST INJURIES
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Keywords: Blast Injury, Adhear, Perforation

Purpose/Aim: Adhear is a new bone conduction hearing aid produced by Med-EI that requires no surgical intervention. An adhesive adaptor, which is waterproof and disposable. The device is positioned on the skin behind the ear and an audio processor connected allowing immediate use. The Adhear can be used for unilateral or bilateral conductive hearing losses or single sided deafness. When comparing Adhear to a bone conduction device on softband using both audiometry and word recognition tests there was a comparable performance between the two options.

Materials and Methods: We share our experience with the use of these devices in military patients who have suffered blast injuries for which, as of yet, there is no literature. Blast injuries are common in modern warfare with a significant proportion suffering tympanic membrane perforations and hearing loss. Perforations may heal without intervention and hearing loss may improve however some patients may require surgical intervention.

Results: Two patients both involved in blast injuries suffered with traumatic bilateral tympanic membrane perforations. Reviewing the patients after several weeks showed little improvement in their perforations or hearing loss. They were both considered for surgical intervention with bilateral tympanoplasties. The patients were keen to continue with normal activities and one patient was given a bone conductor on a headband however with some military duties he found this extremely limiting due to the equipment leads catching on other equipment particularly whilst exercising. As a result the patient was offered an Adhear. The other patient was also offered an Adhear however there were slight difficulties due to head and neck burns.

Conclusions: Adhear may be a useful alternative as a nonimplantable solution to other bone conduction hearing devices in a variety of patients to include those awaiting surgery or not suitable for surgery. They are useful in military patients
who have suffered blast injuries resulting in hearing loss, as communication with seriously injured personnel is vital, such as consenting for procedures. Other options such as a bone conductor on a headband or soundarc are not always appropriate for these patients and Adhear may provide an acceptable compromise to aid hearing without reducing their ability to perform duties.

**42**

**BAHA USE IN ELDERLY POPULATION. CORRELATIONS WITH SOCIAL AND COGNITIVE**

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**Keywords:** Elderly Population, Cognitive Status, Satisfaction

**Purpose/Aim:** Introduction - Bone conduction implants are the treatment of choice for conductive and mixed hearing loss.

The average implantation age of Baha in Spain is 57 years. As a consequence, there is a significant population of elderly Baha users (> 70 years). As treatment of hearing loss in the elderly population and its implications for the society are gaining increasing importance, we wanted to capture the use and satisfaction of Baha devices and correlate these parameters with social and cognitive status in all Baha users older than 70 years.

**Objectives:** The objective of this study is to report the use and satisfaction in all Spanish Baha users older than 70 years. This is then correlated with cognitive status, social life and other aspects of elderly age. Study results may help guide clinicians how to better counsel elderly bone conduction implant candidates.

Hypothesis would be that age is not a barrier to good use of Baha.

**Materials and Methods:** Study design - One hundred and fifty traceable patients treated with Baha when they were aged 70 years or more were surveyed by phone interview. As cohort control, we provide same questionnaire to a reference group to compare results.

**Study population:** 150 Baha users implanted in Spain during 2006-2018 and older than 70 years old (1st Jan 2019) were included into the study.

**Method:** Subjects were interviewed with questions on daily use, device satisfaction, demographic factors, social factors and questions assessing cognitive status of the individuals. The interviews were designed to take no longer than 10 minutes.

**Results:** Results from the survey will be presented at the OSSEO meeting 2019.

**Conclusions:** Conclusion will be made based on the interview results correlating Baha use and subjective performance with social and cognitive aspects. Some guidance on counselling recommendations based on the study outcomes for elderly Baha patients will be presented.

**43**

**SURGICAL APPROACH AND RESULTS OF THE OSIA SYSTEM, ™ A NEW GENERATION OF OSSEOINTEGRATED IMPLANTS**

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**Keywords:** Surgery, Active implant, Osia system

**Purpose/Aim:** To prospectively evaluate the surgical results of this new active bone vibrator placed subcutaneously in 10 patients with conductive hearing loss
Materials and Methods: The surgical technique combines the conventional techniques of the Baha Attract and CI24RE cochlear implant (to be described in the presentation). The internal elements (placed under the skin) are: the stimulator receiver with its magnet and its coil that is connected to the vibrator (actuator) that converts the electrical signals into vibrations and transmits them to a titanium implant in the form of a screw that is inserted in the bones of the skull. The evaluation includes the surgical aspects (surgical time, status of soft tissues, flaps, healing) and comfort and retention (intensity of magnets, hours of use, pain and numbness)

Results: The surgery and healing were without incident. In 2 patients an incision was made in the form of inverted C, in one in the form of S and in 7 in the form of C-S. Average flap thickness of soft tissues and skin 5.1 mm. Thinning of the flap was done in 1 case, healing was satisfactory in all. After adaptation 0 patients switched to a weaker magnet, 0 required a stronger magnet to improve retention. There was no local pain or erythema. To date, all patients use the device without local problems

Conclusions: To date, all patients use the device without local problems

44

WHICH INTERVENTION OFFERS THE BEST HEARING ABILITY FOR GLUE EAR?

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Purpose/Aim: To review the outcomes of children whose families had elected to use technology as an intervention for persistent otitis media with effusion (glue ear). These included behind the ear hearing aids and soft band bone conduction.

Materials and Methods: Retrospective audit reviewing clinical data and journals.

Qualitative outcome data was derived from questionnaires such as LittLEARS and PEACH. Quantitative outcome data was derived from aided speech scores as well as aided level measurements.

Results: The audit showed variance in clinical practise across a small region in the UK. This was surprising given the central purchasing process of BAHAs limiting the impact of cost on decision making.

The outcomes varied significantly across the age and sex of a child. Soft band bone conduction was found to be appropriate in younger children including neonates as well as older primary school age girls however for many boys of the same age they often rejected the technology.

Aided listening ability was better using behind the ear hearing aids when the aids were first fitted however there was uncertainty about the accuracy of the fitting at a later time.

The cost effectiveness of soft band bone conduction depended on the length of time the child was wearing the device.

Conclusions: Families seemed to appreciate being given the choice of intervention for their child. Audibility was better using behind the ear hearing aids however practitioner uncertainty about accuracy after first fitting requires further research.

Although not part of the original study the growing number of soft band bone conductors being fitted to neonates suggests further review into such provision should be undertaken to ensure safe clinical practise. Many providers were routinely offering the technologies and families seemed keen to be issued with such despite limited evidence supporting such early provision.

Cost effectiveness depended significantly on the time in use so it is hard to predict the value of issuing soft band bone conduction technology to a new child entering into the clinic. Providers however commented on the ability of reissuing the bone conduction processor to other children once returned which they anticipated would lead to a significant cost saving in the future.
IMPACT OF AN EHEALTH SOLUTION IN THE BONE-ANCHORED ASSESSMENT PROCESS

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Keywords: eHealth, patient engagement, counseling

Purpose/Aim: With ever advancing technological developments it is becoming increasingly important to adopt new solutions which can improve the patient journey. With the huge increase of smartphone usage worldwide, this study aims to evaluate the impact of using an app (Ponto Trial Companion) during the trial of a bone-anchored device. The hypothesis is that the use of the app will provide enhanced support for the patient – in terms of increasing engagement, and the audiologist – in terms of better insights and improved person-centered counseling.

Materials and Methods: The Ponto Trial Companion is an app that allows patients to rate and comment on the sound experience in different listening situations. At the end of the trial, the app allows patients to share a report featuring these observations with the audiologist. This can then form part of the preparation for the post home trial review.

Twenty-five patients who were undergoing a trial with a bone-anchored device were included in this study. At the first visit, patients were asked to download the app on their smartphone and were encouraged to use it as much as possible during the trial period (approximately three weeks). The patients were asked to add at least 12 ratings and comment on different listening situations and send the report to the audiologist before the follow-up visit.

At the end of the follow-up visit, patients were asked to fill in an 18-item questionnaire to evaluate their experience with the app. After the follow-up visit, the audiologist completed a 17-item questionnaire to clarify whether the app improved the patient pathway and provided additional support in counseling the patient.

Results: The completed outcomes of this study will be presented at the congress.

Conclusions: Using eHealth is becoming increasingly important to allow for improvements in patient management and subsequently enhance service offerings. Solutions such as the Ponto Trial Companion may provide support to both patients and professionals. The impact of using this app on the patients’ engagement and willingness to proceed with the treatment, as well as how the app is helping audiologists in their counseling, will be discussed at the congress.

DESIGNING AND TESTING A SMALL, RELIABLE AND POWERFUL TRANSDUCER

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Keywords: transducer, testing, bone conduction

Purpose/Aim: Designing a small, reliable and powerful transducer is of essence to create a cosmetic appealing and robust bone anchored hearing instrument. This abstract describe design, test design and test results of a newly developed transducer.

Materials and Methods: Many design aspects need to be accounted for to design a transducer. Balancing reliability versus efficiency, balancing high versus low frequency to achieve optimized sound experience and speech recognition and on the system level; considering the driver electronics and choice of battery as well as design of the sound processor housing.

The transducer design was iterated and developed through four prototype series. For each prototype series extensive performance measures such as maximum force output, current consumption and total harmonic distortion (THD) have been tested and evaluated. In addition to this numerous reliability tests such as: drop test (guided and random free fall), temperature, humidity, ageing, corrosion as well as wear and tear of the snap coupling was conducted.

Results: The size of the transducer is more than 15% smaller when comparing to Ponto 3 transducer.
**EXPERIENCES WITH THE MINIMAL INVASIVE PONTO SURGERY SURGICAL TECHNIQUE**

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**Purpose/Aim:** To present the clinical experience of the Minimal Invasive Ponto Surgery (MIPS) technique in a large tertiary referral center setting and compare it to historical control groups using different surgical techniques.

**Materials and Methods:** Adult patients eligible for bone anchored surgery were operated using the MIPS surgical procedure, which is the standard care for patients in the center. All patients received wide Ponto or Ponto BHX implants with pre-mounted 6, 9, 12, or 14 mm abutments according to instructions for the MIPS. Details of the surgical procedure were collected and included surgery time, deviations from instructions and intra-operative events. Postoperative complications, implant loss or removal, skin reactions as judged by the Holgers scoring system (grade 0–4), and subjective pain and numbness around the abutment were assessed. The total follow-up time vary from a few months to 2.5 years. Additionally, post-operative results from historical groups using different techniques were collected.

**Results:** More than 40 MIPS surgeries were performed at our tertiary referral center since the technique was introduced during autumn 2016. The preliminary results on 15 first patients are described here, and the complete set of results will be reported at the conference. In the preliminary data set, the surgery length was 10–20 minutes, and none of the surgeries were converted to linear incision. There was a learning curve in how to avoid soft tissue being stuck under the cannula and how to use cauterization. Surgical events included one case of exposed dura mater and one case bleeding after drilling into vein. At the surgical follow-up, there were two cases of mild skin reaction (Holgers=1). In one of these cases the soft healing cap fell off three days after surgery and the skin was swollen. None of the patients reported pain or numbness around the abutment. Complete follow-up including soft tissue results will be reported at the conference.

**Conclusions:** Implants were successfully installed using the MIPS surgical technique. The complications during surgery were few. Complete post-operative results and comparison to historical control groups with and without tissue preservation will be reported at the conference.

**DO PATIENTS BENEFIT FROM UPGRADING TO PONTO 4 SOUND PROCESSOR?**

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**Keywords:** bone anchored hearing aid system, Ponto system, bone anchored hearing aid

**Purpose/Aim:** To evaluate if there is significant subjective and/or objective listening benefit for experienced bone anchored hearings aid system users following an upgrade from the Ponto 3 processor to the new Ponto 4 sound processor.

**Materials and Methods:** In order to evaluate the potential subjective benefit from using a bone anchored hearing aid
system, patients were asked to fill out two validated questionnaires. Patients filled out the International Outcome Inventory for Hearing Aids (IOI-HA) and the abbreviated short form of the Speech, Spatial and Qualities of Hearing scale (SSQ-12) following years of experience with the Ponto 3 sound processor and also following 1-2 months after an upgrade to the new Ponto 4 sound processor.

In order to evaluate the potential objective benefit, free field audiometries were carried out both with and without noise with both the Ponto 3 and the new Ponto 4 sound processor.

Results: Results from approximately twenty patients will be presented at the conference. Results from both questionnaires as well as the objective measurements will be presented at the conference with both the Ponto 3 system as well as the new Ponto 4 system following an upgrade.

Conclusions: Conclusions will be made regarding the primary endpoint related to whether or not there is a significant subjective and/or objective listening benefit for experienced bone anchored hearing aid system users following an upgrade from the Ponto 3 processor to the new Ponto 4 sound processor.

49

CLINICAL SUCCESS RATES IN RESTORING HEARING AMONG PATIENTS WITH COM

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Keywords: Hearing, surgery, restoration

Purpose/Aim: Studies evaluating chronic otitis media (COM) treatments do not systematically assess post-operative hearing outcomes as a measure of success. Even in cases where air-bone-gap (ABG) closure is used to measure post-operative hearing outcomes, it is assessed at different follow-up time points and there is no consensus on what level of closure should be reported as clinically successful. As untreated hearing loss can impact human development and quality of life, it is vital to identify the most effective strategies for improving audibility and eradicating infections in patients with COM. We performed a systematic literature review to determine how middle ear surgery impacts long-term (12-month) hearing outcomes in COM patients.

Materials and Methods: The review was undertaken following stringent inclusion criteria that allowed for detailed assessment of how COM interventions influence post-operative hearing outcomes. Two reviewers independently assessed 1,221 items identified through a search of PubMed, Embase and the Cochrane library and 52 studies were included for in-depth analysis. Speech audimetry, pure tone audimetry, quality of life measures and complications were extracted and synthesized. Publications were also assessed for risk of bias and strength of evidence.

Results: Data show that 37% of COM patients have a post-operative ABG of 0 dB HL, which is considered as unsuccessful in terms of hearing outcomes under AAO-HNS guidelines. Additionally, hearing was not successfully restored to the sensorineural level (ABG 10 dB) in 74% of patients. Furthermore, infections are not completely eradicated in a sub-population of patients and the poorest hearing outcomes are most common following ossiculoplasties. In comparison to ‘real-world’ outcomes, the proportion of successful cases is likely overestimated as more complex cases are often excluded from clinical studies.

Conclusions: There is a large proportion of COM patients that do not show significantly improved hearing outcomes following middle ear surgery. These patients typically have more severe infections and have usually sustained ossicular damage. Successful surgery is strongly influenced by middle ear status, which must be carefully considered when determining the correct course of treatment for maximal recovery and hearing rehabilitation. In certain cases, surgery is of no benefit.

50

HEARING OUTCOMES WITHIN A DANISH COHORT OF BAHS PATIENTS.

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Purpose/Aim: Primary Endpoint - To evaluate the subjective and objective outcomes within a Danish cohort of patients implanted with a bone anchored hearing systems (BAHS) at Aalborg University Hospital by means of both audiological testings and validated questionnaires (IOI-HA, SSQ-12).

Secondary endpoints - Compare type of hearing loss to treatment outcome (e.g. SSD, conductive, mixed hearing loss).
• Compare different surgical methods (per- or transcutaneous) to treatment outcomes and complications.
• Compare individual BAHS processor (PONTO system vs the BAHA system and their subtypes) outcomes and user satisfaction.
• Compare time of usage with degree of user satisfaction.

Study design: Prospective cross-sectional study.

Materials and Methods: Surgical indications included SSD, conductive or mixed hearing losses. All patients were implanted with a BAHS from either Cochlear (BAHA© series 4 and 5) or Oticon Medical (Ponto© series) by the same surgeon using either per- or transcutaneous approach in local or general anaesthesia. All patients implanted during the period January 1st 2013 to January 1st 2019 were scheduled for a three-part follow up examination. First aided and unaided free field audiometries with and without noise were performed. Then the patients underwent a medical examination registering Holgers classification scores, implant stability etc. Finally all patients filled out the SSQ-12 and IOI-HA questionnaires.

Results: Collection of data and statistical analysis is ongoing and will be presented at the conference.

Conclusions: Data is currently being collected so final conclusions will be presented at the conference.

51

ACCELERATED OSTEOINTEGRATION OF THE TITANIUM-IMPLANT COATED BMP-2 FOR BAHA
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Keywords: Bone anchored hearing aid, Bone morphogenetic protein-2, Osteointegration

Purpose/Aim: To our knowledge, no previous studies have examined the use of BMP- 2/collagen-coated titanium-implants with BAHA for evaluating osteointegration. The purpose of this study was to determine the osteogenesis of BMP-2/ collagen-coated implants in the BAHA-attract system both in vitro and in vivo.

Materials and Methods: We coated hydroxyapatite (HA)/bone morphogenetic protein-2 (BMP- 2)/collagen on the implant screw. The surface was observed by SEM. To evaluate the osteogenesis induced by the modified titanium implant, we conducted in vitro test using mouse preosteoblast . Live/dead cell assay and cell proliferation using MTV were performed. Alkaline phosphatase and alizarin-S were stained. The three group implant screws (no coated: control, collagen coated: group I, BMP-2/collagen coated: group II) were implanted in white rabbits. were used for in vivo study. All rabbits were administered fluorescent bone labels for qualitative evaluation of bone formation. Calcein (blue) was administered at 4 weeks, and oxytetracycline hydro- chloride (green) at 8 weeks, and alizarin (red) at 10 weeks. After 12 weeks, tibia bones were embedded glycol methacrylate solution after fixation process. HE and MT stain were performed.

Results: The number of live cells cultured in group-II was significantly greater than for control and group-I. The result of DAPI-Phalloding stain means that the group-II is associated with meaningfully higher metabolic activities than the control and group-I due to the topological property of the surface roughness due to the HA/BMP-2 particles. Calcium mineralization was significantly higher in group- II, which agreed with the ALP activity results. The control group did not show active initiation of bone formation, but most of the peri-implant spaces were occupied mainly by bone marrow tissue. In group-I, collagen also enhanced new bone formation around the implant compared to in the control group. However, MT staining revealed markedly enhanced peri-implant osteogenesis in the group-II. Based on the histomorphometric analysis, significantly higher osteogenesis of the peri-implant in group-II was observed, compared to in the other two implant groups.

Conclusions: From these results, collagen/HA/BMP-2- coated implant can enhance the peri-implant osteogenesis of the BAHA-attract system, although this study period did not allow the observation of long-term effects.
BILATERAL SEQUENTIAL BONE IMPLANTATION: EVIDENCE OF CLINICAL BENEFITS

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Keywords: Binaural, hearing, benefits

Purpose/Aim: With the technological advances and the new possibilities of implants, some studies in bilaterally implanted patients that have indicated binaural benefit in terms of improvement in the capacity of sound localization and speech comprehension in both silence and noise. The objective of this study is to describe the audiological benefits of speech perception, binaural sum, and quality of life in users implanted sequentially with bone anchorage implants (BAHA). It will be comparing the situation of unilateral versus bilateral listening.

Materials and Methods: Five unilateral users implanted sequentially bilaterally were evaluated. Patients are being evaluated with the HINT (Hearing in noise test) for speech measurements and binaural summation. Four speech conditions are used: speech in silence, speech recognition threshold in silence, threshold of the signal/noise ratio to recognize sentences and performance in fixed noise level. All conditions are done with both, signal and noise presented at 0o. azimuth in unilateral and bilateral conditions. To measure the benefit and satisfaction, it was used the SSQ-12 (Speech, Spacial and Qualities) As for speech tests, the questionnaire will also be applied for unilateral and bilateral conditions. The data will be analyzed comparing unilateral and bilateral conditions.

Results: As expected, the first two patients evaluated presented better speech tests in the bilateral condition than in the unilateral condition. Three patients are still waiting for activation of the second implant to be evaluated in the bilateral condition. The SSQ-12 has also showed a greater score at the bilateral condition 9.2 with 7.9 for unilateral condition.

Conclusions: It is expected that the perception of speech in noise evaluated by the HINT test is superior for the bilateral condition and that the phenomenon of binaural summation can be observed. Also, believe that SSQ scores show improvement in quality of life with bilateral use. The initial data are directed according to the literature, showing that bilateral adjustment after hearing and subjective benefits for patients. Thus, I hope that this study will bring more evidence of the clinical and subjective benefits of sequential bilateral bone implantation.

MULTI-CENTRIC EXPERIENCE WITH THE Baha SYSTEM: PRE-IMPLANTATION DEMOGRAPHIC PROFILE

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Keywords: Demographic, quality of life,

Purpose/Aim: Multicentric studies with representative numbers of participants and with the purpose of collecting long-term results continue to be of great value to the scientific community. The objective of this study is to describe the demographic profile and subjective self-perception of the impact of hearing loss in patients implanted with Baha in Colombia.

Materials and Methods: This is a prospective and multicentric Colombian study. It contains the participation of 126 patients who were going to receive Baha implants and volunteered to be part of the IROS study. The data of subjective evaluation of quality of life and hearing quality prior to implantation were collected through the HUI3 and SSQ, respectively. The answers to the questionnaires and associations with some variables were also explored.

Results: The pre-surgical average in the SSQ was 4.86 (Speech Perception), 4.54 (Spacial Hearing) and 5.83 (Hearing Qualities) and in the HUI3 it was 0.567. No significant association was observed (p> 0.05) when comparing the variables gender, previous ear surgery, tinnitus, use of ipsi and contralateral hearing aids in the pre-implantation condition with the scores of the questionnaires. Age was associated with a lower score on all scales of the SSQ and for the multi-attribute
The presence of vertigo was associated with a lower score in the Speech and Hearing Auditory perception scales in the SSQ (p <0.05).

Conclusions: Age was associated with a worse perception of hearing in SSQ scales, being worse for older than for young people. The self-perception of the auditory situation and quality of life of the candidates to the Baha system could be measured using clinically standardized self-assessment tools providing a general overview of the patients. Data from self-reported multinational populations can provide important information to structure better the rehabilitation target and advice to future implanted patients.

54

BONE CONDUCTION DEVICE: USER’S PROFILE AND SHORT TERM OUTCOMES

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Keywords: Bone conduction, hearing loss

Purpose/Aim: In several developing countries the age of the intervention continuous to be a relevant point to be considered. The cost of the treatment is an issue to consider. In 2016, health insurance and public politics extended their servisss and begun to dispense the bone conduction. The aim of this study is to describe the clinical profile and outcomes of the users who received the first bone conduction devices dispensed in a public hospital.

Materials and Methods: All 14 the participants had their medical records examined considering age when arrival at the service, previous experience with amplification, type of hearing loss. All of them were evaluated for speech performance pre and post-op and the device usage: hour/day, cosmetic, confidence. The study used all three brands of osseo conduction device. Despite the bilateral agenesis ou atresia The population was unilaterally bone conduction implanted following the Brazilian public health criterria. Collected data was analysed.

Results: The participants, both genders, sought the service for a long time waiting for the beginning of the public service to attend the technology of bone conduction. The age varied from 7 years to 70 years old when arrived at the bone conduction ambulatory. 50% participants were with previus experience with bone hearing aid. 75% had bilateral conductive hearing loss and 25% mixed hearing loss varying degree of the sensorial component. Considering time the mean of 9 hours/day was found for percutaneous users and 6 hours/day for transcutaneous users. Transcuteaneous users liked most the cosmetic of the device. No significant difference was found about confidence considering tmascutaneous and percutaneous. All participants were very confidence about listening. Statistical difference was found on pre and post-implant speech recognition test. Although the age of implantation all participant performed well, better in quiet than in noise situation.

Conclusions: Despite the diversity of various aspects including cost for the treatment. The results show the importance of public politics to attend people in unfavorable socio-economic level. Research developments involving all available bone conduction technologies inside the same setor by addressing evaluation, prescriptive gain, speech recognition tests protocols and long term outcomes are the next necessities.
Purpose/Aim: The aim of this study was to evaluate methods for bacterial sampling and to acquire insight into the role of the microbiota on the clinical outcome of BAHS.

Materials and Methods: For the identification and quantification of colonising bacteria, 3 sampling techniques from 3 different compartments were evaluated: (i) retrieval of abutments, (ii) sampling of the peri-abutment exudate using paper-points and, (iii) sampling of the peri-abutment soft tissue using a biopsy punch.

Results: Quantification of viable bacteria was possible from all three compartments. At baseline the soft tissue was mainly colonised by anaerobic bacteria. Anaerobic bacteria and Staphylococcus spp. were subsequently detected in all three compartments at 3 and 12 months. During the one-year follow-up, the common skin coloniser Staphylococcus epidermidis was present at the implant site in most patients whereas Staphylococcus aureus was present in half of the patients. Several associations between clinical and microbiological parameters were found.

Conclusions: This study confirmed a suitable study design, sampling and analytical methodology to quantitate, describe and isolate the bacterial species associated to BAHS. Characterising the microbiota present at different sites surrounding BAHS as well as elucidating their associations with clinical parameters and host response markers may have relevance for the outcome following implantation.

56
COMPARATIVE EXPERIMENTAL STUDY ON A DRILLING SYSTEM FOR BAHS

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Keywords: BAHS, bone-anchored hearing, MIPS

Purpose/Aim: In this study, a drill systems (MIPS) for flapless installation of bone-anchored hearing implants were evaluated with respect to cutting performance, heat generation, drilling procedure and distortion of the bone. Comparison was made with the conventional drill system (Ponto).

Materials and Methods: For the mechanical evaluation, compact artificial bone was subjected to each drill while measuring force and torque. The heat generation was determined by measuring the temperature when drilling in artificial bone using thermocouples. The quality and degree of bone damage of the drill tract was evaluated by drilling in bovine tibial bone subjected to histological evaluation.

Results: The mechanical evaluation of the cutting performance demonstrated that less force was required to drill into the artificial bone using the MIPS drills compared with the conventional drills. Histological analysis revealed relatively more even cut surface and fewer micro cracks in the osteotomy wall when using MIPS compared with the Ponto system. When drilling according to the clinically recommended standard procedure, the temperature increase was significantly higher for MIPS compared with Ponto. Nevertheless, for both systems, the temperature increases were well below the clinically acceptable threshold. On the other hand, a significantly lower temperature increase was demonstrated for MIPS when an impaired irrigation procedure was applied. The results also show that when drilling is prolonged (drill bit left idling after reaching full depth), the temperature increases significantly for both systems compared with recommended standard procedure. However, the heat generation during an idling drilling procedure was significantly higher for MIPS. A three-way mixed ANOVA illustrated a statistically significant three-way interaction between drill systems, drilling protocols and position along the drill tract.

Conclusions: Within the limits of the present in vitro study, the results show that multiple factors influence the distribution of heat as well as the level of the temperature increase at the site of the osteotomy. The results also demonstrate that altering the drill design influences the mechanical performance as well as the degree of heat generation. In conclusion, this study suggests that the MIPS system, conveys a promising design for an efficient osteotomy site preparation for a
minimally invasive BAHS installation.

Figure: Graph showing the mean maximum temperature increase at the position with the highest mean temperature increase for each combination of drill system and drilling procedure. Brackets indicate statistically significant differences between Ponto and MIPS (T-test, p<0.05). Letters indicate statistically significant differences between different protocols within the same drill system (one-way Anova, p<0.05).

57

EFFECT OF DRILL PARAMETERS ON HEAT GENERATION DURING OSTEOTOMY PREPARATION

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Keywords: BAHS, bone-anchored hearing, MIPS

Purpose/Aim: Minimally Invasive Ponto Surgery (MIPS) is a system for installing bone-anchored hearing system. The purpose of this in vitro study was to evaluate a modified MIPS system with respect to cutting performance and heat generation.

Materials and Methods: The MIPS drill system (control) consist of a guide drill and a widening drill. The modified MIPS system (test) includes similar drill bits with minor changes in drill point design, cutting face and osteotomy shape. The cutting characteristics were evaluated by drilling in compact artificial bone while measuring force and torque. The heat generation was determined by measuring the temperature increase by thermocouples positioned 0.5 mm from the periphery of the drill tract of the final drill hole. The modified drill system was compared with the temperature generated by the original MIPS drill system when drilling was performed according to the recommended protocol in terms of irrigation and manual feeding of the drill into the substrate. To investigate the contribution of the operator performing the drill procedure slight deviations from recommended protocol (reduction in irrigation and drill left idling after reaching final depth) was evaluated.

Results: The mechanical evaluation demonstrated that less work was required to drill in artificial bone with the test system compared with the control. When drilling and irrigating according to the recommended procedure, the average maximum temperature increase for the test procedure was 2.3°C (SD 0.7), whereas for the control system it was 5.5°C (SD 0.8). The test system generated significantly less temperature increase compared with the control for all variations of drilling procedure except for when irrigation was reduced.

Conclusions: This bench test show that the heat generated using both the original and modified MIPS systems are well below the threshold for thermal induced tissue damage when drilling in artificial bone. The modified MIPS system is more efficient compared to the original MIPS system reflected in a lower drill force and torque. Moreover, the modified system is less sensitive to deviations from the recommended drilling procedure as demonstrated by a lower degree of heat generation when irrigation is impaired and the drilling sequence prolonged.
58

MULTIMODAL ANALYSIS OF THE TISSUE RESPONSE TO A BAHS IMPLANT

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Keywords: BAHS, pain, osseointegration

Purpose/Aim: We report the case of a 39-year old woman with BAHS presented with recurrent episodes of adverse soft tissue reactions accompanied with pain. Due to persistent pain complaints without macroscopic signs of inflammation, the patient requested implant removal. The aim of this study was to provide a detailed characterization of various tissue compartments, which would offer unique evidence for the patient’s pain complaints related to BAHS.

Materials and Methods: Clinical characteristics, bacterial swabs and soft tissue biopsies were collected at baseline, 12-week follow-up, during episodes of soft tissue complications and at the time of implant removal. The implant was finally retrieved en bloc with surrounding bone. The swabs were analyzed to determine the microbiota. The mRNA expression of a selected panel of cytokines were determined in the soft tissue biopsies using qPCR. The peri-implant bone was subjected to analyses using micro-CT, histology, histomorphometry, BSE-SEM and Raman spectroscopy. The soft tissue biopsy obtained at implant removal was embedded in paraffin for identification and localization of Staphylococcus aureus and coagulase-negative staphyloccoci (CoNS) using fluorescence in situ hybridization (FISH).

Results: Histological evaluation, micro-CT, BSE-SEM and Raman imaging showed an implant well-integrated in dense, mature, bone. The top region adjacent to the implant flange revealed a considerable amount of inflammatory infiltrate, containing mainly chronic inflammatory cells suggesting a bacterial presence at the peri-implant bone. The molecular analysis by IS-pro™ revealed a polymicrobial colonization including S. aureus and S. epidermidis. The localization of S. aureus and CoNS in the soft tissue biopsy was confirmed by FISH.

During inflammation, IL-1?, IL-6, TNF-?, MIP-1?, FGF-2 and TLR-2 expression were all strongly upregulated compared with the 12-weeks expression profile. TGF-? expression only moderately increased during inflammation. In contrast, TIMP-1, COL1?1 and VEGF expression decreased during inflammation compared with the 12 weeks expression.

Conclusions: Here we present an elaborate case report of a patient reporting chronic pain that persisted after abutment removal with a stable implant using a multimodal analysis approach. Our analyses suggest that chronic pain related to the BAHS can result from a chronic bacterial infection with observed intra-cellular bacteria, even without macroscopical signs of infection.
SNAPSHOT ASSESSMENT OF WELL-ESTABLISHED BAHS PLACED USING MIPS
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Keywords: BAHS, MIPS, outcome

Purpose/Aim: The aim of this study is to compare the molecular and microbiological profiles of the peri-abutment interface of well-established BAHS before and after applying a cleaning regimen

Materials and Methods: A total of 12 adult patients with well-established bone-anchored implants, installed using the minimally invasive Ponto surgery (MIPS) technique at least 12 months prior inclusion, were included in the study. In a first visit, the patients were assessed and qualitative information through patient interviews and surveys was gathered. The soft tissue status was determined using Holgers score, IPS score and photographs. The abutment-associated gene expression of specific markers and the presence and number of selected bacterial species were determined by sampling peri-abutment fluid using paper points. The study group was thereafter instructed to use daily application of a specific shampoo, applied locally on the skin around the abutment. Three to four weeks later, the patients were reevaluated and sampled again.

Results: In this study, we aim to determine the abutment-associated gene expression and the microbiological profile around well-established BAHS installed using MIPS. Furthermore, we want to establish if applying a cleaning regimen using a surfactant shampoo could influence the status of the peri-abutment soft tissue.

Conclusions: Data will be available for analysis and presentation in November 2019

INTERNATIONAL CONSENSUS ON OUTCOME MEASURES FOR SINGLE SIDED DEAFNESS INTERVENTIONS
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Keywords: Single-sided deafness, Core Outcome Set, Consensus

Purpose/Aim: Single-sided deafness (SSD) describes the presence of a unilateral severe-to-profound sensorineural hearing loss. SSD disrupts spatial hearing and understanding speech in background noise. It has functional, psychological and social consequences. Potential options for rehabilitation include a contralateral routing of signals hearing aid, a bone conduction hearing aid or cochlear implantation. Benefits and harms for these interventions are documented inconsistently in the literature, using a variety of outcomes ranging from tests of speech perception to quality of life questionnaires. It is therefore difficult to compare interventions when rehabilitating SSD.

In other fields, standardisation has been achieved by developing a minimum set of outcome measures which are recommended for inclusion in all clinical trials. The Core Rehabilitation Set for Single Sided Deafness (CROSSSSD) study is an international initiative to standardise outcome measures for SSD interventions.

Materials and Methods: CROSSSSD adopts the two-step method described by the COMET (Core Outcome Measures in Effectiveness Trials) Initiative. The first step was a systematic literature review whose aim was to identify outcome domains and outcome instruments reported in studies investigating interventions that seek to alleviate the impact of SSD in adults. The second step will be an international two-round online Delphi survey followed by a stakeholder consensus
meeting to develop a patient-centred core outcome domain set for SSD.

**Results:** The search strategy identified 2619 articles. Title and abstract screening identified 509 articles for full-text review, with exclusions primarily due to ineligible populations or study designs. A further 412 articles were excluded on full-text screening primarily due to ineligible populations. Qualitative synthesis of the remaining 68 articles found 144 and 100 unique primary and secondary outcome domain(s), respectively. Secondary outcome domains were not reported in 30 studies. Overall, 237 unique outcome instruments were reported.

**Conclusions:** The identified outcome domains will inform the design of the e-Delphi survey which will seek international stakeholders’ opinions. The resulting Core Outcome Set will act as a minimum standard for reporting in future clinical trials and have applications in guiding the use of outcome measures in clinical practice. Standardisation will facilitate comparison of research findings.

61

**SAFETY OF BAHA IMPLANTATION PERFORMED SIMULTANEOUSLY WITH COM SURGERY**

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**Keywords:** Hearing Aids, Otitis Media, Hearing Loss

**Purpose/Aim:** Bone-anchored hearing aids (BAHA) are a very useful hearing rehabilitation option for patients with single sided deafness or conductive/mixed hearing loss. In patients with chronic otitis media with adhesions, open cavity mastoidectomy may be necessary and in some cases hearing improvement is limited. In this case, it is common to perform the BAHA implantation after COM surgery. We performed several BAHA operations with concurrent COM surgery, and investigate the safety of these one-step operations.

**Materials and Methods:** A retrospective review was conducted to evaluate 5 patients who underwent concurrent COM surgery and BAHA device placement between 2016 and 2019. Patient records were reviewed to identify postoperative complication rates and bone-anchored hearing device usage. We also evaluated the functional gain after BAHA usage.

**Results:** A total of five patients underwent simultaneous BAHA placement and COM surgery. The causes of the surgery were adhesive otitis media with cholesteatoma (2 cases), recurrent chronic otitis media after open cavity mastoidectomy (2 cases), and chronic otitis media with hypertrophic granuloma (1 case). In all cases, open cavity mastoidectomy was performed for the removal of disease, and hearing improvement was limited due to the loss of ossicles. All five patients were applying BAHA well and had improved hearing levels after surgery and no complications were seen. The average functional gain after BAHA implantation was 41dB.

**Conclusions:** In patients with adhesive otitis media requiring open cavity mastoidectomy, improvement of postoperative hearing may be difficult. In this case, simultaneous operation of otitis media surgery and BAHA implantation was possible without any difficulty and no complications occurred. Therefore, BAHA implantation can be considered simultaneously with otitis media surgery in patients who are not expected to have hearing improvement after otitis media surgery and who are unlikely to wear conventional hearing aids.

62

**BONE CONDUCTION OR MIDDLE EAR IMPLANT? A DECISION MAKING ALGORYTHM**

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**Keywords:** active hearing implants, indication, counseling algorithm

**Purpose/Aim:** Active hearing implants (AHI) provide sound amplification by a vibrating actuator, connected either to a
middle ear structure or the skull. The aim of this study was to evaluate indications, safety and efficacy of hearing loss rehabilitation by this class of implants and define an appropriate counseling algorithm based on our experience with certain products approved for the German market.

**Materials and Methods:** Retrospective chart study, single-subject repeated-measures design, single tertiary referral center (Olgahospital, Stuttgart, Germany). All patients with an AHI were evaluated. 143 implants were used. 33 of those were an active BCI. Numerous patients were implanted bilaterally. Air and bone conduction threshold and improvement in word recognition scores in aided and unaided condition were measured. Tests varied according to individual abilities and age groups.

**Results:** The variety of individual surgical situations was summarized in 3 indication groups: a. malformations, b. revision surgery and c. single sided deafness.

Intraoperative complications were not observed, however in few cases a MEI plan was switched to BCI due to an anatomical variation. Significant speech discrimination improvement was found in all patients tested after 3 months. In 6 cases revision surgery was required: 4 cases of skin dehiscence in the BCI, 1 case of cholesteatoma and 1 case of adhesive process in MEI group. Skin problems were observed only in previously percutaneous and Baha users. We propose a simple counseling algorithm based on individual BC hearing threshold and anatomical conditions.

**Conclusions:** BCI and MEI provide variable and effective options for hearing rehabilitation in patients not able to use a conventional hearing aid. In our hands complication rate was low.

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**CLINICAL EXPERIENCES WITH A SUPERPOWER SOUND PROCESSOR**

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**Keywords:** Bone-conduction device, profound mixed hearing loss, device gain

**Purpose/Aim:** Retrospective analysis of fitting parameters and audiological findings in patients with a severe-to-profound mixed hearing loss using a Cochlear Baha SP-5 sound processor on a percutaneous bone-anchored implant. We studied various device parameters, wearing position (head-worn versus body-worn), pure-tone thresholds, BC-direct pure-tone thresholds and aided speech perception.

**Materials and Methods:** From our clinic files we included fifty bone-anchored users with a severe-to-profound mixed hearing loss that were fitted with a Baha SP-5 sound processor. In all patients, the sound processor was fitted on the basis of the direct bone-conduction thresholds followed by some manual fine-tuning. After a trial period of at least four weeks we recorded the gain parameters shown in the fitting software and we measured aided free-field speech scores with the user preferred settings. We evaluated fitting efficacy by comparing the aided free field Speech Reception Threshold with the average BC-direct threshold at 500, 1000 and 2000Hz. Frequency specific bone-conduction gain was derived from the gain parameters of the fitting software and will be compared to the NAL-NL targets used for fitting hearing aids in sensorineural hearing loss.

**Results:** In this group of patients with a severe-to-profound mixed hearing loss the high-gain requirements and the feedback limits for the head-worn position necessitated a body-worn position in a majority of the cases. Currently, only the SP-5 sound processor has a body-worn option. The average estimated effective gain is about one third of the sensorineural component of the loss. This is considerably less than the NAL-NL counterpart.

**Conclusions:** The body-worn position provided more stable gain than the head-worn positions behind-the-ear or below-the-ear. Still, in many cases bone conduction gain is substantially less than the gain prescribed by the NAL-NL fitting rule. The Cochlear Baha SP-5 sound processor provides currently the highest gain (and maximum force output) and is particularly suited for optimally fitting patients with a profound mixed hearing loss.
VOLUNTARY MIDDLE EAR IMPEDANCE INCREASE WITH MILD CONDUCTIVE HEARING LOSS

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Keywords: Stapedius, middle ear, conductive hearing loss

Purpose/Aim: To describe the phenomenon that some persons are able increase their own acoustic middle ear impedances, voluntarily and temporarily, measureable with normal clinical tympanometers.

Materials and Methods: Presentation of five case reports with measurements of the acoustic impedances, hearing thresholds, and otoacoustic emissions (TEOAE) in the relaxed state and while the change in acoustic impedance was invoked.

Results: All five subjects were able to voluntarily increase the acoustic impedance of their ears for short periods of time. While the change was active, TEOAE levels decreased by 0.8–9.7 dB and a mild transient conductive hearing loss in the low frequencies occurred in at least four of the five subjects. In one, the measurement was not possible. The same four subjects showed unusual features in their acoustically evoked reflex and reported a mild to very mild hyperacusis when the voluntary change was not invoked.

Conclusions: Some persons are able to increase their acoustic middle ear impedances reproducibly and voluntarily for short periods of time. The underlying mechanism is not clear and may involve the contraction of the stapedius and/or the tensor tympani muscles. Our results suggest a possible interference with the normal acoustical activation of the reflex, which may lead to an increased prevalence of mild hyperacusis.

THE AUDIOLOGICAL BENEFITS AND PERFORMANCE IMPROVEMENTS OF BAHA® ATTRACT IMPLANTATION

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Keywords: Baha, Hearing aid, audiological

Purpose/Aim: To evaluate the functional and audiological benefits, as well as performance improvements in patients with Cochlear™ Baha® Attract implantation and bimodal users of Baha and hearing aid.

Materials and Methods: We performed a prospective study. Thirteen consecutive adult patients who were audiological eligible for Baha® Attract included in this study. A hearing aid was applied together on the opposite ear of the Baha® Attract if the hearing threshold is thought to be beneficial. All patients were followed-up and performed a series of testing in the sound field before surgery, 1, 2, 3 and 6 months after surgery. Pure-tone audiometry (PTA), speech audiometry (SA), hearing-in-noise test (HINT) as well as sound localization test were performed to assess audiological benefits. Performance improvements were measured through the following questionnaires: the Spatial Hearing Questionnaire (SHQ), the Abbreviated Profile of Hearing Aid Benefit (APHAB) and the Glasgow Hearing Aid Benefit Profile (GHABP).

Results: Based on their hearing impairment type and severity, 9 patients were a conductive hearing loss (CHL) or mixed hearing loss (MHL) and 4 patients were single-sided deafness (SSD). 5 of the 9 CHL or MHL patients get hearing aid on the opposite ear of the Baha® Attract according to their consent. The hearing threshold in the sound field aided with Baha® Attract was similar to preoperative bone conduction hearing threshold of better ear. The result SA was improved postoperatively, but it did not reach that of the ear of better hearing before surgery. The overall score of the HINT test was gradually improved from 1 month to 6 months after surgery. The results of the sound localization test for SSD patients were not as good as those for CHL or MHL. Moreover, among the 9 CHL or MHL patients, the localization test for 5
bimodal users of Baha® and hearing aid were better than those of not. The questionnaires of SHQ, APHAB, and GHABP demonstrated additional benefits which imply performance improvements.

**Conclusions:** The Baha® Attract provide enough auditory benefits and performance improvements for hearing impaired patients. The simultaneous use of Baha® Attract and hearing aid demonstrates additional distinctive benefits.

66

**5-YEAR CLINICAL OUTCOMES OF TWO SURGICAL TECHNIQUES AND TWO BAHIS**

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**Keywords:** BAHI, BCD, IPS

**Purpose/Aim:** To evaluate both the 5-year clinical outcomes of a 4.5mm wide (test) and a 3.75mm-wide (control) percutaneous titanium implant for bone conduction hearing, as well as soft-tissue preservation compared to soft tissue reduction in linear incision surgery for these implants.

**Materials and Methods:** The study was designed as a single follow-up visit of two previously completed prospective comparative clinical trials. 82 patients were eligible for study participation and were contacted for attending a single follow-up visit 5 years after implantation. Main outcome measures were skin sensibility, soft-tissue status by means of the Holgers score and IPS-score, Implant Stability Quotient (ISQ), skin height, implant survival, revision surgery, and subjective benefit.

**Results:** Currently, data collection is underway. Results will be available and presented at the conference.

**Conclusions:** Currently, data collection is underway. Results will be available and presented at the conference.
ECONOMIC EVALUATION OF PERCUTANEOUS TITANIUM IMPLANTS FOR BONE CONDUCTION HEARING

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Purpose/Aim: Developments in bone-anchored hearing implants have resulted in fewer complications, and, thus, lower complication-related costs. However, a weighing of the potential clinical benefits with higher implant purchase price is lacking.

Materials and Methods: A mathematical Markov model was used to evaluate the total costs (complication costs, implant purchase price, and standard costs) of three widely used current generation implants with expected similar outcomes, compared to a previous generation implant in adult patients over a ten-year time horizon from a healthcare perspective. Parameter estimates were derived from published clinical literature. Missing parameter estimates were based on expert opinion. Implant costs were derived from manufacturer catalogues, while standard and complication costs related to the BAHI were derived from a Dutch University Hospital and Dutch guideline for cost-effectiveness research.

Results: The average total costs of the treatment in our clinic with a previous generation implant was €4.967 (SD±€134) per patient over a ten-year time horizon, compared to €4.678 (SD±€83) with a current generation implant. This implant type is potentially up to €506 more beneficial per patient over a ten-year horizon. By further improving implant survival, an additional €645 (SD±€86) per patient could be saved over ten years.

Conclusions: Despite a higher initial purchase price, the current generation implants are potentially cost-beneficial compared to previous generation implants. More data on current generation implants is needed to be able to determine which of the newer implants is most cost-beneficial. Focussing future developments on improving implant survival is likely to have more impact on costs compared to developments on improving soft tissue tolerability.

THE BENEFIT OF BLUETOOTH DEVICES IN SPEECH RECOGNITION WITH BAHÀ®

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Keywords: Bone-anchored hearing aid, Wireless Bluetooth device, hearing aid

Purpose/Aim: To evaluate the effect of a wireless Bluetooth device (WBD) in word and sentence recognition in patients with Baha® Attract (Baha) while using mobile phones.

Materials and Methods: We performed a prospective study evaluating speech and sentence recognition in both quiet and noisy conditions. Total of nine patients, audiologically eligible for Baha, were included. Based on their hearing impairment type and severity, subjects were divided into “Baha only” and “Baha with HA” groups. The speech and sentence recognition scores of each condition were compared by nonparametric methods.

Results: Both the “Baha only” and “Baha with HA” groups had higher scores in the quiet condition than in the noise condition in word and sentence recognition tests, irrespective of whether the WBD was used. The benefit of using a WBD was greater in the noise condition. There were significant differences in the word recognition test results before and after using the WBD in the “Baha only” group, and in both the word and sentence recognition tests results before and after using the WBD bimodally in the noise condition in the “Baha with HA” group.

Conclusions: WBDs improve word and sentence recognition in adult Baha recipients when they use mobile phones. WBD use provides additional benefits in “Baha with HA” patients in a bimodal situation.
DESIGN OF ELECTROMAGNETIC TRANSDUCER FOR IMPLANTABLE BONE CONDUCTION HEARING DEVICES

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Purpose/Aim: Recently, clinical implications of implantable bone conduction hearing aids have been increasing and related studies are being widely reported. We have been developing a new electromagnetic vibrational transducer for implantable bone conduction hearing devices. The proposed transducer has a design to increase Lorentz force via the dual-coil method with a closed magnetic circuit. Especially, the transducer can generate high output in a specific frequency range using a vibrational membrane with a cantilever. The membrane was consisted of two cantilevers connected symmetrically on a circular plate and a fixed ring. To derive optimal structure of the vibrational membrane, frequency characteristics were analyzed through mathematical modeling and finite element analysis (FEA). The vibrational membrane was fabricated through chemical etching and computer numerical control process, and the components of the transducer were assembled by the precision assembly process. The vibrational characteristics of the transducer were measured by using a laser Doppler vibrometer. From the experimental results, it was shown that the frequency characteristics of the transducer could be controlled by adjusting the natural vibration characteristics of the membrane same as the FEA simulation.

70

A NOVEL TRANSCUTANEOUS BONE CONDUCTION DEVICE

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Keywords: bone conduction, transcutaneous device, clinical outcome

Purpose/Aim: Bone conduction hearing systems are an important solution for hearing rehabilitation in patients with conductive or mixed hearing loss (CMHL) as well as in patients with single-sided deafness (SSD). Percutaneous bone conduction devices have been used for about 30 years. While they lead to improvements in speech perception, these devices may also produce partially substantial complications at the interface between the titanium screw and the surrounding skin. Active bone conduction implants in which the transducer receives power and sound transcutaneously across the intact skin do overcome this problem.

Materials and Methods: Clinical outcomes of a novel transcutaneous bone conduction device are investigated within this study. All patients are at least 5 years of age and have been suffering from CMHL or SSD. The audiological test battery includes unaided and aided air-conduction and bone conduction thresholds, as well as speech intelligibility tests in quiet and noise. To evaluate the subjective benefit, patients are interviewed with the AQoL and SSQ questionnaires.

Results: In Hannover, the treatment with bone conduction devices is a commonly used approach for patients with CMHL and SSD. Transcutaneous and percutaneous devices show comparable audiological results, whereas transcutaneous show less complications compared to percutaneous devices in our clinic.

Conclusions: Transcutaneous bone conduction devices are a beneficial solution for patients with CMHL and SSD and show a substantially lower complication rate than percutaneous devices.

71

TRANSCUTANEOUS BCD AND MAGNETIC RESONANCE IMAGING

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Keywords: BCD, transcutaneous, MRI

Purpose/Aim: To awaken awareness of potential problems and risks when implanting a patient with a transcutaneous magnetic BCD in the light of future need of an MRI.

Materials and Methods: Description of current available transcutaneous BCD systems and its implantation. When counseling a patient or parent concerning a transcutaneous solution, MRI is often mentioned when a H&N MRI is needed but forgotten when eg sports trauma's are at hand. The current rate of MRI's performed in the world is increasing with currently more than one MRI per second.

Results: Careful thought is warrented when implanting a patient (child) with a transcutaneous BCD solution. Chances are nearly 100% of needing an MRI in the future, leading to demagnetisation, torque, pain, ... Most problems of torque, demagnetisation occur when an MRI of the foot or knee is needed (due to sports trauma) and artefacts and pain or torque are present when an MRI of the H&N is at hand.

Conclusions: Careful thought is warrented when implanting a patient (child) with a transcutaneous BCD solution, as chances are nearly 100% of needing an MRI in the future.

72

VERIFYING OUTCOMES WITH AN ADHESIVE BONE CONDUCTION DEVICE

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Keywords: adhesive bone conduction device, RETVFL, indication range
**Purpose/Aim:** The ADHEAR is a new non-invasive adhesive bone-conduction device for conductive hearing loss and single-sided deafness. The system consists of an audio processor attached to an adhesive adapter which is placed on the skin covering the mastoid. Verifying the output of a bone conduction device in individual hearing-impaired listeners has limitations in a clinical setting because of individual differences. Therefore, a new method with normal-hearing listeners and technical measurements was developed to minimize variabilities. The presented approach was used to estimate maximum hearing level output and the indication range of the device.

**Materials and Methods:** The maximum force level output of the audio processor was measured on a skull simulator directly. Reference equivalent threshold vibratory force levels (RETVFL) were determined in 20 normal-hearing listeners by measuring hearing reference thresholds with the audio processor on the adhesive adapter attached to the skin covering the mastoid. The transducer of the audio processor was directly stimulated by a clinical audiometer. The RETVFL were obtained by measuring the corresponding hearing thresholds on the skull simulator as described above. The maximum hearing level output provided by the device was defined as the difference between the maximum force level output of the device on the skull simulator and its RETVFL. The maximum sensorineural hearing loss components for a dynamic range of 30 dB was calculated by subtracting 30 dB from the maximum hearing level output of the device.

**Results:** The indication of the adhesive bone conduction device regarding maximum bone conduction hearing thresholds of 25 dB HL between 500 Hz and 4 kHz seems to be a good estimate. More details regarding calculation procedure and discussion of the results will be presented in the poster.

**Conclusions:** The procedure for measuring the reference equivalent force level threshold with an adhesive bone conduction device was feasible. The proposed estimation of the maximum hearing level output of the device was estimated using this reference curve. With the results the indication range of the ADHEAR could be verified. The results should be compared with clinical findings and can also be used for other devices.

**73**

**ACTIVE TRANSCUTANEOUS BONE CONDUCTION IMPLANTS: A SYSTEMATIC LITERATURE REVIEW AND META-ANALYSIS**

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**Purpose/Aim:** To give an objective overview of the current status of the literature on safety, efficacy and subjective benefit after active transcutaneous bone conduction device implantation. A meta-analysis was performed to integrate the quantitative findings and provide a numerical estimate of the overall effect of the intervention.

466 million people worldwide (34 million of which are children), suffer from disabling hearing loss (WHO statement 2018). While the majority of patients with moderate to severe hearing loss can be supplied with conventional hearing aids, some patients may benefit more from implantable hearing devices such as the active transcutaneous bone conduction implant presented here.

**Materials and Methods:** The Systematic Review was performed using the guidelines available from the Cochrane Collaboration to identify all publications on the only available active transcutaneous bone conduction device, namely Bonebridge (MED-EL). Subgroup analysis and sensitivity analysis was performed to test the stability of the results in meta-analysis. Separate random effect models were fitted to outcome variables of mean functional gain (FG), mean benefit in word recognition score at 65dB (WRS) with separate models fitted for subgroups of hearing loss types: CHL, MHL, SSD or combinations thereof. The follow up dependent complications incidence rate in person years were calculated for adverse events.

**Results:** This systematic review comprises of 39 citations comprising of 487 subjects: 303 CHL, 67 MHL and 53 SSD (for the remaining numbers no details regarding hearing loss were stated). The mean age was 35.6±16.9, ranging from 5 years up to 80 years of age. The via meta-analysis weighted overall FG exhibited a mean of 30.89 dB SPL [95%CI 27.53, 34.24]. Various kinds of speech tests were used and the meta-analysis outcomes for reported mean word recognition scores at 65 dB SPL resulted in an improvement of 56.73% for the 57 CHL subjects [95%CI 45.52, 67.94]. Outcomes were similar in the C/MHL subjects, reported in 3 studies comprising of 31 subjects (mean WRS improvement 55.14%)[95%CI 21.67, 88.68]. Outcomes in children (?18 years) were reported in eleven publications. For children the average functional gain was 34 dB for 77 implantations and the average aided sound field threshold reported was close to normal hearing with the Bonebridge (i.e. 24 dB HL for 67 implants).

25 publications out of the 39 identified citations reported on complications, out of which 90.6%, explicitly stated that no complications occurred. In total 286 ears were evaluated for safety outcomes over a mean follow up period of 11.7±4.5
months, resulting in persons-years, the actual time-at-risk in years per person, of 148.9.

Conclusions: Substantial and stable benefit for all implanted patients was shown. A mean weighted word recognition score benefit of 52.1% was achieved with the Bonebridge. SSD subjects still performed well, but not as high as the other hearing loss types (38.3% WRS Improvement). Most benefit was reported for the CHL group with 56.7%. Speech understanding in noise also improved significantly. The devices’ transcutaneous technology results in an incidence rate of one in 148.9 person-years. Other, passive bone conduction devices, such as the percutaneous Baha Ponto system (Cochlear, Oticon, respectively) or the transcutaneous Sophono- and Baha Attract (Medtronic, Cochlear respectively) options still have to battle high complications rates. Based on the audiological outcomes, the high patient satisfaction as well as the low complication rate the authors recommend the Bonebridge as first line treatment for patients suffering from hearing loss within the devices’ indication criteria.

74

LONG TERM STABILITY OF MIDDLE EAR TRANSDUCERS T1 AND T2
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Keywords: Carina, middle ear implant, long term stability

Purpose/Aim: The Middle Ear Transducer (MET) is an actuator that was used in partially and is currently used in the fully implantable active middle ear implant Carina® (Cochlear Ltd.). Here we compare long term stability of the 1st generation T1 actuator (Otologics LLC) with the current generation T2 actuator (Cochlear Ltd.) in all our clinical cases with standard incus coupling.

Materials and Methods: 52 ears implanted with a MET coupled to the body of the incus (standard coupling) between 2008 and 2016 were analyzed. All patients suffered from sensorineural hearing loss, 23 ears were implanted with the transducer T1 and 29 ears were implanted with the current transducer T2 (since 2011). In situ and bone conduction (BC) thresholds were measured for a follow up period of up to 7 years. Long term stability of coupling and actuator performance was evaluated by tracking differences between in situ and BC thresholds.

Results: In the T1 group, 9 out of 23 implants were used by the patients at their last follow-up visit (avg. 3.7 yrs.; min 1.0 yrs., max 7.4 yrs.). In 9 patients a technical failure (decrease of in situ threshold > 15 dB) compared to BC thresholds (in situ – BC]) occurred and led to 7 explantations. Five other patients were explanted due to medical reasons (BC threshold decrease, infection or insufficient speech intelligibility). In the T2 group, 23 out of 29 implants were still used at their last visit (average observation time 3.3 yrs.; min 1.0 yrs., max 4.8 yrs.). No technical failures were observed up to more than 4 years after implantation. Five T2 patients discontinued using the device due to insufficient benefit and one patient was explanted due to medical reasons. Nevertheless, a small decrease in hearing loss corrected coupling efficiency (in situ – BC]) was seen in the T2 group.

Conclusions: In contrast to the T1 transducers of the earlier generation of the MET systems where technical failures occurred frequently, no technical failures were detected after 29 implantations with the current T2 transducers. However, a small decline of transmission efficiency was seen in the T2 implanted group.

75

REVIEW OF PATIENTS WHO DECLINED A BCHI AFTER A TRIAL
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Keywords: Decision-making

Purpose/Aim: Commissioning for the provision and funding of Bone Conduction Hearing Instruments (BCHI) for hearing loss in the UK recommends a minimum 2 week trial of a BCHI, allowing the patient to try the aid in their home, work, social and learning environments and provides both the patient and the hearing professional with an indication of the
possible benefits in their daily life.

To understand and provide further evidence about what factors influence a patients’ decision making and to gain knowledge about why some patients reject BCHIs after their trial we aim to further evaluate the trial patient data to gain an insight from the patient’s perspective and provide an understanding why some patients decline BCHIs post trial.

Materials and Methods: Over a 10 month period, in the BCHI clinic at Freeman Hospital, Newcastle upon Tyne, 65 patients were fitted with trial BCHIs, of which 20 patients declined to proceed after their 2 week trial period (31%). We aim to review the data of the patients who declined a BAHA after their 2 week trial period.

Results: Analysis of the patient demographics, aetiology, hearing thresholds, type and attachment of the trial BCHI and a qualitative review of the patient post trial diaries and APHAB questionnaires was undertaken. Team analysis of the results was performed to safeguard robust data. Patient quotes were used to represent a true patient perspective of their experience and narrative.

Conclusions: Participant's diary entries frequently described poor sound quality as a reason not to proceed with a BCHI. Careful consideration to the Bone conduction hearing thresholds at higher frequencies (2 and 4KHz) has shown to be an important part of the selection process and should inform pre-fitting counselling to provide more realistic, patient centred expectations of the BCHI, resulting in a more positive trial experience. Patients also detailed a preference for CROS aids, issues with feedback and noise, cosmetic issues and not wanting surgery as reasons for not proceeding with BCHIs after the trial indicating the importance of how provision of the right information, specific to that patient pre-trial and a positive experience during their trial can influence their decision making.

76

SUPERIOR PLACEMENT OF THE BONEBRIDGE IMPLANTS IN ADULTS: LONG-TERM OUTCOMES
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Keywords: bonebridge, middlefossa, outcomes

Purpose/Aim: Here we present our experience with the Bonebridge active transcutaneous bone conduction implant. We document our experience moving from a standard mastoid placement to a more superior (middle fossa) placement. The standard surgical implantation site for the Bonebridge has been in the sinodural angle of the mastoid cavity. This can be a small space to accommodate a large device that may be further complicated by variable anatomy (emissary veins, sigmoid sinus and dura). Mastoid placement may further complicated by prior mastoid surgery such as mastoid obliteration, congenital abnormalities, chronic infection or persistent disease such as cholesteatoma. We investigate the effect of this superior placement on outcomes. We did not use lifts and chose to rest the device on the dura in all cases.

Materials and Methods: After ethics board approval, all patients with a Bonebridge implant from 2013-2019 had their outcomes prospectively assessed and their charts reviewed.
A review of records was performed to obtain patient demographics, pre-operative audiological assessments, device indications, operation details (including placement site) and complication rates. Outcomes were assessed at follow up with audiometry, quality of life questionnaires (APHAB, HIT-6, GBI), rate of device utilization and any long-term complications such as headache. Statistical analysis was performed to assess any significant differences in surgical placement and outcomes.

Results: There was no significant difference in outcomes for both groups at follow up. All patients had a significant gain in their pure tone averages, speech reception threshold and word recognition scores. There was a significant increase in encountering the sigmoid sinus and emissary veins in the mastoid placement.

Conclusions: The superior placement of the Bonebridge implant is a safe and effective technique. There is no evidence of increased complications, difference in audiological outcomes or device utilization. Our outcomes do not indicate any negative consequences to the device resting on middle cranial fossa dura. The mastoid placement is complicated by significant variability in surgical difficulty, whereas the superior placement combines anatomical predictability with surgical simplicity.
TREATMENT FOR CHILDREN WITH CONDUCTIVE AND/OR MIXED UNILATERAL HEARING LOSS: AUDIOLOGIST DECISION AND COUNSELING STRATEGIES

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Purpose/Aim: Gordey and Bagatto (2017) found that fitting protocols for bone conduction devices for infants and children are not well-established. Clinicians reported uncertainty around candidacy and selection for non-surgical transcutaneous bone conduction devices (e.g. soft headband). Building on this work, the aim of this project was to investigate audiologists’ perspectives about bone conduction technology candidacy, counseling, and their recommendations for treatment options for permanent unilateral conductive or mixed hearing loss in infants and children.

Materials and Methods: An online survey will be distributed to over 300 pediatric in North America to gather information on the decision and counseling pathway used for bone conduction devices for children with permanent unilateral conductive or mixed hearing loss. The survey consists of fifteen questions, with multiple choice and open-ended items. During the presentation, the findings of the survey will be discussed.

Results: An estimated one hundred and fifty responses for the survey items will be compared, evaluated and described. Item categories include those relating to recommendations and counseling and data will be examined to identify differences in how audiologists approach bone conduction device fittings in children with permanent unilateral conductive or mixed hearing loss.

Conclusions: Data obtained from this work could be used to inspire and inform a foundation with which to develop a document for audiologists outlining a pathway for recommendations and counseling when working with infants and children who have permanent unilateral conductive or mixed hearing loss.

78

BONE CONDUCTION IMPLANTS SURVIVAL

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Keywords: implant loss, complication, quality of life

Purpose/Aim: During last few years there have been published many reports on loss of implants for bone-anchored hearing aid. To systematize our own results in this field, to assess the survival of the implants used, the analysis of follow-up data in patients with implantable bone conduction systems was performed.

Materials and Methods: Medical records of 44 patients (50 implants) observed since 2008 were analyzed. The analysis of complications registered in patients including the extrusion of implants, as well as the causes of these complications was provided. Inflammations were evaluated on the Holgers scale, the stability of implants was assessed using the Osteill. Assessment of patient’s satisfaction was carried out by the GBI, GCBI questionnaires.

Results: In the studied group of patients only 2 (5,5% of patients) refused to use their devices: the first patient was after tympanoplasty with hearing improvement and the lack of the need for further use of the device, and the second patient had frequent trauma of the graft. Inflammatory reactions of grade 1 were periodically observed in half of the Baha system users and did not require medical treatment and medical care, grade 2 was noted in around 15 (35,7%) of the implanted abutments, grade 3 - in 5 (11,9%) cases. The most common causes were the loss of implant fixation to the abutment and, as a result, traumatization of surrounding tissues, as well as the defect of care. The loss of Baha implants occurred in 4,7% due to injury, the extrusion of Alpha fixing elements was observed in 12.5% patients (Tricher Collins syndrome with low bone density in the implantation area). Evaluation of quality of life showed high satisfaction of patients in all respects.
Conclusions: According to the Baha BI300 implant stability assessment, a sufficient level of osseointegration with constant ISQ indices was achieved 1 month after the operation. The observed inflammatory reactions did not affect the survival and stability of the implanted elements and patients’ satisfaction with the rehabilitation. The injury is the leading factor in the occurrence of inflammatory complications and extrusion.

THE CLEATING STITCH: AN ADJUNCTIVE TECHNIQUE FOR PERCUTANEOUS OSSEOINTEGRATION SCREWS

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Keywords: bone anchored hearing aid, cleating stitch, osseointegration screws

Purpose/Aim: The bone anchored hearing aid (BAHA) has become a widely used and successful option in treatment of conductive and mixed hearing loss, and single sided deafness. Despite improvements in technique and cosmesis, complications remain that can result in implant revision or removal. Herein we describe a unique adjunctive technique, the cleating stitch, in placement of osseointegration screws and examine its impact on complication rates.

Materials and Methods: In this retrospective case review in a tertiary academic medical center, a total of 66 implants in 65 patients (35 male, 30 female) with an average age of 54 years (15-81 years). Average follow up 10.8 months. All patients underwent BAHA implant placement by a single surgeon between April 2012 to June 2017 using the linear incision or punch techniques with soft tissue reduction and placement of a cleating stitch. Main outcome measures include rates of revision surgery, overgrowth, extrusion and Holgers reaction ?2. Secondary outcome measures include associations between primary outcome measures and outlying factors.

Results: The overall rate of revision was 3%, rate of overgrowth 1.5%, rate of extrusion 1.5%, and Holgers reaction ?2 10.6%. Overgrowth and extrusion both required revision. Older age was associated with decreased risk of Holgers reaction ?2 (p=0.03) with a Hazard Ratio of 0.95 (Confidence Interval 0.9-1.0). There were no other statistically significant associations between primary outcome measures and outlying factors.

Conclusions: The cleating stitch is an effective adjunctive technique in placement of osseointegration screws associated with low rates of overgrowth and overall revision surgery.

BAHD FOR UNILATERAL SENSORINEURAL LOSS. HALIFAX COHORT 10 YEARS ON

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Keywords: BAHD, SSD, long term follow-up.

Purpose/Aim: This presentation will revisit a highly scrutinized and carefully selected cohort of patients with unilateral sensorineural hearing loss who were rehabilitated with ipsilateral percutaneous bone anchored hearing devices (BAHD) in Halifax over 10 years ago. Our initial publication (Clin Otolaryngol. 2011 Oct;36(5):442-9) concluded that just 50% (25/50) of an initially enthusiastic group chose to proceed to surgery after an extended preoperative headband trial and a cooling off period. At the time, we felt that careful case selection was rewarded with no immediate non-users, however subsequent developments in BiCros technology were sufficient to persuade a shift away from BAHD in these cases. We were keen to revisit this interesting cohort to see how they had fared in the intervening years and what lessons we might learn from their varied experiences.

Materials and Methods: This study brings us up to date by taking a snapshot in time to reassess the group. Interviews will be conducted when the patients attend for otologic and audiological follow-up to reassess their auditory rehabilitation requirements.
Parameters to be assessed include current use or non-use and reasons given to explain such decisions. Current rehabilitation of choice in cases of non-use. Device history and upgrade experience. Implant site issues, infection, skin overgrowth and the need for abutment replacement or removal. In cases where an unused abutment exists, ‘salvage’ of non-users will be offered with newer ‘power’ devices. Directional performance, impact on effort of listening and hearing in noise will also be assessed in those who are able to be tested. Comparisons will be made between occasional and regular users and those who are current non-users.

Results: Results will be collated and common themes presented. Particular focus will be made on factors that influenced adherence to device use and in capturing objective evidence of benefit in those who persist with device use.

Conclusions: Our preliminary conclusions suggest that further attrition occurs with long-term follow-up of a carefully selected cohort of BAHD users with unilateral sensorineural loss. The reasons for this are multiple and complex and should be considered prior to offering such an intervention.

### AIDED CORTICAL AUDITORY EVOKED POTENTIALS WITH BONE CONDUCTION FITTINGS

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Keywords: Cortical Potentials, BC Fitting

Purpose/Aim: It is understood that hearing instruments should be evaluated using reliable, objective techniques—practically in young children who cannot respond using conventional assessment. While technology such as the Interacoustics Affinity SKS10 Skull Simulator can provide information similar to the 2cc couple in hearing aids, obtaining a measurement compatible to real-ear measurements has not yet been available for non-surgically implanted bone conduction instruments. While the skull simulator designed for the Audioscan Verifit is helpful with older implanted children, aided audibility cannot be obtained for our youngest patients who use a softband. Assessment of aided audibility is possible using cortical auditory evoked potentials (CAEP), but it is challenging to obtain reliable responses as it requires that a child to sit facing a loud speaker for an extended duration in order to obtain a full assessment. Our center has had early success using a multi-mic transmitted to a Resound hearing aid and hypothesized that this technique could also be employed for children with bilateral hearing loss who are fit with Cochlear BAHA devices using a mini microphone 2+. It is the purpose of this paper to highlight our early responses in order to create a dialogue with other professionals.

Materials and Methods: Patients with bilateral hearing loss who were fit with Cochlear BAHA devices were recruited to participate in this exploration. An Interacoustics Eclipse/EP25 was coupled to a Cochlear Mini-mic which had been paired to the patient’s Baha device. The stimulus intensity was set to 50 dB HL and was sent to the Baha via the Mini Mic. The child’s Baha program was not altered. Speech stimuli included were /da/, /ga/ and /s/. For each stimulus, two repetitions were completed with at least 75 accepted runs. Each waveform demonstrated reproducibility of 75% or greater and were then merged together.

Results: As can be seen from Figure 1 from our first subject, we are able to obtain reliable responses. We have subsequently performed this measurement on additional subjects with good results.

Conclusions: While there are many factors that remain unknown with this technique, it does appear that an aided bone conduction cortical auditory evoked potential can be obtained using a mini-mic. Continued use of this technique will allow us to better understand the variables inherent in obtaining these responses. We look forward to continuing work towards determining the audibility of speech sounds this this difficult to assess population.
FITTING INSIGHTS: BAH A SOUNDARC ON A DIVERSE PEDIATRIC POPULATION

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Keywords: Soundarc, Fitting

Purpose/Aim: In December of 2017, Rady Children’s Hospital joined other centers in obtaining after-market trial information of Cochlear Corporation's Baha SoundArc. Rady has a large clinical population who continued to wear their Baha processors on a softband, after five years of age. The SoundArc offers the potential to provide an attractive alternative that is stylish, light and discreet. We were tasked to compare functional gain, sound quality performance, cosmetics, and acceptance of the two wearing options (SoundArc and softband) by long-term Baha softband users. This particular presentation will focus on patient acceptance and fitting strategies, particularly on syndromically misshapen heads.

Materials and Methods: Between February-May of 2018, a total of 28 children were recruited to participate in this study. Participation involved assessment of performance with the softband, fitting the SoundArc and one follow up appointment to assess the performance of the SoundArc after at least three weeks of usage.

Results: From our group of the initial 28, 7 did not complete the process due to in ability to attend appointments or lost devices. Two were withdrawn due to an inability to complete the second visit in a timely fashion. Nineteen children ultimately completed both visits and all but one has elected to continue to use the SoundArc. Of those 18 children, they either like their SoundArc equally to their softband, or utilize their Baha more on the SoundArc then their softband. One child was unable to find a comfortable position to wear the device. Several children required smaller SoundArc (extra-small) and many required molding the device to fit their heads.

Conclusions: The SoundArc is a viable option for families who choose not to obtain a surgically implanted Baha option. For syndromically misshapen heads, additional steps might need to be taken to create a comfortable fit.

SKIN REACTION IN PATIENTS USING TRANSCUTANEOUS TITANIUM IMPLANTS

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Keywords: BAHA

Purpose/Aim: Introduction: Patients with conductive and mixed hearing loss in cases of bilateral microtia with external auditory canal atresia or after chronic otitis media can be conducted applying Bone Anchored Hearing Aids (BAHA).

Aim: Our aim was to compare the effects of application of different surgical techniques in implantation of titanium fixtures (U-graft technique, Dermatome technique, Linear incision technique and hydroxyapatite-coated fixtures usage) affecting postoperative wound healing and occurrence of early and late skin reactions, requiring surgical intervention.

Materials and Methods: Material and methods: Our metod of choice was attachment of titanium implant to the temporal bone with or without removal of subcutaneous tissue in general anesthesia. Three skin incision techniques were used: U-graft technique, Dermatome technique, Linear incision technique and hydroxyapatite-coated fixtures (without collecting skin graft). Our material consists of 145 patients in the age form 3 y.o. to 67 y.o. Universally adopted Holger’s classification of skin reactions was used to determine soft tissue reactions around the transcutaneous implants. In case of severe infection of the soft tissue in the implant site (Grade 4, according to Holgers scale) tissue reoperation was performed.
Results: Results: Assessing the results of treatment it was indicated that considering inflammatory tissue reaction in the implantation site (Grade 4) it was observed that the skin incision technique affects significantly occurrence of reoperations (p = 0.00167). In the groups where Linear incision or U-graft techniques were used nearly 20% of patients required reoperation, and in the group operated using Dermatome technique reoperation was necessary in little above 2% of cases. Till now we haven’t performed any reoperation in patients with hydroxyapatite-coated fixtures.

Conclusions: Conclusions: Assessment of the effects of different surgical techniques application in titanium fixtures implantation (U-graft technique, Dermatome technique and Linear incision technique and hydroxyapatite-coated fixtures) on postoperative wound healing and occurrence of early and late skin reactions indicated that the best result of wound healing and the lowest risk of skin reaction can be obtained using hydroxyapatite-coated fixtures and/or dermatome technique.

84

BAHA IN VARIOUS ACQUIRED AND CONGENITAL EAR MALFORMATIONS IN CHILDREN
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Keywords: BAHA

Purpose/Aim: Treatment and rehabilitation of children with conductive and mixed hearing loss in cases of congenital ear malformations (bilateral microtia with external auditory canal atresia), after chronic otitis media, or in single sided deafness (SSD) can be conducted applying Bone Anchored Hearing Aids (BAHA). Our aim was to assess the results of application of BAHA in children and to compare hearing obtained with typical bone conduction hearing aids (head-band hearing aid, bone conduction glasses, or cross system in SSD) to hearing in BAHA system.

Materials and Methods: Our method of choice in treatment of hearing impairments in presented cases of various defects of the ear was attachment of titanium fixture to the temporal bone, with or without removal of subcutaneous tissue around attachment. The procedure was performed as a one stage in older children or two-stage in younger children. After implantation and osseointegration hearing aid was selected. Audiological examinations were performed 1 and 6 months after hearing aid fitting. Our material consists of 125 patients in the age form 3 y.o. to 18 y.o.

Results: Audiological results are good and sustainable. Thresholds measured in the free field audiometry wearing BAHA hearing aids are on average 8,8 dB lower in comparison to previously used hearing aids. Our patients emphasize that the new hearing aids provide better sound quality, speech understanding, are comfortable and are more aesthetic comparing to typical bone conduction hearing aids.

Conclusions: Application of BAHA in children with various hearing loss in ear malformations is good from audiological perspective as well as with regard to safety and everyday comfort of a user.

85

BAHA SYSTEM IN PATIENT WITH PAGET’S DISEASE - CASE STUDY
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Keywords: BAHA

Purpose/Aim: The authors present a case report of a 38-year-old female patient with Paget's disease who came to our Clinic because of progressive mixed hearing loss. Paget's disease was diagnosed in a patient at the age of 7. She
suffered from chronic middle ear inflammation with many years of purulent leakage and hearing loss from childhood. In childhood, bilateral surgery of the middle ear was performed, however, as the disease progressed, the external auditory tract was completely overgrown.

Material and Methods: In the otoscopic examination, both external auditory meatus were closed by bone. After the CT of the cranium, a massive fibrous reconstruction of bone formation with areas of osteosclerotic thickening, overgrowth of the external auditory meatus, and significant thickening of the cranial bone with symptoms of deformation of the bone and base of the skull were found. In addition, the patient complained about a number of orthopedic and neurological problems.

Results: Due to such a massive reconstruction of the cranial bones and practically closing the space of both middle ears, it was decided not to perform tympanoplasty and using a hearing aid using the bone conduction (BAHA). Due to the practically impossible intubation, local anesthesia was used. A 4mm titanium fixture was used, however, due to abnormal bone tissue (heavily bleeding during surgery), it was decided not to insert the abutment and to perform the implantation in two stages. After the 6-month period of osteointegration, an abutment was installed under local anesthesia.

Conclusions: BAHA bone conduction system was used with a very good hearing effect. The bone connection was permanent, but the slow growth of the bone tissue leading to obstruction of the abutment along with the bone tissue support was observed, which may force the use of a longer abutment in the future.

86

BINAURAL HEARING RESTORATION WITH A BILATERAL FULLY IMPLANTABLE DEVICE

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Purpose/Aim: The Carina system is a totally implantable hearing device. The Carina system is designed for patients with moderate to severe sensorineural hearing loss or those with mixed hearing loss. Object: to analyze the audiological post-operative results of subjects bilaterally implanted with Carina system.

Materials and Methods: Materials and Methods: Retrospective study. 13 patients with bilateral, moderate-to-severe, sensorineural or mixed hearing loss were treated. This clinical sample includes 13 cases bilaterally implanted (11 sequentially, 2 simultaneously). Surgeries were performed under general anesthesia, with an average operation time of 2 hours. No intra-operative or post-operative complications occurred. Surgery included an atticotomy to expose the incus and the transducer was attached to the mastoid bone. The transducer tip was coupled to the incus. The mean follow-up was 52.5 months (range 12-108 months).

Results: The mean daily use time was 17.4 and 16.7 hours respectively for right and left side. At night three patients used the Carina ON, two of them at a reduced volume; the remaining subjects turned off devices to save charged energy. There are no significant differences between pre and post-operative pure tone averages. The patients showed significant differences between unaided and implant-aided conditions in terms of word recognition scores and the Speech, Spatial and Qualities Hearing Scale total score. Speech perception in noise under different loudspeaker arrangements and localization tests demonstrate a significant binaural advantage in bilaterally implanted patients.

Conclusions: The presented results on 13 patients, bilaterally implanted with Carina device, suggest that the bilateral implantation of the fully implantable middle ear hearing devices is an effective procedure.

87

THE ADHEAR SYSTEM EFFECTIVELY TREATS CONDUCTIVE HEARING LOSS IN CHILDREN

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Keywords: children, conductive hearing loss, hearing aid

Purpose/Aim: Bone conduction hearing devices as integrated in softbands (BCD-S) are frequently not well accepted by children with conductive hearing loss due to pressure on the head, sweating, or cosmetic stigma. The non-surgical hearing system ADHEAR uses a new bone conduction concept. It consists of an audio processor connected to an adhesive adapter fixed behind the ear. This study evaluated the short- and long-term clinical efficacy of the ADHEAR in children compared with conventional BCD-S.

Materials and Methods: For 10 children with conductive hearing loss (age: 8 months to 9.7 years) the ADHEAR was compared with a BCD-S. Aided and unaided pure tone/behavioral observational audiometry and?if applicable?speech audiometry in quiet and noise were performed initially and after 8 weeks of ADHEAR use (Neumann et al. 2019). The subjective hearing gain, usage of the ADHEAR, and patients’ as well as parents’ satisfaction were assessed by questionnaires. First long-term results and data of four additional children are available.

Results: The functional gain with the ADHEAR averaged over 0.5, 1, 2, and 4 kHz exceeded that of the conventional BCDS (35.6?dB±15.1 vs. 29.9 dB±14.6, p<.001, n=9 ears). Speech perception in quiet and noise (n=8) improved in the aided situation similarly for both hearing devices. The parents of 8 of 10 children evaluated the ADHEAR system as being useful. After an average use of 13 months (n=4) the functional gain with the ADHEAR remained stable or even improved, as did the adhesion time of the adhesive adapter and the wear acceptance. Eight weeks after first fitting six children used the ADHEAR permanently, one year later eight children and the additional four children.

Conclusions: The ADHEAR system is a favorable technical solution for children with conductive hearing loss or chronical draining ears.


88

AESTHETIC LINEAL INCISION IN BAHA® ATTRACT SURGERY

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Keywords: Baha attract, bone anchoring hearing aids, bone conduction

Purpose/Aim: In the last two decades, otology has been the scene of innumerable changes in the treatment of hearing loss. Patients with different degrees and forms of hearing loss, who cannot be equipped with conventional hearing aids, have been benefited by new implantable hearing devices. These new implantable devices surprise us every moment with innovative technologies, increasingly smaller sizes and aesthetic care for patients. As regards the aesthetic care for patients, not only is the size of the devices important, but also the minimally invasive incisions without alopecia sites and with scars as small as possible, especially in teenagers. The transcutananeous devices, such as the BAHA Attract, allow intact skin without pedestals to pass through it (4), but as the dimensions of the internal component are larger, so are the incisions, leaving alopecia scars on the scalp. To minimize scarring, we have modified the skin incision for the placement of the device. The aim of this work is to show a series of 12 cases, two of them with bilateral implantation of BAHA ® Attract System, and present our experience in small incisions following the hair line to place the internal component of the BAHA Attract System.

Materials and Methods: A series of 12 cases is presented, two of them with bilateral implantation of BAHA ® Attract System

Results: To sum up, fortunately the general results of the surgeries were positive; there were no risks during or after the surgeries. The implantation of the internal component was safe and the scar is invisible and the patients were really satisfied with this new technique.

Conclusions: This technique was very successful, the placement of the implant behind the scalp was possible despite the big size of the internal system. Not only is the connection to sound invisible, but also the scar. This is the best choice
for aesthetic purposes. Moreover, the general results of the surgeries were positive; there were no risks during or after the surgeries. To sum up, the implantation was safe, the scar is invisible, and the patients were really satisfied with this new procedure.

89

TRANSITION FROM PERCUTANEOUS TO TRANSCUTANEOUS BONE CONDUCTION HEARING AID: OUTCOMES

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Keywords: Conductive Hearing Loss, Bone Conduction Hearing, Quality of Life

Purpose/Aim: To describe the clinical, audiological and change of quality of life outcomes in a group of patients who underwent a change from a percutaneous bone conduction hearing aid to a transcutaneous one.

Materials and Methods: We evaluated eight users of the percutaneous osteointegrated system that were taken to a transcutaneous system. The change of the auditory system was made due to skin infection problems with the percutaneous system. Functional gain, speech perception in noise with the HINT test and the change in quality of life with the Glasgow scale were evaluated.

Results: The follow-up of the group was between 2 and 14 months. The eight patients received the transcutaneous system without complications in surgery. In all cases there was adequate healing of the skin where the percutaneous system was and the area of skin where the transcutaneous system is located has not had inflation or infection problems. The functional gain with the transcutaneous system (free field, 0.5-3KHz) exceeds 25dB in all cases and is not significantly different from that with the percutaneous system (p> 0.05). The group had a significant change in their perception of quality of life (Glasgow scale), both in the global measures and in their three subscales (general state, social relationships and physical health).

Conclusions: In patients with a percutaneous bone conduction hearing aid system that present skin problems that limit the use of the device, the transition to a transcutaneous system can be made without affecting significantly the auditory performance and generating a positive change in the perception of Quality of Life related to the elimination of skin problems.
BETTER UNDERSTANDING OF BONE-CONDUCTED THRESHOLDS USING PTA, ABR, AND BCDIRECT

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Keywords: BC Direct, Bone-anchored hearing aid, Bone conducted measurements

Purpose/Aim: It is acknowledged that patients suffering from conductive or mixed hearing loss may benefit from bone-conduction hearing aids (BAHA). However, since the amount of amplification provided by BAHA is based on the individual's sensorineural frequency-specific thresholds, especially for the patients who are not able to provide thresholds behaviorally, their reliable thresholds from objective testing are required to support successful fitting of their BAHA. In this light, the present study aimed to compare the thresholds of bone-conducted (BC) Direct with those of behaviorally measured BC PTA and objectively measured BC ABR and to confirm clinical feasibility as their relations.

Materials and Methods: A total of ten young adults with normal hearing participated for three measurements in testing frequencies of 0.5, 1, 2, 4 kHz. In BC Direct, vibrator of BAHA softband (Cochlear Ltd.) was placed on mastoid of each subject to estimate the thresholds. Pure-tone thresholds of subjects were determined with routine clinical BC audiometry. With tone-burst stimuli, the BC ABR was conducted by two-channel EEG recording with Fpz (ground), Fz (active), and the left/right ear lobe (reference). The sound intensity level was initially set to 50-70 dBnHL depending on the frequency and then reduced as 5-dB steps until the individual threshold was confirmed. It took about 2 hours per subject to complete all experiments.

Results: Compared with the BC PTA, the thresholds of BC ABR were consistently higher across the frequency. That is, 4-tone average of BC PTA was 2.62 dB (SD:6.20) and that of BC ABR was 29.00 dB (SD:9.88). Regardless, there was a large individual variance at 4 kHz of the ABR measure. As expected, the BC Direct showed a different pattern between low and high frequencies. The thresholds of BC Direct were 13.50 and 13.50 dB HL at .5 and 1 kHz, respectively, whereas they were 23.00 and 22.50 dB HL at 2 and 4 kHz.

Conclusions: Based on the current results, BC Direct showed 15–16 dB lower (or better) thresholds at low frequency and similar ones in high frequency compared to the BC ABR, although we need a big data for the standardization.

ADHEAR VS Baha Attract IN PEDIATRIC CONGENITAL AURAL ATRESIA

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Keywords: Adhear, Baha Attract, congenital aural atresia

Purpose/Aim: In 2017, the non-implantable bone conduction device (Adhear Med-El) was created. The aim of our study is to compare the auditory outcomes and patient satisfaction between ADHEAR system and the Baha Attract.

Materials and Methods: We included 6 pediatric patients with bone conduction threshold > 25dB users of Baha Attract (Baha 5 or 4) for at least one year, and gave them ADHEAR for one week. After a week of use with ADHEAR, pure tone and word recognition masked with bisyllables at 65dB with and without noise were performed for each of the two devices. Finally, the ADHEAR specific satisfaction questionnaire, SSQ life questionnaire and the Kinddle quality of life questionnaire adjusted to the patient's age were passed.
Results: The mean age of the patients was 7.3 years. All of them with congenital aural atresia, 3 unilateral and 3 bilateral. Only one child associated comorbidities, specifically a Treacher Collins syndrome. The pure tone average in the studied ear recorded a mean threshold of 57 dB without help. The mean BAHA-aided threshold was 35 dB and 36 dB ADHEAR-aided. The average threshold of word recognition was 91% for the BAHA and 93% for the ADHEAR in silence. In noise, 45% for the BAHA and 62% with ADHEAR.

Conclusions: The new ADHEAR provides the same auditory results as the BAHA Attract in free field and in silent word discrimination, and it is slightly better in word recognition with background noise. The overall satisfaction of the new ADHEAR device is good. In the future, it is necessary to increase the sample size to obtain more statistical power.

92

OUTCOME AFTER 15 YEARS OF OSSEOINTEGRATED IMPLANTS IN CHILDREN
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Keywords: BAHA, LONG-TERM SATISFACTION

Purpose/Aim: The objective of this study was to a) analyze the long-term satisfaction, b) assess the surgical variations, and c) evaluate the auditory outcomes in a 15-year period handling the BAHA system in a Pediatric University Hospital

Materials and Methods: We included 39 patients with an age ranging from 5 to 16 years, undergoing an osseointegrated bone conduction implant, between January 2003 and December 2018. Socio-demographic variables, surgical indication, type of surgery performed, technical characteristics of the implant used, complications and free field audiometry with BAHA, were collected retrospectively. For the long-term satisfaction, we measured the number of hours of daily use for BAHA device.

Results: The congenital aural atresia was the main indication in 97% of the cases (82% unilateral and 18% bilateral). 74% of users were happy with the audiological results, and used their BAHA for at least 6 hours per day. The remaining 26% were adolescents with unilateral atresia. All Attract systems were long-term users. 97% of the children had at least one minor skin complication. With the lineal eccentric techniques less complications were observed. The free field PTA with the BAHA was between 35 and 40dB in more than 90% of patients. Regarding osseointegration, 25% of the patients had an implant extrusion, mostly a 9% in patients with BIA300 screw and 87% in BIA400 screw patients.

Conclusions: Most of the implanted children are regular users. The main cause for stop using their implants was for aesthetic reasons during the adolescence, rather than by causes of hearing. Current surgery lineal eccentric techniques are associated with minimal complication rates. For percutaneous preference the BIA300 screw had less extrusion.

93

TOTALLY IMPLANTABLE MIDDLE EAR DEVICE
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Keywords: Active middle ear prosthesis, Carina implant, Middle ear transducer

Purpose/Aim: The aim of this work was to describe the first outcomes for the active middle ear device fully implantable Cochlear™ Carina® System.

Materials and Methods: From December 2014 to June 2017, 15 patients underwent device implantation. Preoperative and postoperative air conduction and bone conduction thresholds were evaluated. Functional gain, speech perception in silence and in noise, and localization sounds abilities, were also analyzed. All the implants were from the last generation developed by Cochlear® Company.
Results: A total of 16 active middle ear implants were performed. Post-operatively, the mean pure tone threshold was 50.5 dB (± 12.64) in bone conduction and 64.9 dB (± 15.36) in air conduction. No differences were found between postoperative and preoperative audiometric threshold previously the system activation (p > 0.05). The mean postoperative threshold in free field with the device activated was 46.8 dB, 45.75 dB, 42.6 dB and 43.38 dB at 1, 3, 6 and 12 months, respectively. In speech understanding in silence the global result was 50.7 dB, 47.18 dB, 42 dB and 42 dB, respectively for 1, 3, 6 and 12 months. Patients with mixed hearing loss presented better results than sensorineural hearing loss patients. Speech discrimination in noise and localization improved with this implant.

Conclusions: In spite of the small number of patients, our results confirm that this fully implantable active middle ear device is a viable treatment for patients with moderate to severe sensorineural hearing loss that can’t or don’t want to use a traditional hearing aid, due to clinical or cosmetic reasons.

PATIENT OUTCOMES WITH THE ADAPTIVE FEEDBACK CANCELLER
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Purpose/Aim: The primary objective of this study was the evaluation of an upgrade of the Carina firmware from the Fixed Feedback Canceller (FFC) to the Adaptive Feedback Canceller (AFC) on the patient performance. The secondary objective of this study was to evaluate the effect of AFC on sound quality, feedback problems and quality of life.

Materials and Methods: Retrospective (TBD), mono-centre, repeated measures study with 15 subjects where each subject serves as own control
All patients involved in this trial will be experienced Carina users (> 6 months implant use) with a sensorineural hearing loss where the actuator is coupled to the incus.
A periodic evaluation was performed at 1, 3, and 6 months after the change for a new feedback control system. Functional gain, speech perception in silence and in noise, and localization sounds abilities, were analyzed.

Results: Pure tone results are similar between AFC and FFC. However AFC is more effective in cancelling feedback and improves the sound quality and speech understanding in silence. During the clinical trial clinically relevant improvements in speech outcomes have been seen with a number of patients. However, further investigation is needed to quantify the improvement AFC provides in speech understanding in quiet and in noise.

Conclusions: AFC can give Carina patients improved speech understanding, better sound quality and reduces feedback problems compared to FFC.

PRELIMINARY DATA ON QOL AND HEARING FUNCTION FOR CARINA® RECIPIENTS
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Purpose/Aim: Carina® recipients are familiar with regular hearing performance assessments in specific test
environments as part of their clinical follow-up visits. Although these assessments are crucial, testing environments may significantly differ from daily listening situations. Patient-reported outcomes and quality of life (QoL) data has increasingly gained importance for supporting efficacy claims and reimbursement decisions. We used the Cochlear® Implant Recipient Observational Study (Cochlear IROS) to capture patient-reported results for Carina® recipients in nine different clinics.

**Materials and Methods:** Observational data were collected in an online database. 38 patients (20 females, 18 males) implanted with the Carina® system were included in this analysis. Questionnaires were used to assess general daily life information, quality of life (Health-Utilities-Index Mk3 (HUI3)) and overall hearing performance (Speech Spatial Qualities (SSQ)). Answers were collected prior to first activation of the device and at 1 year post-implant (n=18). Air- and bone-conduction hearing thresholds were also collected pre- and post-surgery as well as at 1 year post-implant. Given the small population size available at this stage of the study, no inferential statistical tests were performed.

**Results:** A HUI3 multi-attribute score mean increase of 0.03 was registered 1 year after implantation compared to baseline condition (n=18). SSQ scores also increased 2.1 points on average (Speech: 2.1, Spatial: 2.2, Qualities: 1.9). When asked about their hearing ability and the impact on their daily work, 92% of the employed patients (n=12) reported enhanced ability at 1 year post-implant. Air- and bone-conduction thresholds measured immediately after implantation were clinically similar to the pre-operative thresholds. Moreover, 1 year after implantation, there were no clinically relevant changes in either air- or bone-conduction thresholds, compared to the pre-operative thresholds.

**Conclusions:** Preliminary audiometric data indicate that Carina® implantation is a safe surgical procedure and that air- and bone-conduction thresholds remain stable after 1 year of implant use. When using self-assessment tools, patients appear to accrue a clinically significant improvement in health-related quality of life (HUI average ?0.03) and self-perceived hearing abilities (SSQ average ?2). Furthermore, enhanced work-related achievements were reported by most of the employed patients implanted with the Carina® system.

**OUTCOMES FROM A 15 YEAR OLD COCHLEAR CARINA RECIPIENT**

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**Keywords:** Mixed hearing loss, Carina, Quality of life

**Purpose/Aim:** To present the outcomes of the worlds youngest Cochlear Carina recipient. A 15 year old female with bilateral moderate to severe mixed hearing loss of unknown aetiology was referred to the St Thomas’ Hearing Implant Centre. She was unable to consistently wear conventional hearing aids due to psoriasis and recurrent episodes of otitis externa. She was assessed and discussed in the multi-disciplinary team meeting. After explanation of her options including the risks of surgery and long term implications of the Carina system the decision was made for left sided implantation. Surgery was carried out on 23rd August 2018.

**Materials and Methods:** Audiological and speech discrimination testing using Arthur Boothroyd word scores were carried out pre and post implantation. Patient reported quality of life outcomes were collected 6 months after activation.

**Results:** The patient and her family report a marked improvement in general health and quality of life with fewer days missed from school. There has been a reduction in episodes of otitis externa (none on the implanted side) and no further conchal psoriasis. Her 4 figure pre- and post-operative pure tone averages were 65 dB and 70 dB respectively with some post-operative high frequency deterioration. She gains good benefit using the device with and without the processor, although she has had some feedback from the device when using it without the processor. The pre-operative AB word score for the left ear (tested at 80dB) was 17%. Post operative scores awaited (due for testing in May).

**Conclusions:** Left sided Carina implantation has drastically improved this patient’s listening ability and quality of life. Feedback related to the internal microphone has led to re-programming which has subsequently improved her hearing benefit. They report a satisfaction rating of 10/10 despite a drop in high frequency pure tone thresholds. We are now assessing her for implantation in her right ear. Appropriate patient selection and patient centred decision making are integral to successful outcomes.
AUDIOLOGICAL OUTCOMES OF THE NEW COCHLEAR OSIA IMPLANT

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Keywords: Outcomes, Cochlear, Osia

Purpose/Aim: The active transcutaneous Cochlear Osia system has now been implanted in a small number of patients as part of a controlled market release. This has a receiver stimulator package which is coupled to a piezoelectric transducer. The transducer is mounted on the well-established BI300 fixture providing a single point of contact.

We aimed to evaluate the audiological outcomes of patients with the new Cochlear Osia implant system.

Materials and Methods: Ten patients with moderate conductive and mixed loss were selected after informed consent. All patients had pure tone audiometry and speech testing. A bone conduction device (BAHA 5) on a headband was trialled for 2 weeks and patients completed a diary to record their experiences. Each device underwent intraoperative testing using the manufacturer supplied software. The devices were switched on at 4 weeks after surgery.

Results: Ten patients were implanted. The patient population consisted of a mixture of moderate conductive and mixed hearing losses. Average follow up was 3 months. The software was straightforward and user friendly. There were no minor soft tissue complications. There were no long term sequelae. The average gain was excellent. The trial of BAHA 5 on a headband provided a realistic and accurate assessment of the postoperative results. The sound quality was good to excellent. Patients liked the external processor as it was less conspicuous.

Conclusions: The new Cochlear Osia active transcutaneous implant provides an excellent solution for moderate conductive or mixed hearing losses. The audiometric gain was as predicted and the processor is very well liked by all patients.

SHEFFIELD EXPERIENCE OF THE COCHLEAR CARINA FULLY IMPLANTABLE HEARING DEVICE

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Keywords: Carina, Middle Ear Implants, Severe Hearing Loss

Purpose/Aim: The Cochlear Carina is a fully implantable middle ear implant capable of amplifying up to 85dB SNHL. It can be attached to the incus or stapes and is suitable for pure SNHL or mixed hearing losses. We evaluated our initial experience in surgical technique, indications and surgical outcomes with this device in our centre.

Materials and Methods: 14 patients have been implanted. The indications were moderate to severe SNHL and unable to benefit from hearing aids (air or bone conduction) and above the UK NICE guidelines for cochlear implantation (>80dB at 2 & 4Khz). 13 of 14 surgeries used the intact ossicular chain for connection.

Results: Surgery was well tolerated with all being discharged the day after the surgery. Three complications occurred – (1) a seroma 5 days after surgery managed with aspiration (2) intraoperative displacement of the incus corrected during surgery (3) surgical site infection necessitated removal of one implant. Average follow up is 12 months (2 – 18 months) and there has been no device failure post implant. No battery issues have occurred. All patients still using the implant. Unaided thresholds are well preserved. There has been improvement in hearing threshold, and significant improvement in
speech intelligibility (Pre-op best aided AB word list presented at 70dB was 45% to Post-op 75%). Patients report that the sound was more normal. Some patients with severe loss preferred to use an additional external microphone to improve clarity and reduce feedback. Glasgow hearing aid benefit showed reduction in disability from 60% to 6% which high patient satisfaction.

Conclusions: The Cochlear Carina is a safe, stable and effective implant for patients with moderate to severe hearing loss; It is an excellent solution for patients who cannot benefit from conventional aids. It is totally implantable and is audiologically and cosmetically acceptable.

99

HISTORICAL ROOTS AND RESEARCH TRENDS IN BONE CONDUCTION DEVICES
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Purpose/Aim: Bone conduction devices are becoming increasingly popular in last 30 years. Using bibliometrics we analysed how increased popularity influenced the research literature production.

Materials and Methods: Papers were harvested from the Scopus bibliographic data base using the search string including keywords "bone-anchored hearing aid", «baha» or "bone conduction device" in the title, abstract or keywords. We limited our search to papers written in English and the time span from 1980 until the present. Only publications from the Scopus subject areas of Medicine, Neurology and Health were selected. Historical, descriptive and exploratory bibliometrics were used for the data analysis. Reference Publications Years Spectroscopy was employed to identify historical roots; descriptive statistics to identify the most prolific institutions, countries, source titles and literature production trends; and the triangulation of bibliometric mapping and thematic analysis to identify themes and historical trends.

Results: The search resulted in 828 publications. The literature production trend exhibits exponential growth. United States, United Kingdom and Netherlands were the most productive countries. 13 historical roots were identified. Following research themes emerged in the analysis: “Single Sided Deafness”, “Congenital Anomalies”, “Different Possibilities for Treating Mixed Hearing” and “Benefit of Transcutaneous Devices”.

Conclusions: The study revealed bibliometric patterns of bone conducting devices research literature production and shows facts about its knowledge developments. Hot topics are forming BCD clinical databases, measuring quality with Glasgow Benefit Inventory and BBSS questionnaires, skin necrosis, bimodal stimulation, 3d laser doppler vibrometry, Baha Attract, single sided deafness, and osseointegrated implants.

100

PATIENT SATISFACTION OF PERCUTANEOUS AND TRANSCUTANEOUS BONE CONDUCTION DEVICES
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Keywords: bone conduction devices, Glasgow Benefit Inventory questionnaire

Purpose/Aim: Bone conduction devices are widely used to treat conductive and mixed hearing loss as well as single-sided deafness (SSD). A transcutaneous system was introduced recently with the clear advantage of fewer local reactions. Our goal was to evaluate and compare the satisfaction of patients with percutaneous and transcutaneous bone conduction devices.

Materials and Methods: We divided a cohort of 72 patients into groups by type of hearing loss and their relation to the use of the percutaneous or transcutaneous system. The Glasgow Benefit Inventory (GBI) questionnaire, adapted for
hearing aids, was employed to assess patient satisfaction, along with an additional questionnaire covering the general usefulness of the devices.

**Results:** Overall median daily wearing time was 12 hours for the percutaneous and seven for the transcutaneous groups (p<0.001). We found no correlation between the bone conduction level at any frequency and the GBI satisfaction score. The median total GBI score of the entire patient cohort was 30.1; median values for general, social support and physical health subscales were 0, 37.5 and 16.7, respectively. People suffering from SSD had the lowest satisfaction rates, and these were significantly lower for the patients who used transcutaneous aids than for those with percutaneous devices (p=0.033). Similarly, the percutaneous system brought more satisfaction to combined hearing loss patients than did the transcutaneous (p=0.010).

**Conclusions:** Both types of bone conduction devices provide a safe and efficient way to improve hearing for candidates within correct indications. Our study revealed that patients wore the transcutaneous device less than they did the percutaneous. Satisfaction was the lowest among SSD patients who used the transcutaneous device; hence it is especially important to carry out preoperative counseling for such patients.

101

**EXPERIENCE WITH THE SUPER POWER DEVICES**

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**Keywords:** superpower, baha, mips

**Purpose/Aim:** Stronger auditory osseointegrated sound processors such as the Cochlear Americas BAHA 5 Superpower and the Oticon Ponto 3 Superpower have been approved with a fitting range up to 65 dB SNHL bone conduction hearing loss. In this study we examine our patients’ experiences using the stronger processors including analysis of post-operative complaints like audio feedback and softness of sound.

**Materials and Methods:** Single institution, single surgeon retrospective study of patients who received either of the two extended range bone anchored hearing devices. Patients with at least 6 months follow-up were evaluated for pre-operative auditory testing including pure tone averages (bone conduction), speech testing in quiet and noise, and post-operative outcomes.

**Results:** Twelve patients were included in this study. Five were males, seven females with a mean age of 71 (65.7-76.7 95% CI). Ten patients received the Ponto 3 Superpower, two received the BAHA 5 Superpower processor. Ten patients received the implant for treatment of single sided deafness, two for mixed hearing loss. Mean bone conduction pure tone averages was 36 (27.8-45.1 95% CI). CNC speech testing aided with the bone anchored device was performed with a mean of 70.3 (60.3-80.3 95% CI). Four patients (33%) of the patients had complaints of feedback (two with BAHA 5, two with Ponto 3) and six patients (50%) complained that the amplified sound was not loud enough (one with BAHA 5, five with Ponto 3). Multivariate analysis found that a longer abutment size and BAHA 5 processor were statistically significant factors (p=0.02 and p=0.01 respectively) with complaints of feedback after surgery. No statistically significant variables predicted complaints of the hearing device being too weak.

**Conclusions:** Feedback and softness of sound were common complaints with the increased power processors evaluated in this study. Longer abutment size and BAHA 5 superpower may be more predictive of feedback complaints after surgery.

102

**EFFECT OF NOISE REDUCTION ON SPEECH INTELLIGIBILITY AND SELF-REPORTED PERFORMANCE**

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**Keywords:** noise reduction, speech intelligibility, BAHS

**Purpose/Aim:** The aim of this study was to evaluate the noise-reduction scheme of Ponto 4 in terms of speech
intelligibility and users’ self-reported performance.

**Materials and Methods:** The noise-reduction scheme evaluated in this study consists of a fast-acting combination of a minimum variance distortion-less response beamformer and a single-channel Wiener post-filter. This combined system is implemented in Ponto 4 as a feature called OpenSound NavigatorTM (OSN). This is a prospective study, where the listeners served as their own control. Listeners with a conductive, mixed conductive-sensorineural, or single-sided deafness were included in the study. The listeners with mixed hearing losses had bone-conduction pure tone thresholds lower or equal to 45 dB HL PTA and all participants were Ponto 3 users prior to the commencement of the study. Each listener participated in two visits. At the first visit, Ponto 4 was fitted to the individual hearing loss. After a field-trial period of about 14 days, speech-in-noise performance was evaluated in a spatial setup with the OSN feature active and inactive. Self-reported performance during the trial period was also evaluated via questionnaires.

**Results:** Preliminary results indicate a significant benefit of OSN. Specifically, speech-in-noise performance significantly increased when the OSN feature was activated. The complete results will be presented at the conference.

**Conclusions:** By combining speech intelligibility measures in the laboratory with subjective perception in real-life listening scenarios, this study evaluates the benefit of OSN for bone anchored hearing systems users.

### 103

**SURGICAL EXPERIENCE WITH AN ACTIVE OS IMPLANT IN SSD**

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**Keywords:** bone-conduction, implant, new

**Purpose/Aim:** Patients with single sided deafness have problems with speech understanding in noise. Beside restoring the auditory pathway with a cochlear implant in these patients, bone anchored hearing implants are established as a contra-lateral routing of signal (CROS) solution in patients with single sided deafness to enhance speech understanding in noise. We report about our surgical experience with a new active osseointegrated steady state implant system (OSI), Osia? (Cochlear Limited Company), in patients with single sided deafness.

**Materials and Methods:** Patients suffering from single sided deafness that were not indicated for a cochlear implant were implanted with the new OSI in our clinic. They received an audiological test battery with pure tone thresholds and measurements of brainstem evoked potentials to confirm single sided deafness with a near normal inner ear function (bone-conduction threshold ? 20dB HL) on the contralateral side. Pre-operative cone beam CTs were used for planning to find the right position of the implant. The operations were carried out under general anesthesia. We performed a retro auricular straight incision and the active unit of the implant was fixed onto a 4mm BI300 implant

**Results:** So far operations were successful without any peroperative complications as well as during follow-up.

**Conclusions:** The new active transcutaneous osseointegrated steady-state implant system Osia? provides a straight forward surgical procedure and offers the possibilities of an active bone conduction implant without large removal of bone.

### 104

**COST COMPARISON AND LONG-TERM FOLLOW-UP OF MINIMALLY INVASIVE PUNCH TECHNIQUE**

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**Keywords:** Quality Assurance, Costs and Cost Analysis, Minimally Invasive Surgery

**Purpose/Aim:** Minimally Invasive Ponto Surgery (MIPS) is a newly described technique to facilitate the placement of percutaneous bone anchored hearing devices. The procedure has resulted in a simplification of the surgical steps and a
dramatic reduction in surgical time while maintaining excellent patient outcomes. Our group sought to move the procedure out of the main operating suite. The longest follow-up data for a North American MIPS cohort was obtained.

Materials and Methods: 20 operations (10 MIPS and 10 traditional linear incisions) were performed on adult patients from 2013-2016 by the same surgeon. A retrospective direct cost comparison considering time, staff and equipment needs of MIPS and open approaches for the implantation of bone conduction implants was conducted. Minimum follow-up period of 1 year in MIPS group assessing soft tissue reaction using the IPS scale, device success and patient satisfaction were recorded for the cohort.

Results: MIPS had a mean reduction in cost of CAD$456.83 per operation when compared to open approaches, largely due to a 61 minute reduction in operating time. Long term follow-up indicated zero fixture losses, subclinical soft tissue changes and minor complications (skin redundancy, abutment screw length) in the MIPS group. There was no difference in complication rate for MIPS performed outside the main OR. MIPS had improved patient satisfaction.

Conclusions: The MIPS technique was more cost effective than traditional open approaches with minimal complications despite this being a new technique and departure from conventional wisdom. This simple, quick intervention was found to be feasible and with proven safety based on long term outcomes with zero fixture losses.

105

MIPS: A PROSPECTIVE STUDY ON SURGICAL PROGRAMME EVOLUTION

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Keywords: MIPS1, OutcomeMeasures2

Purpose/Aim: We prospectively studied the development of a MIPS (Minimally Invasive Ponto Surgery) programme. Data comparison in evaluating implant osseointegration and fixture site skin reactions (FSR) with that previously documented for Soft Tissue Reduction (STR) and Linear Scalp Sparing (LSS) techniques has allowed critical justification for this procedure whilst steering evolution of our surgical technique.

Materials and Methods: A prospective study involving our initial x75 MIPS procedures was performed recording a data set including: skin depth, dural exposure, surgical time and ISQs (per-operative, weeks 1, 5, 12) all using Oticon 'wide' implants. This included our initial x10 cases which contributed to the pre-marketing multi-centre trial. Outcome measures included implant osseointegration stability and assessment of the incidence of FSR utilising the Tullamore Classification (TO-T3).

Comparison evaluation used previously documented STR (n=100) and LSS (n=75) data. Evolution of the surgical technique to incorporate enhanced bone-drill interface cooling was introduced after case no. 35 to combat the unexpectedly high early extrusion incidence.

Results: The initial trial cohort (n=10) were uncomplicated, but our subsequent x25 procedures elicited a 30% extrusion rate (Total 17.5%). Optimised bone pre-cooling has reduced our subsequent predicted extrusion rate to 4%, which equates with our 4 month extrusion rate for STR and LSS procedures. FSR within the first 12 months for combined T1 (excoriation with flat granulation) and T2 (heaped granulation) were equitable MIPS (12%), STR (12%) and LSS (10.5%) whereas delayed onset T3 (stable skin overgrowth) was notably absent in MIPS (0%) c.f. STR (10%) and LSS (8%).

Conclusions: MIPS has offered a meaningful but selective addition to our technical arsenal with reduced surgical time and minimised intraoperative soft tissue trauma. It is however operator sensitive, and we have responded to a need for increased bone-drill interface cooling by extending intra-operative duration and implementing implant site bone pre-cooling to limit the risk of physiological heat shock which may influence early osseointegration rates.

A trend towards reduction in early FSR has been indicated since the introduction of more selective patient education, and the absence of T3 FSR may be due to the reduction in tissue trauma and a greater awareness of the need to maintain the skin/ abutment flange metric to >2mm.
TULLAMORE CLASSIFICATION: FIXTURE SITE SKIN REACTIONS COMPARING MIPS/LSS/STR TECHNIQUES

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Keywords: MIPS, Skin-reactions, Outcome-measures

Purpose/Aim: We evaluate the impact of surgical technique evolution on the incidence of fixture site skin reactions (FSR) using the Tullamore FSR Classification (TC).

Materials and Methods: Using prospectively collected data we have logged FSR arising in Linear Scalp Sparing (LSS) (n=75) and MIPS (n=75) techniques and compared this with previously reported data derived from a cohort of patients receiving Soft Tissue Reduction surgery (STR) (n=100) before 2012. The Tullamore FSR Classification has 5 categories derived from clinical, histological and temporal healing phase evidence,

Results: With data derived from a longitudinal study of 250 pBAHS fixture sites, we discuss our findings in terms of early healing stage T1/T2 FSR, and late onset T3 stable skin overgrowth. Our respective findings were:

STR. LSS. MIPS
T1/T2. 12%. 10.6%. 12%
T3. 10%. 8%. 0%

Conclusions: The Tullamore Classification has proven to be easy to use and is a particularly user friendly and objective applied tool for clinicians unfamiliar with pBAHS FSR. Using this tool a management algorithm is easily applied. The prospective physiological and histological basis of TC plotted on a time line has allowed recognition of T3 FSRs as a different pathophysiological process from T1/T2, and as such this sub category is not recognised in’Holgers’ classification’. The TC has permitted identification of reduced T3 FSR incidence in MIPS recipients.

107

TULLAMORE CLASSIFICATION: PBAHS FIXTURE SITE SKIN REACTION REEVALUATION

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Keywords: Skin-Reaction, BAHA, Outcome-measures

Purpose/Aim: We demonstrate the Tullamore Classification (TC) of Fixture Site Skin Reactions (FSR), it’s evolution incorporating clinical, histological and temporal factors and its ease of objective application by clinicians unfamiliar with BAHA FSR.

Materials and Methods: The TC is a category classification ranging from T0 - T5:
T0 – normal
Tr (reactive) dry / moist erythematous skin adjacent abutment
T1 excoriation c dry or moist flat granulation
T2 x heaped granulation
T3 - stable skin overgrowth
Coding suffix: a - alopexia, pth - paraesthesia, p - pain, e – extrusion
The ‘Tullamore Classification Equivalence Matrix’ permits retrospective comparison with Holgers classified data.
Results: Tba

Conclusions: The TC is a prospectively developed tool to record outcome data for coding and management algorithm allocation.

108

PBAHS IN THE MANAGEMENT OF MENIERE’S SYNDROME
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Keywords: Meniere’s, SSD

Purpose/Aim: We review the role and impact of pBAHs in the management of Meniere’s Syndrome and evaluate the perceived benefits in comparison with other forms of single sided SNHL (SSD)

Materials and Methods: 15 patient with MS were compared with 45 individuals with SSD of varying aetiology. They were evaluated using PTA, Speech Discrimination, aggregated daily sound processor usage, perceived benefit using linear analogue scales and Tullamore Classification for FSR incidence.

Results: Tba

Conclusions: This presentation documents the perceived benefits of pBAHS in patients with MS when utilising subthreshold ipsilateral transcranial stimulation. The tendency for MS patients to be particularly effective placebo responders may contribute to the substantial SP usage and absence of FSR in this cohort.

109

IS THERE A FUTURE FOR PERCUTANEOUS BONE CONDUCTION IMPLANTS
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Keywords: BAHA, Deramlock, Bone conduction

Purpose/Aim: Evaluate the surgical outcomes for the BAHA Dermalock abutment (BA400) focusing on the patient factors like skin thickness, diabetes, smoking.

Materials and Methods: This study is a prospective monitoring of these implants with a retrospective review over a four year period. The surgical technique was manufacturer recommended and involved a small 2cm vertical incision in the postauricular region without soft tissue reduction or hair removal. Majority of abutments were delivered through a separate skin hole punched slightly behind the incision line.

Results: 162 implants were undertaken in 138 patients (12 bilateral). Majority were adults. We found no significant difference in the complications suffered by male or female patients. Rate of complications was higher amongst smokers (36%) than amongst non smokers (12%). Similarly diabetics had a higher complication rate (67%) than non diabetics (14%). More skin related complications were seen with the longer abutments The current study shows a relatively reduced rate of minor soft tissue complications compared to older techniques. The wound dehiscence although only small in number was seen only in cases where monopolar diathermy was used and not in those where this was not used. Smoking and diabetes are well known risk factors for poor skin healing and this is reflected in this study as well. The complication rate was also higher in these with excess scalp thickness.

Conclusions: Osseointegrated titanium implants are now a well established route to anchor Bone Conduction Hearing
Devices (BCHDs). The earlier implants had a significant rate of soft tissue complications and implant loss. The BAHA Dermalock abutment (BA400) was developed with hydroxyapatite coating of the pure titanium abutment. A minimal access incision and no soft tissue reduction or hair removal accompanied by a Tioblast treatment of the fixture was thought to improve osseointegration and implant retention. The BAHA Dermalock is a stable implant which has excellent soft tissue outcomes and is well tolerated by patients. The surgery is short and simple and ideal in patients with additional health issues or those needing repeated brain scans.

110

BAHA ATTRACT IMPLANTATION USING A SMALL INCISION: A SURGICAL TECHNIQUE

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Keywords: Baha attract, Small incision, Surgical technique

Purpose/Aim: To determine the appropriate anatomical borders of implantation on the temporal bone in a cadaver study, and to develop a simplified surgical technique for Baha Attract implantation through a small incision along the hairline using anatomical evidence and a navigation system.

We successfully implanted the Baha Attract according to the newly developed surgical procedure and validated the feasibility of this technique. The method developed has three advantages over the conventional technique: (i) improved cosmetic effect, as abnormal hair growth that occurs along a semicircular incision line does not occur when using this technique; (ii) omitted polishing of the temporal bone; and (iii) a short operating time (< 30 minutes), thus enabling the use of local anesthesia.

Materials and Methods: In a cadaver study, 20 human adult dry skulls were used to find flat areas of the temporal bone for Baha Attract magnet implantation. Four borders of the 'Optimal surgical site' were defined: Asterion line, Occipitomastoid suture line, sigmoid sinus line, and digastic groove line. In three patients, we implanted the Baha Attract according to the newly developed surgical procedure and validated the feasibility of this technique with a navigation system.

Results: We identified the appropriate position of the implant on the temporal bone, suggesting a simplified surgical technique for Baha Attract with a small incision. We determined the spot of implantation, and the implants were inserted through a small surgical incision (< 2.5 cm) under local anesthesia; the procedure lasted approximately 30 minutes.

Conclusions: the B zone of the temporal bone is a safe and easily accessible location for implantation of the Baha Attract. Although more clinical studies should be conducted, this newly developed surgical technique to implant the Baha Attract will provide clinicians with anatomical knowledge of the implant surgery, and patients undergoing implantation with convenience. The implants will be placed in similar positions based on anatomical evidence, so that implantation of the Baha Attract can be performed quickly, under local anesthesia, and through a small incision.

111

DEVELOPMENT/ESTABLISHMENT OF IN-VITRO MODEL TO UNDERSTAND THE EFFECT OF ELECTRICAL-STIMULATION

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Purpose/Aim: There is a trend to implant patients with residual hearing. The usage of new devices such as inner ear stimulator for tinnitus or cochlear implant for patients with residual hearing, can expose the inner hair cells to electrical field. However, the effect of this electrical field generated by the implant has not been investigated to date. There is a need to develop in-vitro models which closely mimic human clinical conditions that will help in understanding the precise contribution of electrical stimulation in cochlear damage.
Materials and Methods: A custom stimulator circuit that allows to study several parameters, including stimulation amplitude, pulse width, and total stimulation duration was designed. The organ of Corti explant cultures from P3 day rats were used and placed in microchannel slide (Ibidi GmbH) in the incubator and exposed to stimulation or left unstimulated. We also determined the efficacy of an otoprotective compound in providing protection against adverse effects of electrical stimulation. Parameters (amplitude, pulse width and duration) were changed one at a time. The organ of Corti explants were subjected to FITC phalloidin staining to visualize hair cells using confocal microscopy. The number of surviving hair cells were counted. The organ of Corti was also subjected to CellROX and cleaved caspase 3 staining to determine the levels of oxidative stress and apoptosis, respectively.

Results: In-vitro testing suggests that the electrical stimulation may cause some damage to hair cells, mainly with higher stimulation levels and longer times of stimulation. The identified otoprotective compound provides significant protection against loss of hair cells in response to electrical stimulation. The molecular mechanisms behind otoprotection involves abrogation of activation of oxidative stress and apoptosis pathways.

Conclusions: The stimulator circuit we designed and constructed very closely simulates the electrical field of a cochlear implant. It has enough task flexibility to be used as an in-vitro model of electrical stimulation. The models developed in this study using electrical stimulation can be used to understand the effect of electrical field on inner ear sensory cells and to screen future otoprotective drugs for the preservation of residual hearing post inner ear trauma using similar approach as used in this study.

CENTRAL AUDITORY PATHWAYS IN UNILATERALLY HEARING RATS

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Keywords: fMRI, rat, longitudinal

Purpose/Aim: Unilateral hearing loss has been shown to negatively affect study results and language development as well as bear impact on sound localization and speech understanding in a noisy environment. The aim of this study was to map any changes in functional connectivity within the central auditory system and related areas over time, and to look for therapeutic windows for hearing rehabilitation. The hypothesis was that a prehearing onset conductive unilateral hearing loss, i.e. atresia of the ear canal, alters the central auditory pathways over time.

Materials and Methods: A model of prehearing onset unilateral conductive hearing loss was created using rat pups where the external ear canal was surgically removed before 10 days of age (n=8). Normal hearing controls were kept (n=5). Rats were scanned in a 9.4 T MR-scanner at 3- and 6-months age with T2 weighted and BOLD resting state functional MRI data acquisition. Independent component analysis was performed to estimate differences between the groups.

Results: Differences in activity level (p<0.05) of the left cochlear nucleus and left primary auditory cortex was seen at 3 months, but not at 6 months. Differences (p<0.05) was also seen at the primary motor cortex was stable over time and more activation was seen here of the unilateral hearing loss group.

Conclusions: Rats with unilateral hearing loss have more activity over time in cortical motor areas. We speculate this indicates a different movement pattern to compensate for the hearing loss in localizing sound. Differences within the auditory pathways were seen at 3 months but not at 6 months. This may be due to plasticity in overcrossing connectivity in young adult rats.
SOUNDARC: A NON - SURGICAL PEDIATRIC OPTION

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Keywords: Pediatric patients, Dysgenesis, SoundArc

Purpose/Aim: To describe the benefits of the use of SoundArc in pediatric patients with unilateral or bilateral dysgenesis and deafness and who don't want or can't undergo a surgery.

Materials and Methods: Descriptive and comparative retrospective research. Five pediatric patients were evaluated, four boys and one girl with an average age of 10 years (5 a 17 years). All the boys have moderate unilateral or bilateral conductive deafness due to auricular dysgenesis; and the girl has mixed moderate bilateral deafness due to bilateral cholesteatoma. As first treatment, all of the patients were equipped with BAHA 5 device and softband. The five patients did not access to an osteointegrated implant for different reasons, which are described. There is also a comparison between the functional hearing gain obtained with softband and with SoundArc. SSQ-12 questionnaire was applied.

Results: For adjusting SoundArc, the suitable size should be measured and selected for each patient, fitting the best point with the mastoids. The five patients who were equipped with BAHA 5 device and SoundArc are regular users and did not have drawbacks. The functional hearing gain is the same or similar to the obtained with softband. All of them found it easy to put on and take off the SoundArc.

Conclusions: The use of SoundArc is a valid option for those patients who cannot access to the osteointegrated implant, even the pediatric ones. It is highly recommended for children who have surgical counter-indications for medical, psychological or personal reasons. Before the appearance of SoundArc, some patients remained without a solution for their hearing problem.

BENEFITS IN NOISE DISCRIMINATION WITH BAHA 5 IN UNILATERAL DYSGENESIS

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Keywords: Pediatric, BAHA5, Unilateral Dysgenesis.

Purpose/Aim: To describe the benefits in noise on Unilateral Dysgenesis in pediatric patients, using BAHA 5 with soft band. Preliminary results.

Materials and Methods: Descriptive and comparative prospective research in patients with Unilateral Dysgenesis and conductive moderate unilateral hearing loss, and normal hearing in the other ear. Discrimination in noise was tested with the Hearing in Noise Test (HINT). We used one condition of this test. S/R: 0, fixed noise: 60 Db speaks: 60 Db. The performance in noisy environment was compared with and without the use of BAHA 5. SSQ-12 questionnaire was applied.

Results: Nine patients were evaluated, five boys and four girls. Mean age: 9 years (range 7 to 11 years). Seven with right Dysgenesis and two with left Dysgenesis. The overall mean benefit percentage of discrimination in noisy environment with BAHA 5 device was 7, 01 % (range 0, 19 to 16, 64).

Conclusions: Binaural hearing ability is essential for communication in noisy settings and for the other aspects of functional hearing. Children suffer learning in noisy environments at school so we recommend the use of BAHA 5. The percentages obtained varied from patient to patient. Those are preliminary result because this investigation is ongoing. The SSQ-12 questionnaire was applied in all the patients, but we don't have yet the final conclusion. All the patients demonstrated a better discrimination in a noisy environment with the use of BAHA 5 with soft band.

TEN YEAR REVIEW OF BAHI SURGERY WITHOUT SOFT TISSUE REDUCTION
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Keywords: Bahi Surgery, W'osr, Ponto Abutments

Purpose/Aim: We present our 10 year experience of Bone Anchored Hearing Implant (BAHI) Surgery without soft-tissue reduction (WoSR). Being one of the first centres in the world to trial and pursue soft tissue preservation techniques in BAHI surgery and we also have a complete follow up history of every patient to date.

Materials and Methods: All operations were performed by a single surgeon with every patient having a complete follow up history. Patients were aware of the change in technique, along with its pros and cons. After the first three years, soft tissue reduction techniques were no longer offered.

Our WoSR Technique involves, using a 6mm skin biopsy punch with a vertical incision running through the punch site. An Aims retractor provides good exposure. Standard bone work is carried out with predominant use of a 4mm fixture with a 9mm abutment coupling. Wound closure is with 5/0 prolene. A nano-crystalline silver dressing along with a non-adhesive sponge, are kept in place with a healing cap and a mastoid bandage. Prophylactic intravenous antibiotic is administered during surgery. The mastoid dressing is removed at home by the patient or family member 48 hours after surgery. The dressing and sutures are removed by the surgeon in one week and wound care instructions given. The aid is fitted by our Audiology BAHA team at week six. Thereafter, patients are reviewed in the joint BAHA Clinic, usually every six months.

Results: In our cohort of 103 patients(Table 1), 96 continue to use their Bone anchored aids. Thirteen patients had Holger’s Grade 1 inflammation, with three going on to need soft tissue reduction, in view of persistent pain. There have been NO implant extrusions. All patients had long abutments (8.5mm to 12mm), with our preferred and predominantly used one being the PONTO 9mm and 12mm (92/103).

Conclusions: Over a ten year period this technique of BAHI surgery without soft-tissue reduction(W'oSR) has produced predicable and consistently good results. There is a significant reduction in operating time, healing time, absence of
numbness around surgical site, minimal soft tissue inflammation and no issues with long term fixture retention.

BONEBRIDGE – AUDIOLOGICAL AND SURGICAL RESULTS IN WORLD HEARING CENTER
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Keywords: bone conduction, results

Purpose/Aim: To measure self-assessed quality of life in patients implanted with the BONEBRIDGE, a bone conduction device. The secondary objective is to confirm the device’s effectiveness in hearing rehabilitation in a population suffering from mixed or conductive hearing loss.

Materials and Methods: Prospective, observational, longitudinal study with one treatment group. Twenty-one patients with mixed or conductive hearing loss were included and each individual served as its own control. The Abbreviated Profile of Hearing Aid Benefit (APHAB) and the Assessment of Quality of Life (AQoL-8D) questionnaires were used to measure patient-reported quality of life before intervention and at 3 and 6 months after activation of the device. At the same timeframes, pure-tone audiometry and speech understanding in quiet and in noise were tested.

Results: Hearing-specific and generic quality of life increased significantly after intervention and remained stable up to 6 months. The mean functional gain after 6 months of device use was 28.02 dB HL. Both word recognition in quiet and speech reception threshold in noise were significantly better after 6 months compared to before surgery. Outcomes of aided speech understanding were independent of initial bone-conduction thresholds and equally high (word recognition score > 75%) across the device’s indication range that is up to 45 dB HL (BC).

Conclusions: Our results show a significant improvement in quality of life with the BONEBRIDGE up to 6 months after activation. Patient-reported outcomes should be considered when selecting among treatment options with equal audiological benefit. Furthermore, the BONEBRIDGE provides significant audiological benefit for patients suffering from mixed and conductive hearing loss in both speech understanding in quiet and in noise. Together with a very low rate and minor nature of adverse events, it is an excellent solution for hearing rehabilitation in patients with mixed or conductive hearing loss up to a bone conduction threshold of 45 dB HL. Future studies should investigate the long-term effect of this device on the patient’s quality of life.
ADHEAR IN PATIENTS WITH CONDUCTIVE HEARING LOSS – VARIOUS ISSUES
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Keywords: conductive hearing loss, clinical issues, practical issues

Purpose/Aim: The ADHEAR is a novel non-implantable bone conduction hearing system, in which audio processor is connected directly to the skin via a special Adhesive Adapter that is placed behind the ear. It is intended for treatment of patients with conductive hearing loss. The objective of this acute clinical study was to assess the audiological efficacy with this hearing.

Materials and Methods: Material of this study consists of five native Polish adults with uni- or bilateral conductive hearing loss. Unaided and two aided conditions with the ADHEAR and the BC device on softband will be compared using the following tests: (1) Sound field audiometry with warble tones. (2) Speech in quiet by determining the word recognition score in sound field with Polish monosyllables. (3) Speech in noise by determining the SRT50 in sound field using the Polish Matrix Test with speech and noise coming from the front.

Results: Preliminary results of pilot tests showed comparable performance between the ADHEAR and a bone conduction hearing device on a softband.

Conclusions: The new bone conduction hearing device ADHEAR as a non-implantable solution could be a good alternative to the other bone conduction hearing devices and shows comparable audiological benefit in patients with pure conductive hearing loss. It seems that the ADHEAR can be a good solution for patients with small mastoids, especially for babies and children, who are waiting for surgical procedure or are not suitable for it.

EVALUATION OF BAHAA ATTRACT EFFICACY IN TERMS OF HEARING PERFORMANCE
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Keywords: bone conduction, results

Purpose/Aim: The Baha Attract System is bone conduction implant which uses a magnetic connection to attract the sound processor to the implant and sends sound as vibrations through the bone to stimulate the inner ear. It is intended for patients with mixed or conductive hearing loss and also single-sided deafness. The device aims to reduce the perceived barriers for Baha candidates by providing a non-skin penetrating bone anchored hearing device which gives improved cosmetic outcomes and minimal aftercare. The main aim of the investigation is to compare the auditory benefits preoperatively and during two years observation period after Baha Attract System implantation.

Materials and Methods: The group of 27 patients with mixed or conductive hearing loss were evaluated preoperatively, during activation, 6, 12 and 24 months after Baha Attract System implantation using pure tone audiometry, speech audiometry, threshold audiometry in free field and self-report questionnaires.

Results: In two years observation period, using of Baha Attract brought significant improvement in sound perception and understanding of speech in relation to preoperative state. There was also observed self-perceived improvement in Abbreviated Profile of Hearing Aid Benefit (APHAB) and Speech, Spatial and Qualities of Hearing Scale (SSQ) questionnaires.

Conclusions: The Baha Attract System seems to be an effective treatment option for patients with mixed and conductive
hearing loss. The results of examinations and questionnaire study indicate long-term auditory benefits and related positive change in quality of life. It is essential to conduct more researches to confirm effectiveness of Baha Attract in bigger group of patients.

119

EVALUATION OF MIPS WITH PONTO SYSTEM AT WORLD HEARING CENTER

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Purpose/Aim: The main aim of the study was to present the characteristics and to evaluate safety and efficacy of 5 patients who have been implanted with Ponto system. All of patients had mixed hearing loss and all received Ponto Bone Anchored Hearing System.

Materials and Methods: All patients had been implanted with the implant and abutment between July and August 2015 and followed up. The evaluated group consisted of patients eligible for implantation of the Oticon Medical Ponto Bone Anchored Hearing System. They had from moderate to profound mixed hearing loss of different etiologies. To present the results there were pre - and post-operative examinations of audiological evaluation, including pure tone audiometry, free field audiometry, speech audiometry in free field and Matrix test. Descriptive statistics were done for age, follow up time, implant length, abutment length, implant extrusion rate, revision surgery rate and skin reaction rate. Skin reactions were classified as adverse or non-adverse by the surgeon who performed the surgery. The follow up period after surgery, and the type of surgery in terms of technique (e.g. linear incision) were also documented for each patient.

Results: Postoperative BC thresholds in the implanted ear were stable for most of the observed frequencies. It was observed that patients have better results in speech understanding after Ponto System surgery comparing to preoperative results and results with and without speech processor. All patients underwent single stage implantation, with linear incision technique or Torbay technique (all with soft tissue thinning). All patients received the 4 mm implant and 6 mm abutment. The follow up period was about 6 months. Data from the very first survey of the Ponto implantation have clearly shown its success in terms of the implant extrusion, revision surgery and skin complication rates.

Conclusions: Adults with mixed hearing loss obtained benefits from implantation of the Oticon Medical Ponto Bone Anchored Hearing System.

120

AUDIOLOGICAL AND QUALITY OF LIFE BENEFITS AFTER BONEBRIDGE IMPLANTATION

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Purpose/Aim: The Bonebridge is active bone conduction implant system dedicated for patients suffer from chronic otitis media or congenital malformations, resulting with conductive or the mixed hearing loss. Moreover, it can be used by the patients with the single-sided deafness. Bonebridge consist of sound processor and coil that generate vibrations to the bone, transmitted via screws to mastoid. The aim of the study was to evaluate the audiological results of patients after implantation Bonebridge system.

Materials and Methods: 18 cases of the patients with the mixed and the conductive hearing loss were analysed. Bonebridge implantation surgery were performed in all cases in the World Hearing Centre, Kajetany. The prospective study were performed based on 58 patients, audiological tests included: pure tone audiometry, sound filed audiometry, sound field speech audiometry and the ABHAB questionnaire.
Results: Results obtained before and after implantation were compared. In all cases hearing thresholds were stable. The post-implantation audiological results present considerable benefits of using the Bonebridge system. Moreover, ABHAB questionnaire results shows the increase in hearing ability, the speech recognition and the spatial hearing.

Conclusions: Summing up, Bonebridge implant system provides the substantial audiological benefits. Furthermore, this study confirms the effectiveness and the safety of the system, with good aesthetic effect, crucial for patients.

121

IS TREATMENT OF UNILATERAL CONGENITAL CONDUCTIVE HEARING LOSS EFFECTIVE?

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Purpose/Aim: Advantages of having two inputs (ears) are the ability to better understand speech in a noisy environment and to localize sounds. However, in case of congenital conductive unilateral hearing loss, it remains to be seen whether or not surgical repair or the fitting of any hearing device of the impaired ear leads to binaural hearing. A systematic review was carried out aiming at binaural hearing abilities after treatment of unilateral congenital conductive hearing loss and our own data were included.

Materials and Methods: Of 61 identified studies (search period 1992-2018), 11 met the inclusion criteria (presenting outcomes on binaural hearing in at least 5 patients). Published data on binaural summation, sound localisation and dealing with head shadow were reviewed.

Results: Across studies, summarized, atresia repair and applications of either a bone-conductor (BCD) or an active middle ear implant resulted in bilateral hearing rather than binaural hearing. The non-optimal results were ascribed to remaining asymmetry in hearing after treatment and, regarding the BCDs, to the effect of the inevitable cross stimulation of the normal hearing ear. Regarding that cross stimulation, an explanation is proposed that might explain the outcomes, based on a difference of sensitivity of both cochleae. In contrast to BCDs, when using an active middle ear implant, the cochleae remain 'acoustically' well isolated; cross stimulation doesn't play a role. Nevertheless, the review showed that results were not better than those obtained with BCDs, suggesting that the remaining asymmetry in hearing after treatment is the dominant limiting factor.

Conclusions: On the average, treatment of unilateral congenital conductive hearing loss with reconstructive surgery or application of hearing devices doesn't lead to binaural hearing but rather bilateral hearing, irrespective of treatment. This conclusion might explain the relatively high rate of non-use of the hearing devices.

122

OUTCOME MEASURE DRIVEN AUDIOLOGICAL CONSIDERATIONS FOR BCI/MEI HEARING IMPLANTS

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Purpose/Aim: There are an increasing number of implantable hearing devices suitable for individuals with unilateral or bilateral conductive, mixed and sensory hearing losses who cannot gain appropriate benefit from conventional hearing aids. These devices have various benefits and limitations when compared against one another. These differences include power output characteristics at various frequencies and differences in digital signal processing. At St Thomas' Hearing Implant Centre we have a wide range of experience of rehabilitation using these devices.

Materials and Methods: We have retrospectively analysed audiometric, speech in quiet and noise and a patient related outcome measure (PROM) for all Attract (n=12), percutaneous BCI (n=120), Bone-Bridge (n=20), Vibrant Soundbridge (n=44) and Carina/MET (n=7) devices implanted in our adult population over the last 5 years. This analysis was also separated into conductive, mixed or sensory losses and single sided sensory deafness.
Results: This retrospective analysis highlighted notable differences between the various devices across several outcomes measures. For bone conduction devices percutaneous BCIs provided superior aided gain levels to both Attract and Bone-Bridge devices. This difference was most notable for the Attract device which averaged 0-10 dB HL poorer in aided testing than a softband device versus 0-10 dB HL better for percutaneous devices. Bone-Bridge devices displayed similar improvement over a softband in high frequencies to percutaneous devices whilst being 0-10 dB HL poorer than a softband in low frequencies. These differences in aided levels between softband trials and devices translated into differences in speech intelligibility in noise. Percutaneous devices yielded an average improvement of 3.5 dB S:N (4.3 dB conductive, 2.4 dB SSD). Bone-Bridge devices also showed an improvement (1.9 dB) whilst Attract devices showed no significant improvement (~0.2 dB). However, these audiological differences did not significantly affect the outcomes of our PROM (APHAB) which showed comparable subjective benefit from each device.

Conclusions: Bone conducting and middle ear implants consist of a substantial and growing number of different devices with different audiological characteristics. By analysing our large repository of retrospective outcome data for these implants we make suggestions to assist clinicians when considering which device may be the most audiologically appropriate in situations where several are medically feasible.

BONEBRIDGE IN SINGLE SIDED DEAFNESS (SSD)
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Keywords: Ssd, Bonebridge, Outcomes:

Purpose/Aim: To evaluate the impact of the BONEBRIDGE device on the management of patient with SSD referred for auditory rehabilitation

Materials and Methods: The management of SSD provides unique challenges in implant otology. The hearing disability experienced by most patients is more subtle and often situational, therefore rehabilitation solutions offered to the patient need to matched to patients expectations.

The results from our cohort of 150 bone conductor patient cohort with follow-up periods from 12-1 year will be presented.

Results: The option of the BONEBRIDGE has increased uptake of surgical intervention in patients referred to our centre, and a previously observed ‘gender gap’ has been narrowed. The importance of a systematic patient selection procedure including preoperative imaging will be outlined. We will present our surgical data including complications; Outcome measures including QoL assessment, and audiological evaluation of speech in noise and localisation results discussed.

Conclusions: The inclusion of BONEBRIDGE in the range of options offered to our patients has had a significant impact on our program, with an increased uptake of a surgical option. The importance of careful patient selection is confirmed.
FUNCTIONAL OUTCOMES IN BONEBRIDGE RECIPIENTS: SINGLE CENTER EXPERIENCES FROM SLOVAKIA

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Purpose/Aim: Hearing loss (HL) due to aural atresia, chronic otitis media or single-sided deafness (SSD) offers several options for rehabilitation. The aim of our study was to evaluate the outcomes and experiences with bone conduction implant (MED-EL Bonebridge) at our hearing implant center in Bratislava, Slovakia.

Materials and Methods: To date, 24 patients (mean age 42.8 +/- 19.1 years) received Bonebridge (BB) at our department. These included 12 mixed HL, 9 conductive HL, and 3 SSD cases. The underlying diagnoses were aural atresia (7), middle ear malformation (1), schwannoma of the facial nerve (1), chronic otitis media (12), congenital SSD (1), postinfectious SSD since childhood (1), SSD post chronic otitis media (1). Audiological data from the first 17 subjects are presented (3 SSD and 14 conductive/mixed HL cases). Free field thresholds, Slovak speech audiometry and monosyllabic word test (both under 60/50 dB SN ratio conditions) were evaluated in aided and unaided conditions. In SSD cases, these tests were performed with plugged contralateral ear canal.

Results: Mean bone conduction (BC) and air conduction (AC) pure tone thresholds in the operated ear did not change after BB surgery (BC: 18.4 dB vs. 18.4 dB; AC: 64.5 dB vs. 64.9 dB). In the conductive/mixed HL group, the mean free field thresholds (0.5-4 kHz) were 57.1 dB without BB and 33.4 dB with BB (23.7 dB improvement). The SSD group achieved 65.8 dB thresholds without BB and 36.7 dB with BB (29.2 dB improvement). In free field speech audiometry the mean word discrimination score in conductive/mixed HL group without and with BB was 37.1% and 71.4 % respectively. The SSD group scored 36.7% and 83.3% in unaided vs. aided conditions. In monosyllabic word test the conductive/mixed HL group achieved 45% score without BB and 77.2% with BB. In SSD group the scores in monosyllabic words were 25% and 82% (unaided/aided). One subject was non-user.

Conclusions: BB implantation is currently a preferred method for hearing rehabilitation in aural atresia cases with normal BC thresholds and it also represents an efficient alternative for selected patients with HL due to chronic otitis media or SSD.

POWER STAPES WITH THE CARINA® SYSTEM: CLINICAL AND SURGICAL EXPERIENCE

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Keywords: Carina middle ear implant, speech in noise, power stapes

Purpose/Aim: The Carina fully-implantable active middle ear implant system can be used for subjects with mixed or sensorineural hearing loss when no hearing aid or bone conduction implant is indicated. The aim of this single center study is to evaluate the clinical outcomes and surgical experience in patients implanted with the Carina system. Also one case of a power stapes, i.e. an active middle ear implant coupled to the incus that in turn is coupled to the inner ear via a stapes prosthesis, will be presented.

Materials and Methods: Three patients were implanted with the Carina system after written informed consent. The surgical techniques used for adequate coupling will be discussed at the meeting. Preoperative and postoperative aided thresholds as well as speech perception scores in quiet and in noise have been gathered prospectively.

Results: The postoperative hearing performance in quiet and in noise is favorable for all 3 subjects and improved compared to the patient’s pre-operative hearing condition. No surgical complications have been reported.
Conclusions: Preliminary data shows good clinical results and the patients are satisfied with the Carina system. The implantation can be regarded as a safe procedure also in case of a combination with a previously performed stapes surgery.

126

AURICULAR PROSTHESES ATTACHED TO OSSEOEINTEGRATED IMPLANTS: WORK-UP & CLINICAL EVALUATION

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Purpose/Aim: Not long after the introduction of osseointegrated implants outside the oral cavity, auricular prostheses are retrained on osseointegrated implants. New insights have been gained with the next generation percutaneous osseointegrated titanium implants for bone conduction hearing (BIA300®) since its introduction in 2010. As a result, the same technology was introduced in the Vistafix® system (VXI implant) to retain auricular prostheses. The aim of this study is to evaluate the surgical procedure, clinical outcome and satisfaction of the patient of osseointegration-retained auricular prosthesis using VXI implants.

Materials and Methods: All patients who received an auricular prosthesis using VXI implants between December 2012 and November 2017 were identified and retrospectively analysed. The patient’s medical files were reviewed to assess clinical complications and the necessity for revision surgery. The subjective outcome was measured using the Glasgow Benefit Inventory (GBI).

Results: No implant loss is observed or revision surgery needed in the analysed patients. An adverse skin reaction was observed in 13.0% of the implants and in 27.2% of the patients, adequately treated with an antibiotic ointment. The average follow-up time was 2 years and 7 months. The GBI displayed a positive score in every patient.

Conclusions: The VXI implants used are a safe and reliable treatment option for retaining auricular prostheses in patients with an absent auricle. Patients were satisfied with their auricular prosthesis and showed benefit in quality of life.

127

COCHLEAR RESERVE WITH THE CARINA® ACTIVE MIDDLE EAR IMPLANT

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Keywords: indication, dynamic range, MPO

Purpose/Aim: Sensorineural hearing loss causes a reduced dynamic range, which may impact the ability of the brain to analyze speech, in particular in noisy environments. In order to enable best speech intelligibility, a hearing amplifier must be able to provide output over a large enough part of the residual dynamic range, (van Barnefeld et al 2018) recommends that a device have a maximum output (MPO) at least 30-35dB above the hearing threshold. If the MPO of a particular device can be calculated from clinical measurements or preclinical studies, then it can be compared to the desired dynamic range coverage for a given indication range.

Materials and Methods: The MPO of the Cochlear™ Carina® System was calculated from the technical specification of the electrical drive level into the actuator, and from published data (Grossoehmichen et al 2017) on the MicroDrive™ actuator of the Carina system, stating actuator efficiency in equivalent SPL output for a given electrical drive level.

Results: The stated indication range for the system extends to 60dB HL at 250 and 500Hz, and 70dB HL at 1000Hz and above, which translates to a desired MPO of 95dB equiv. HL at 250-500Hz, and 105dB equiv. HL above, in order to achieve a 35dB dynamic range.
For the most popular coupling to the incus and typical (median) coupling efficiency, the predicted achievable MPO of the
Conclusions: The draft Consensus Statement for Treatment of Patients with Conductive and Mixed Hearing Loss with Implantable Devices (Maier et al, CI 2018) recommends that device performance be derived from clinical or preclinical studies, and compared to a published rationale for audiological needs. In the present study, this recommendation was followed using the Carina system as an example. The Carina system with incus coupling completely satisfies the stated rationale for MPO, for the coupling efficiency typically seen clinically, and even for subpar coupling efficiency, it satisfies the audiological need at all but one frequency.

128

MEASURING AIDED THRESHOLDS WITH ACTIVE MIDDLE EAR IMPLANTS
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Keywords: expansion, masking, functional gain

Purpose/Aim: In conventional hearing aids, gain can be measured objectively, in a 2cc coupler or in real ears. In active middle ear implants (AMEI), the output signal is not accessible to objective measurements, so effective gain is usually determined psychoacoustically, by measuring aided sound field threshold and subtracting unaided threshold (sound field for SNHL, bone conduction for mixed HL). However, the measured “aided threshold” may be influenced by factors other than the patient’s hearing loss and AMEI amplification. These extraneous factors were investigated by modeling and by analysis of clinical data, and their impact on estimation of AMEI effective gain determined.

Materials and Methods: Calculated minimum aided thresholds due to expansion were based on the known expansion kneepoint of the Cochlear™ Codacs™ System. Actual aided threshold were measured in free field. Calculated minimum aided thresholds due to input noise masking were based on the estimated microphone noise of the Cochlear™ Carina® System.

Results: One confounding factor is the expansion programmed into the gain-vs-input behavior of the processor, i.e. a prominent reduction of gain for input signal levels below the expansion kneepoint. This may or may not be accessible via the AMEI fitting software. The predicted impact on measured aided thresholds of the expansion kneepoint programmed into the Cochlear™ Codacs™ System direct acoustic cochlear implant matches data from a clinical study.

Another confounding factor, for devices with a subcutaneous microphone such as the Cochlear Carina® System, is the intrinsic noise of the microphone, which is typically higher than for a hearing aid microphone in air. Here, measured “aided thresholds” may actually be masked thresholds, determined by the masking level of the microphone noise, rather than thresholds in quiet. The predicted impact on measured aided thresholds matched clinical observations.

Conclusions: These factors are irrelevant if the aided thresholds are only used to estimate outcomes for an individual patient, because they do reflect actual audibility. However, if aided thresholds are used to estimate AMEI device performance (gain), to make decisions regarding future patients, then these effects need to be taken into account.

129

A NOVEL BONE CONDUCTION IMPLANT: MINIMIZATION OF PRE-OPERATIVE PLANNING
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Keywords: 3D Reconstruction, Active Bone Conduction Implant, Pre-Operative Planning

Purpose/Aim: The purpose of this study was to increase the knowledge about skull bone thickness in the implantation
area of bone conduction implants to make recommendations concerning the pre-operative planning strategy in adults and children for a novel bone conduction implant, Sentio Ti (Oticon Medical AB).

**Materials and Methods:** Computed tomography (CT) scans of 132 mastoids from 85 adults and 65 mastoids from 36 children and adolescents from the age of 7 months to 17 years were retrospectively analyzed. After three dimensional reconstruction of the ROI, the transducer was virtually implanted on the Frankfurt Horizontal in the ROI and bone thickness was measured at 5 points of the transducer and at 6 possible places for fixating screws.

**Results:** In adults and children from the age of 5 years the bone thickness was sufficient to place the implant in the ROI in 100% of the cases. In children younger than 5 years, the bone was too thin to place the implant adequately in 70% of the mastoids.

**Conclusions:** The geometry of this novel bone conduction implant opens up the opportunity to do surgery without pre-operative CT planning in mastoids without malformation from a certain age when the implant is placed as intended. Radiological planning is recommended for young children due to limited bone thickness.

130

**SPEECH PERCEPTION FOR DIFFERENT NOISE TYPES WITH OSIA**

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**Purpose/Aim:** In subjects with bilateral conductive hearing loss (CHL) or mixed hearing loss (MHL), speech perception, particularly in noisy listening situations, is severely restricted. Bone-conduction implants have been proven to enable successful treatment of these types of hearing loss. This study aims at investigating the effect of the type of competing background noise on speech recognition obtained with the new active bone-conduction system Osia in adult patients with bilateral CHL or MHL. The Osia system comprises of an osseointegrated implant with a piezoelectric transducer controlled by an external sound processor, and allows for direct bone-conduction stimulation.

**Materials and Methods:** Two adult bilaterally implanted Osia patients with bilateral MHL have been recruited so far. A modified version of the Oldenburg sentence test (OlSa) was administered to measure speech reception thresholds in noise (SRT) with bilateral Osia for two different competing noises: the noise of the OIa (oIa), i.e. a speech-simulating noise, and the International Collegium of Rehabilitative Audiology (ICRA) noise 5 (ICRA-5, Dreschler et al. 2001), i.e. a speech-modulated noise mimicking a single interfering male speaker. Each noise was simultaneously presented from three loudspeakers (90°, 180°, 270°) at 65 dB SPL uncorrelated. Speech was presented at an adaptive level from a frontal speaker. As a reference, two normal-hearing subjects were recruited as well.

**Results:** Preliminary results reveal an effect of noise type on binaural speech reception threshold of up to 1.4 dB in the Osia recipients. Normal-hearing subjects showed a larger effect of noise type on SRT of about 3-4 dB. Both groups showed a lower, i.e. better SRT for speech-modulated noise compared to speech-simulating noise.

**Conclusions:** Binaural speech reception thresholds seem to be affected by the type of competing background noise. Both, normal-hearing subjects as well as bilateral Osia recipients can make use of temporal gaps in noise for speech perception.

131

**EARLIER INTERVETION FOR MEDICALLY FRAGILE PEDIATRIC INPATIENT POPULATION WITH BCD**

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**Keywords:** pediatrics, early intervention, medically fragile

**Purpose/Aim:** The importance of early intervention for children with hearing loss is well documented. However, it is often
overlook or delayed for infants with long-term NICU stays or who are medically fragile. This typically occurs while the patient’s acute medical needs are the priority for their care team. When audiolologic intervention is considered, traditional hearing aids often fall short due to the challenges of the inpatient hospital environment and the specialized needs of this population. This presents a need to consider non-traditional options for these patients with extended hospital stays in an effort to support their developmental and sensory milestones. The Inpatient team within the Division of Audiology at Cincinnati Children’s Hospital Medical Center (CCHMC) consists of audiologists specialized in the assessment and management of this unique population. Through collaboration with a well-established Bone Conduction Device (BCD) team at CCHMC, a treatment plan to support earlier intervention for this population has begun to emerge.

Materials and Methods: The current practice at CCHMC for the audiolologic intervention in the long-term NICU and medically fragile inpatient population will be presented. The delicate balance of managing audiolologic needs with the patient's individual complex medical needs will be discussed. Unique challenges and special considerations for the use of BCDs will also be explored, including the need for a transition process to bridge the gap between inpatient management and the outpatient clinic for long-term follow-up.

Results: Supportive cases will be presented to illustrate treatment plans and initial outcomes for this population. Parent and caregiver feedback will also be shared.

Conclusions: This presentation aims to generate discussion around the application of BCDs with the long-term NICU and medically fragile inpatient population. Providing early intervention for these patients where treatment would typically be overlooked or delayed has the potential to improve their quality of life and long-term outcomes.

132

BONE ANCHORED HEARING AID IMPLANT REGISTRATION

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Keywords: Implant Registration Warranty

Purpose/Aim: In order for the warranty of a Bone Anchored Hearing Aid Implant to start, it must be registered onto the Cochlear online portal during the surgical phase.

Materials and Methods: Access is required for each professional who enters the implant details onto the online portal, this can be obtained from Cochlear support. If a center is split over several sites, then there must be two separate sites that register for a login to the portal. We provide Cochlear with just enough information for us to recognise our patient without allowing them to identify or contact an individual. We use the first two letters of the first name, provide the full surname and their DOB is entered as 01/01/ then their year of birth. The portal then asks for details of device type such as Lot number, surgery date and to whether it is right, left or bilateral. You then provide details of the surgeon.

Results: A database is built of Cochlear Bone Anchored Hearing Aid implants and can be traced to an end user. If a patient requires a change of implant at a later date there is the option to edit and update the end users new implant details.

Conclusions: A database is required for traceability of implants, and for recall purposes from the company.

133 - Cancelled

134

AUDIOLOGICAL OUTCOMES OF IMPLANTED SOPHONO IN CONGENITAL MICROTIA

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Keywords: Bone conduction hearing aid, Congenital microtia, Sound field hearing thresholds

Purpose/Aim: The aim of the study was to evaluate the hearing benefits of an implanted bone conduction hearing aid in congenital microtia.

Materials and Methods: Fourteen patients who suffered from bilateral congenital microtia from Eye & ENT Hospital of Fudan University were implanted with Sophono bone conduction hearing aid during their ear reconstruction operations. Audiological tests were performed under unaided (before implantation) and aided conditions (0 day, 3 months and 6 months after implantation), including free field tests of the hearing thresholds and speech recognition thresholds (SRT) in quiet. Adverse events were also documented by a self-reported questionnaire.

Results: The average PTA (pure tone average in free field) under unaided condition was 57.6±4.6 dB HL. It improves to 21.8±3.5, 20.7±4.5, 19.5±2.9 dB HL, respectively, 14 days, 3 months and 6 months after the implantation. Statistically significant improvements of about 37 dB HL in free field thresholds were found between the unaided and aided conditions. In aided conditions, SRT in quiet were significantly improved compared to unaided conditions. No adverse events related to the devices were reported.

Conclusions: The Sophono implanted bone conduction hearing aid is an alternative choice to improve bilateral congenital microtia patients with satisfactory audiological outcomes in hearing thresholds and speech recognition.

HEARING PERFORMANCE OF BAH AATTRACT IN PATIENTS WITH BILATERAL MICROTIA

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Keywords: Bone conduction, magnetic system, microtia

Purpose/Aim: Emerging bone conduction hearing implant systems and refined sound processors have brought new avenues in treatment for patients with congenital microtia. Baha Connect System has long been a golden-standard bone conduction hearing device; however, a high skin reaction rate limits its use. The newest Baha attract System is designed to fill the deficiency, yet few studies have been reported its hearing outcomes for this subgroup of conductive or mixed hearing loss patients, especially in Mandarin speakers. The aim of the study was to evaluate the hearing performance and adverse events of Baha 5 Attract system after implantation for congenital microtia patients.

Design: Prospective single-center cohort study.

Materials and Methods: Setting: One Chinese tertiary referral center.
Participants: Twenty congenital microtia, Mandarin-speaking patients
Main outcome measures: Acoustic parameters including hearing threshold, speech recognition in quiet and in noise were compared between aided and unaided conditions to verify the efficacy of the system. The subject outcome was also evaluated using the Speech Spatial Qualities questionnaire (SSQ). Adverse events especially the soft tissue reactions were evaluated and documented.

Results: After 6 months, the mean AC hearing threshold average was significantly reduced to 25.31±3.76 dB, leading to a hearing gain of 34.13±4.97 dB. Speech recognition in quiet and in noise were both significantly improved comparing pre-implantation and post-implantation. SSQ scores in three dimensions were better in aided condition. Four patients reported a slight adverse event.

Conclusions: Baha Attract system has satisfactory hearing performance in bilateral conductive or mixed hearing loss patients, and have good soft tissue tolerance.
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