program

SEPTEMBER 19-22, 2012
MÖVENPICK CONFERENCE CENTER
AMSTERDAM

7TH
INTERNATIONAL
SYMPOSIUM

on objective measures in auditory implants

welcome to OM2012

your point of view

Dear colleagues,

It is a great pleasure to welcome you to the 7th International Symposium on Objective Measures in Auditory Implants, to be held in Amsterdam from September the 19th to September the 22nd. We are delighted and honored that colleagues and delegates from all over the world will contribute to this symposium.

It has been our ambition to organize a symposium with a high quality scientific program, appealing to all otologists, audiologists and other professionals engaged in cochlear implantation and the application of other implantable hearing aids. Our focus has been most recent developments in objective measurements, imaging techniques and developments in molecular biology, we all witness in this field.

We express our gratitude for the members of the scientific committee and the local faculty for their assessment of the submitted abstracts. In our endeavour to ensure sufficient time for each presentation and discussion, we hope to have composed a program with an optimal balance in high quality oral presentations as well as posters.

The support we received from you as participants and from the sponsors was indispensible. We like to thank all those who have committed themselves to make this symposium a success. We live in an exciting era, in which developments in medical technology have become/are the pivot in diagnostics in hearing loss, and the support and recreation of the function of our auditory organ. We hope this symposium will fulfill your expectations and inspire you for new research.

On behalf of the Departments of Otorhinolaryngology of the Radboud University Nijmegen Medical Centre and the Leiden University Medical Center.

Dr. Emmanuel A.M. Mylanus, MD PhD
University Medical Centre St Radboud
Nijmegen, The Netherlands

Prof. Johan H.M. Frijns, MD PhD
Leiden University Medical Centre
Leiden, The Netherlands

Dr. Andy J. Beynon, PhD
University Medical Centre St Radboud
Nijmegen, The Netherlands

Dr. Jeroen J. Briaire, PhD
Leiden University Medical Centre
Leiden, The Netherlands

previous organizers

1999 Nottingham
Steve Mason & Gerard O'Donoghue

2001 Lyon
Lionel Collet & Eric Truy

2003 Ann Arbor
Paul Kileny & Teresa Zwolan

2005 Hannover
Thomas Lenarz & Rolf-Dieter Battmer

2007 Varese
Sandro Burdo & Sergio Razza

2010 St Louis
Jill Firszt & Richard Chole

Organising committee

UMC St Radboud, Nijmegen, The Netherlands
Emmanuel Mylanus
Andy Beynon

Leiden UMC, The Netherlands
Johan Frijns
Jeroen Briaire

Scientific faculty

Pim van Dijk, UMC Groningen, The Netherlands
John van Opstal, RU Nijmegen, The Netherlands
Olivier Macherey, MRC CBU Cambridge, UK
Berit Verbist, Leiden UMC, The Netherlands
Jan Wouters, KU Leuven, Belgium
Bert van Zanten, UMC Utrecht, The Netherlands
Andrzej Zarowski, St Augustinus, Belgium

Regional faculty

UMC St Radboud, Nijmegen, The Netherlands
Lucas Mens
Jef Mulder
Ad Snik

Leiden UMC, The Netherlands
Peter Paul Boermans
Liselotte Rotteveel
Wim Soede

International Advisory Board

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Paul Kileny (Michigan, US)
Thomas Lenarz (Hannover, Germany)
Steve Mason (Nottingham, UK)
Angel Ramos (Las Palmas de Gran Canaria, Spain)

to the point

PROGRAM

wednesday september 19th 2012

OPENING REGISTRATION DESK: 9.30

LOCATION: ZURICH I + II

10.30 - 11.45 satellite symposium Cochlear

Chair Norbert Dillier

- Welcome and Introduction
  Richard Brook (Switzerland)
- Where to go with NRT
  Norbert Dillier (Switzerland)
- State of the Art: NRT in clinical practice today
  Joachim Müller-Deile (Germany)
- New approach to intra- and postoperative clinical care
  George Tavartkiladze (Russia)
- From NRT to ICT?
  Andy Beynon (The Netherlands)
- Close
  Richard Brook (Switzerland)

12.00 - 13.30 satellite symposium Neurelec

Chair Andy Beynon

- Welcome and Introduction
  C. Briand (Neurelec, France)
- Neurelec product lines updates
  D. Piana (Neurelec, France)
- Theoretical and measured audiological performance outcomes for bilateral / binaural cochlear implants
  B. Backus (Neurelec, United Kingdom)
- Speech performance and sound localization abilities in Neurelec Digisonic® SP Binaural cochlear implant users
  Dr. N. Verhaert (Leuven, Belgium)
- Surgical and audiological outcomes in Digisonic® SP Binaural users
  Dr. T. Zehlicke (Hamburg, Germany)
- Impact of pulse width on intracochlear electrically evoked auditory brainstem response at different sites
  Dr. N.X. Bonne (Lille, France)
- Introducing the "Smart Start" fast and efficient fitting method for Neurelec cochlear implants
  Dr. G. De Ceulaer (Antwerp, Belgium)

13.30 - 14.00 Lunch – *we thank Advanced Bionics and Cochlear for the support of the lunch*

14.00 - 15.30 satellite symposium Advanced Bionics

Chair Johan Frijns

- Welcome
  Johan Frijns
- AB welcome and update
  Hansjuerg Emch
- Population-based prediction of fitting levels for individual cochlear implant recipients
  Feddo van der Beek, Jeroen Briaire & Johan Frijns
- Insights into the long term effects of electrical stimulation
  Dietmar Basta, Ingo Todt & Arne Ernst
- Latest developments in RSPOM
  Philip Dykmans & Alexandre Gault
- Measurement of the spread of excitation and insights into performance
  Lutz Gärtner, Andreas Büchner & Thomas Lenarz
- The usefulness of various objective metrics to assist in fitting
  Thierry van den Abbeele
- Summary
  Volkmar Hamacher

15.45 - 17.15 satellite symposium Med-El: 'Spreading the excitation'

Chair Peter Nopp

- Welcome
  Ingeborg Hochmair
- Introducing the OPUS 2XS
  Gregor Dittrich
- Introducing the Bonebridge
  Severin Fuerhapter
- Experiences with the Bonebridge
  Oliviere Deguine
- HP and Electrodes
  Roland Hessler
- Introducing the MAESTRO 4.1
  Stephanie Dudek, Philippe Spitzer
- Electrically evoked compound action potentials in patients using MED-EL CIs
  Mattheus Vischer
- The Coding of Fine Structure with FineHearing Technology
  Peter Nopp
- Closing words
  Peter Nopp

18.00 - 19.30 Welcome reception at the terrace of 'Muziekgebouw aan 't IJ'

thursday september 20th 2012

LOCATION: MAINDECK PTA (PASSENGER TERMINAL AMSTERDAM) AND ZURICH I + II

08.00 Opening of the symposium Maindeck PTA

08.20 - 08.50 keynote speaker: *Jay Rubinstein*
Past, present and future of objective measures

08.50 - 10.00 plenary session 1
eCAP and cochlear potentials I

location Maindeck PTA
moderators Jill Firszt and Johan Frijns

- Recordings to Acoustic stimuli from the round window in cochlear implant patients – *Douglas Fitzpatrick, Chapel Hill* (Thu001)
- The effect of transition in pulse shape and polarity on psychoelectric and ECAP responses – *Andreas Bahmer, Frankfurt* (Thu002)
- A convolutive ECAP Model to assess the firing properties of the auditory nerve – *Stefan Strahl, Innsbruck* (Thu003)
- Expanded objective measures in Auditory Neuropathy Spectrum Disorder – *Christina Runge, Milwauki* (Thu004)
- Auditory neuropathy spectrum disorder is a misnomer – *William Gibson, Birchgrove* (Thu005)

10.00 - 10.30 Coffee break & poster session group 1

10.30 - 12.00 parallel session 1a
eCAP and cochlear potentials II

location Maindeck PTA
moderators Paul Abbas and Jeroen Briaire

- Time dependent behaviour of the TECAP threshold post reimplantation – *Joachim Müller-Deile, Kiel* (Thu006)
- Functional and histological characterization of the degenerating auditory nerve in deaf guinea pigs – *Dyan Ramekers, Utrecht* (Thu007)
- Electrically Evoked Compound Action Potentials in patients supplied with a cochlear implant – *Mattheus Vischer, Bern* (Thu008)
- Objective measures for vestibular dysfunctions after cochlear implantation – *Dietmar Basta, Berlin* (Thu009)
- Spread-of-excitation measurements using masker and probe electrodes which are both current steered – *Lutz Gärtner, Hannover* (Thu010)
- The diagonal elements of the cochlear implant impedance matrix – *Randy Kalkman, Leiden* (Thu011)

10.30 - 12.00 parallel session 1b
Plasticity

location Zurich I + II

moderators Andrej Kral and Jos Eggermont

- Simultaneous bilateral cochlear implantation protects auditory pathways in children who are deaf – *Karen Gordon, Toronto* (Thu012)
- Does assessment of brain visual speech circuits in profound acquired deafness support the hypothesis of latent multimodal connectivity? – *Eric Truy, Lyon* (Thu013)
- Bilateral reorganization of posterior temporal cortices in post-lingual deaf subjects – *Diane Lazard, Paris* (Thu014)
- Improved detection of ASSRs with electrical stimuli in cochlear implant users – *Michael Hofmann, Leuven* (Thu015)
- The Listening Brain – *Miriam Geal-Dor, Jerusalem* (Thu016)

12.00 - 13.30 Lunch & poster session group 1

13.30 - 14.00 keynote speaker: *Andrej Kral*
Cell biology and cochlear implants: a happy marriage?

14.00 - 15.30 plenary session 2
Objective evaluations

location Maindeck PTA

moderators Carolyn Brown and Andy Beynon

- Comparison of peripheral and central physiological responses in cochlear implant users – *Paul Abbas, Iowa City* (Thu018)
- Cortical evoked potentials: comparisons between NH listeners, HA and CI users – *Carolyn Brown, Iowa* (Thu019)
- Intracorporeal Cortical Telemetry (ICT): capturing EEG with a CI – *Andy Beynon, Nijmegen* (Thu020)
- Electrophysiological and behavioral manifestations of binaural processing in bilateral CI users – *Yael Henkin, Tel Aviv* (Thu021)
- Obligatory auditory evoked potentials in implanted children with ANSD – *Ayca Ciprut, Istanbul* (Thu022)
- Cortical Activity in Bilateral Cochlear Implant Users – *Katarzyna Ciesla , Warsaw* (Thu023)

15.30 - 16.30 Tea break & poster session group 1

16.30 - 17.30

parallel session 2a
Binaural/Bilateral

location Maindeck PTA

moderators Ulrich Hoppe and Cas Smits

- PET study of word recognition in binaurally implanted post-lingually deaf patients – *Pascal Barone, Toulouse* (Thu024)
- Objectifying measures with young children who are fitted with bilateral cochlear implants – *Ruth Litovsky, Madison* (Thu025)
- Binaural benefit and cortical effort in bilateral CI and bilateral bimodal CI simulations – *Kristi Buckley, Buffalo* (Thu026)
- Preserving binaural cues for bilateral cochlear implants – *Zachary Smith, Centennial* (Thu027)
- Use of NRT to balance bilateral sequential implants – *Fiona Vickers, London* (Thu028)

16.30 - 17.30

parallel session 2b
Miscellaneous

location Zurich I + II

moderators Bert Maat and John van Opstal

- Impedance changes in paediatric cochlear implant re-implantations – *Catherine Birman, Gladesville* (Thu029)
- CI suitability in ANSD: imaging and objective testing in cochlear implant candidacy – *Jane Brew, Sidney* (Thu030)
- Cochlear implantation in children: do the right choice – *Michel Mazzuca, Lyon* (Thu031)
- Cochlear implant mapping through Electrical Cochlear Response (ECR) – *Juan Manuel Cornejo Cruz, Mexico* (Thu032)
- Neural adaptation effects for high rates – *Matthias Hey, Kiel* (Thu033)

17.45 - 18.45

parallel session 3a
Imaging

location Maindeck PTA

moderators Joachim Müller and Berit Verbist

- Preoperative imaging for patient-tailored surgical planning – *Berit Verbist, Leiden and Nijmegen* (Thu034)
- Intraoperative CT scanning and image guided navigation to support cochlear implant surgery – *Klaus Stelter, Munich* (Thu035)
- "Imaging" electrode placement by analysis of the intracochlear electrical potentials – *Filiep Vanpoucke, Mechelen* (Thu036)
- Cone-beam versus multi-slice CT for postoperative imaging after cochlear implantation – *Erik Theunisse, Nijmegen* (Thu037)
- Electrode migration in patients with a cochlear implant – *Kim van der Marel, Leiden* (Thu038)

17.45 - 18.45

parallel session 3b
Fundamental

location Zurich I + II

moderators Olivier Macherey and Sjaak Klis

- Polarity sensitivity of the electrically stimulated human auditory nerve measured at central levels – *Jaime Underraga, Leuven* (Thu039)
- Centrally mediated masking release in electric hearing – *Stefan Zirn, Munich* (Thu040)
- Polyphonic pitch perception in CI. How to minimize the error with direct electrical stimulation – *R. Penningen, Gent* (Thu041)
- 8th nerve correlates of intensity dl and MDT functions of stimulus pulse-rate and amplitude – *Mark White, Cary* (Thu042)
- A dual-task paradigm as an objective measure of listening effort with cochlear implant simulations – *Carina Pals, Groningen* (Thu043)

friday september 21st 2012

LOCATION: MAINDECK PTA (PASSENGER TERMINAL AMSTERDAM) AND ZURICH I + II

08.00 - 08.30 keynote speaker:
John Middlebrooks
Is there a future for direct neuronal stimulation?
location Maindeck PTA

08.30 - 10.00 plenary session 3
Speech processing
location Maindeck PTA
moderators Andreas Büchner and Deniz Başkent

- Improved coding strategies based on electrophysiological measurements and models – *Norbert Dillier, Zürich* (Fri001)
- Age-related effects with stimulation pulse rate on speech understanding and CAEPs in CI listeners – *Lendra Friesen, Toronto* (Fri002)
- Conveying low frequency information through electrical stimulation – *Waldo Nogueira, Barcolona* (Fri003)
- Plasticity and perception in the human brain – investigating speech with functional imaging – *Sophie Scott, U.K.* (Fri004)
- Spread of excitation in single and dual electrode cochlear implant stimulation – *Jorien Snel-Bongers, Leiden* (Fri005)
- Event-related potential evidence for the perception of emotional prosody through cochlear implants – *Andreas Büchner* (Fri006)

10.00 - 10.30 Coffee break and poster session group 2

10.30 - 11.50 parallel session 4a
Middle ear implants
location Maindeck PTA
moderators Bob Shannon and Andrzej Zarowski

- The capacity of new auditory implants for sensorineural and conductive hearing loss – *Ad Snik, Nijmegen* (Fri007)
- Preliminary results on ASSR measurements in Codacs patients. – *Nicolas Verhaert, Leuven* (Fri008)
- Effect of round window stimulation on intracochlear pressure for superior canal dehiscence – *Marlien Niesten, Eindhoven* (Fri009)
- Intra-operative measurement of a Floating Mass Transducer at the round window – *Jérémie Guignard, Bern* (Fri010)
- Can we predict the influence of a ossicular sensor on the mobility of the ossicular chain? – *Jean-Marc Gerard, Brussels* (Fri011)

10.30 - 11.50 parallel session 4b
Implant biology

location Zurich I + II

moderators Stephen O'Leary and Emmanuel Mylanus

- Reduced impedances and fibrous tissue growth using dexamethasone eluting cochlear implants in vivo – *Verena Scheper, Hannover* (Fri012)
- Hearing measurement during and after cochlear implantation – experimental and human studies – *Douglas Fitzpatrick, Chapel Hill* (Fri013)
- The peripheral processes of spiral ganglion cells in guinea pigs: deafening and neurotrophic factors – *Sjaak Klis, Utrecht* (Fri014)
- Systemic is more effective than local administration of dexamethasone for reducing the tissue response to cochlear implantation – *Stephan O'Leary, Melbourne* (Fri015)

12.00 - 13.30 Lunch & posters session group 2

13.30 - 14.00 keynote speaker: *Kevin Green*
Functional imaging in the age of cochlear implantation

location Maindeck PTA

14.00 - 15.00 plenary session 4
Functional imaging

location Maindeck PTA

moderators Yael Henkin and Pim van Dijk

- Visual cross-modal reorganization of phonological pathways in post-lingual deaf subjects – *Diane Lazard, Paris* (Fri017)
- Comparison of resting state activity in individuals with unilateral hearing loss and normal hearing – *Jill Firszt, Washington* (Fri018)
- New insights on the tonotopy of the human auditory cortex – *Pim van Dijk, Groningen* (Fri019)
- Electrophysiological signatures of cortical plasticity in cochlear-implant users – *Pascale Sandman, Oldenburg* (Fri020)
- Functional Near Infrared Spectroscopy: a novel imaging technique for cochlear implants – *Paul Kileny, Ann Arbor* (Fri021)

15.00 - 15.30 Tea break & poster session group 2

15.30 - 16.30

parallel session 5a
Functional imaging

location Maindeck PTA

moderators Wai Kong Lai and Robert Stokroos

- Neural correlates of tinnitus improvement by cochlear implant in patients with single-side deafness – *J.J. Song, Edegem* (Fri022)
- CT-analysis of intrascalar position of cochlear implants: Relation with clinical stimulation levels – *Feddo van der Beek, Leiden* (Fri023)
- Music perception by normal-hearing and cochlear implant children: a neuroelectrical imaging study – *Pasquale Marsella, Rome* (Fri024)
- The use of cone beam CT to determine electrode position in human temporal bones – *Shakeel Saeed, London* (Fri025)
- Automated registration and superimposition of multiple CBCT volumes of the temporal bone – *Guido Dees, Maastricht* (Fri026)

15.30 - 16.30

parallel session 5b
eSRT

location Zurich I + II

moderators Kurt Stephan and André Goedegebure

- Postoperative stapedius reflex tests for CI fitting in children with bilateral cochlear implants – *Kurt Stephan, Innsbruck* (Fri027)
- Fast fitting procedures for CI by electrical stapedius reflex thresholds (ESRT) – *Victor Koci, Innsbruck* (Fri028)
- Multimodal electrophysiological tests–A guideline to program 'Difficult to MAP' cochlear implantees – *S. Raghunandhan, Chennai* (Fri029)
- Objective registration of stapedial reflex during cochlear implantation by impedance technique – *Serge Petrov, St. Petersburg* (Fri030)
- A comparison of stapedial muscle activity during measurement of ECAP with two strategies – *Madhuri Gore, Bangalore* (Fri031)

16.45 - 17.45 parallel session 6a
Diagnostics

location Maindeck PTA

moderators Jan Wouters and Bert van Zanten

- Electrocochleography responses in infants with auditory neuropathy spectrum disorder (ANSD) – *Kirsty Gardner-Berry, Rozelle* (Fri032)
- Neural diagnostics using psychophysics, CT scans, and electro-anatomical modeling – *Christopher Long, Centennial* (Fri033)
- Neuropathy of the auditory system due to Infantile Thiamine Deficiency: Eight years of follow-up – *Joseph Attias, Haifa* (Fri034)
- Stimulus intensity influence on the characteristics of Speech Auditory Brainstem responses – *Annie Moulin, Lyon* (Fri035)
- Automated measurement of ECAP threshold using Smart-NRI: normative data – *Dzemal Gazibegovic, Annaba* (Fri036)

16.45 - 17.45 parallel session 6b
Middle ear implants

location Zurich I + II

moderators Thomas Lenarz and Hannes Maier

- Intra-cochlear pressures elicited by forward sound stimulation and reverse round-window stimulation – *Hideko Nakajima, Boston* (Fri037)
- Functional assessment of implantable hearing device using a Laser Doppler vibrometer – *Jae Hoon Sim, Zurich* (Fri038)
- Assessment of reconstructed hearing based on measurements – *Albrecht Eiber, Stuttgart* (Fri039)
- Ear-canal acoustic reflectance monitoring during middle ear implant surgery: a feasibility study – *Stéphane Tringali, Pierre Benite* (Fri040)

18.15 Departure boats to symposium dinner, at the pier of the Mövenpick hotel

20.15 Start dinner at West-Indisch Huis

saturday september 22nd 2012

LOCATION: MAINDECK PTA (PASSENGER TERMINAL AMSTERDAM) AND ZURICH I + II

08.30 - 09.00 keynote speaker: *Paddy French*
Next generation sensors and actuators in Medicine
location Maindeck PTA

09.00 - 10.30 plenary session 5
Objective measures and future technologies
location Maindeck PTA
moderators David McAlpine and Jef Mulder

- Advances in integrity testing for Nucleus implants – *Britta Böhnke, Kiel* (Sat001)
- Intra-operative techniques for the measurement of residual hearing during cochlear implant surgery – *Halit Sanli, New Port* (Sat002)
- Infrared stimulation of the cochlear nucleus: implications for the ABI – *Rohit Verma, Boston* (Sat003)
- Estimating neural threshold without artefact subtraction from the linearity of the eCAP recording – *Robert Morse, Birmingham* (Sat004)
- An additive instantaneously companding readout system for cochlear implants – *Cees Jeroen Bes, Delft* (Sat005)
- Comparison of ECAP measurements using traditional and novel equipment – *George Tavartkiladze, Moscow* (Sat006)

10.30 - 11.30 Coffee break & poster session group 2

11.30 - 12.30 parallel session 7a
Objective evaluations
location Maindeck PTA
moderators Bram van Dun and Wim Soede

- Detecting and avoiding cochlear implant artifacts in cortical auditory evoked potential recordings – *Bram van Dun, Chatswood* (Sat007)
- Electrically-Evoked Auditory Change Complex in children with Auditory Neuropathy Spectrum Disorder – *Shuman He, Chapel Hill* (Sat008)
- Application of ASSR for evaluating the hearing preservation in cochlear implantations – *Sabine Haumann, Hannover* (Sat009)
- Cortical processing of changes in music and speech in children with cochlear implants; role of music – *Rivta Torppa, Helsinki* (Sat010)
- Cochlear implant artifact cancellation using a high bandwidth high sample rate approach – *Myles Mc Laughlin, Irvine* (Sat011)

11.30 - 12.30 parallel session 7b
Fitting

location Zurich I + II

moderators Waldo Nogueira and Lucas Mens

- ESR, ECAP and MCL: Their relation for charge-based fitting in implants with 31,5 mm electrode – *Adam Walkowiak, Warsaw* (Sat012)
- Fitting optimization through de-activation of electrodes based on NRI recordings – *Elie Zir, Baabda* (Sat013)
- Future fitting methods for clinicians with limited cochlear implant experience – *Saji Maruthurkkara, Maquarie* (Sat014)
- Comparison between objective and subjective methods of the Comfortable Balanced Profile (C-Profile) – *Alessandra D'Elia, Bari* (Sat 015)

12.45 - 13.45 parallel session 8a
Objective measures in bone conduction

location Maindeck PTA
moderators Paul Van De Heyning and Ad Snik

- A Novel Bone Conduction Implant (BCI) Device – *Sabine Reinfeldt, Göteborg* (Sat017)
- Clinical utility of Resonance Frequency Analysis (RFA) for bone conduction auditory implants – *Mark Flynn, Mölnlykke* (Sat018)
- Transcranial attenuation as a measure to predict the outcome of a BCD trial in SSD patients – *Jolien Desmet, Antwerp* (Sat019)
- Mechanical measurement of frequency response in Baha implants in the live skull – *Noriko Nishizawa, Sapporo* (Sat020)

12.45 - 13.45 parallel session 8b
Robotics, surgery, navigation

location Zurich I + II
moderators Olivier Sterkers and Wilko Grolman

- A self-developed and constructed robot system for cochlear implantation – *Marco Caversaccio, Bern* (Sat021)
- Measuring insertion forces for CI Implantation in cadaveric human temporal bones – *Omid Majdani, Hannover* (Sat022)
- Future impact of miniaturized approaches in cochlear implantation – *S. Hansen, Düsseldorf* (Sat023)
- Mechatronic Electrode Array Insertion: Experimental Results – *Yann Nguyen, Paris* (Sat024)

13.45 Closing ceremony Objective Measures 2012

location Maindeck PTA

- ANSD 2012 Award
- Poster Award Objective Measures 2012

meeting point

CONFERENCE FACILITIES

Mövenpick floorplan

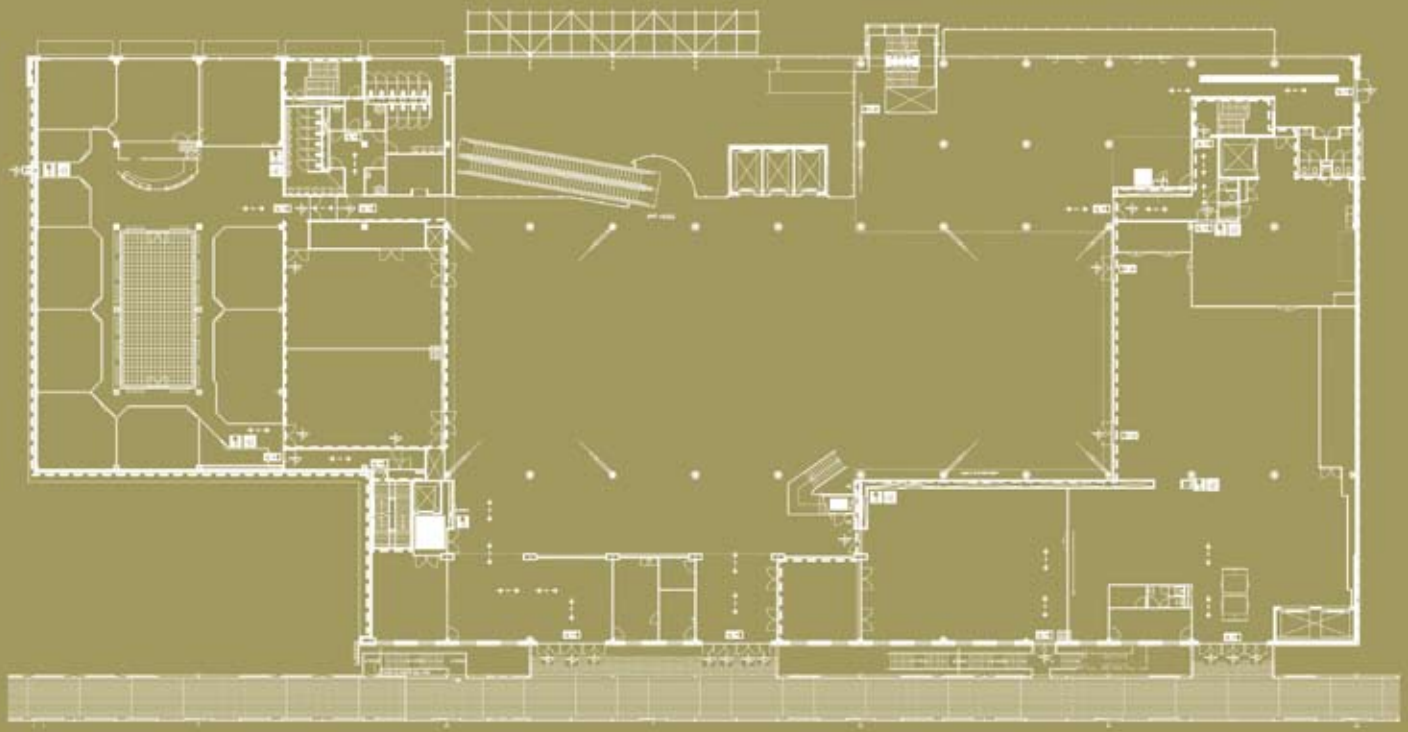
FUNCTION ROOMS

1 Matterhorn I: exhibition, posters and catering
2 Matterhorn II: exhibition, posters and catering
3 Matterhorn III: exhibition, posters and catering
4 Basel: symposium secretariat OM2012
5 Luzern: hospitality suite Cochlear
6 Geneva: slide preview room
7 Lausanne: hospitality suite Neurelec
8 St.Gallen: hospitality suite Advanced Bionics
9 Winterthur: hospitality suite Med-El
10 Zürich II: satellite symposia and parallel sessions
11 Zürich I: satellite symposia and parallel sessions
12 Foyer I: exhibition, posters and catering
13 Foyer II
14 Atrium Foyer: exhibition, posters and catering

maindeck PTA →

maindeck PTA

(PASSENGER TERMINAL AMSTERDAM)



← Mövenpick

point of stay

with pleasure we present our keynote speakers

Jay Rubinstein
Past, present and future of objective measures
THURSDAY
SEPTEMBER 20th
08.20 - 08.50

Jay Rubinstein

Dr Rubinstein received ScB/ScM degrees in Engineering at Brown University in 1981/83. He received an MD and PhD in Bioengineering at the University of Washington in 1987/88. He completed postdoctoral research training and residency in Otolaryngology in 1994 at the Massachusetts Eye and Ear Infirmary. He completed a Neurotology fellowship at the University of Iowa in 1995 staying as Assistant then Associate Professor of Otolaryngology and Bioengineering. In 2003/04 he was the Boerhaave Professor at Leiden University, the Netherlands. He is currently Virginia Merrill Bloedel Professor of Otolaryngology and Bioengineering and Director, Bloedel Hearing Research Center, University of Washington. He is past-president of the American Auditory Society and President-elect of the Association for Research in Otolaryngology. He is a member of the Collegium Otorhinolaryngologicum as well as a Senior Member of the Institute for Electrical and Electronics Engineers. He has published over 100 peer-reviewed articles in both clinical and basic science journals and has mentored 18 predoctoral and postdoctoral trainees in basic and translational research, as well as providing clinical training to a large number of otolaryngology residents and fellows. His laboratory studies models of, signal processing in and perception with cochlear implants, and is collaborating in the development of a vestibular implant.

Andrej Kral
Cell biology and cochlear implants: a happy marriage?
THURSDAY
SEPTEMBER 20th
13.30 - 14.00

John Middlebrooks
Is there a future for direct neuronal stimulation?
FRIDAY
SEPTEMBER 21st
08.00 - 08.30

Andrej Kral

CV, Prof. Dr. Andrej Kral
Institute of Audioneurotechnology &
Dept. of Experimental Otology
Hannover Medical School
Feodor-Lynnen-Str. 35, 30625 Hannover

Education & Appointments:
2009: Professor and Chair of Auditory Neuroscience, Medical University Hannover, Germany
2004: Adjunct Professor of Neuroscience, The University of Texas at Dallas, School of Behavioral and Brain Sciences, USA.
2004-2009: Professor of Neurophysiology, University of Hamburg School of Medicine, Germany
2002: Associate Professor ('Priv.-Doz.'), J.W.Goethe University School of Medicine, Frankfurt am Main, Germany
1998: Ph.D., Comenius University School of Medicine, Bratislava
Thesis: Frequency discrimination of hearing studied by methods of computational neuroscience
1993: M.D., Comenius University School of Medicine, Bratislava, summis cum laudibus
1987-1993: School of Medicine, Comenius University, Slovakia
Address: Spitalska 24, SK-811 08 Bratislava, Slovak Republic; Student, human medicine

John Middlebrooks

John C. Middlebrooks joined the faculty of the University of California at Irvine in 2008. There, he is a Professor in the Departments of Otolaryngology – Head and Neck Surgery, Neurobiology & Behavior, Cognitive Sciences, and Biomedical Engineering. He was trained at the California Institute of Technology (B.S., 1976), UC San Francisco (Ph.D., 1982), and Stanford University (post-doc, 1985). Prior to UC Irvine, he has served on the faculties of the University of Florida (1985-1995) and University of Michigan (1995-2008). Dr. Middlebrooks uses neurophysiology and psychophysics to study the brain mechanisms of hearing. His NIH-supported research includes studies of cortical responses to cochlear implant stimulation, studies of cortical mechanisms of spatial hearing, and tests of the feasibility of an auditory nerve implant for auditory prosthesis. A major emphasis in the laboratory currently is to translate an auditory nerve implant toward human application. Dr. Middlebrooks is a Fellow of the Acoustical Society of America and recently has served as Associate Editor for the Journal of the Acoustical Society of America and the Journal of the Association for Research in Otolaryngology. He currently is the President of the Association for Research in Otolaryngology

Kevin Green
Functional imaging in the age of cochlear implantation
FRIDAY
SEPTEMBER 21st
13.30 - 14.00

Paddy French
Next generation sensors and actuators in Medicine
SATURDAY
SEPTEMBER 22nd
08.30 - 09.00

Kevin Green

Kevin Green is a Consultant ENT Surgeon based in Manchester, UK. His main clinical interests are otology and, in particular, implantation otology. He is experienced in adult and paediatric cochlear implantation, hearing preservation cochlear implant surgery, bone anchored hearing aid surgery and middle ear implant surgery. He has active research interests in these areas and in the use of functional neuroimaging techniques in the investigation of patients prior to and after cochlear implantation. His thesis was on the use of Positron Emission Tomography (PET) in cochlear implant recipients for which he was awarded a MD by the University of Manchester. He has recently completed studies using functional Magnetic Resonance Imaging to investigate cross modal plasticity before cochlear implantation and a PET study of bilateral cochlear implant recipients.

Paddy French

Paddy French received his B.Sc. in mathematics and M.Sc. in electronics from Southampton University, UK, in 1981 and 1982, respectively. In 1986 he obtained his Ph.D., also from Southampton University, which was a study of the piezoresistive effect in polysilicon. After 18 months as a post doc at Delft University, The Netherlands, he moved to Japan in 1988. For 3 years he worked on sensors for automotives at the Central Engineering Laboratories of Nissan Motor Company. He returned to Delft University in May 1991 and is now a staff member of the Laboratory for Electronic Instrumentation In 1999 he was awarded the Antoni van Leeuwenhoek chair and in June 2002 he became head of the Electronic Instrumentation Laboratory. He is Editor-in-chief of Sensors and Actuators A and General Editor of Sensors and Actuators A&B. His research interests are integrated sensor systems, micromachining, in particular for medical applications.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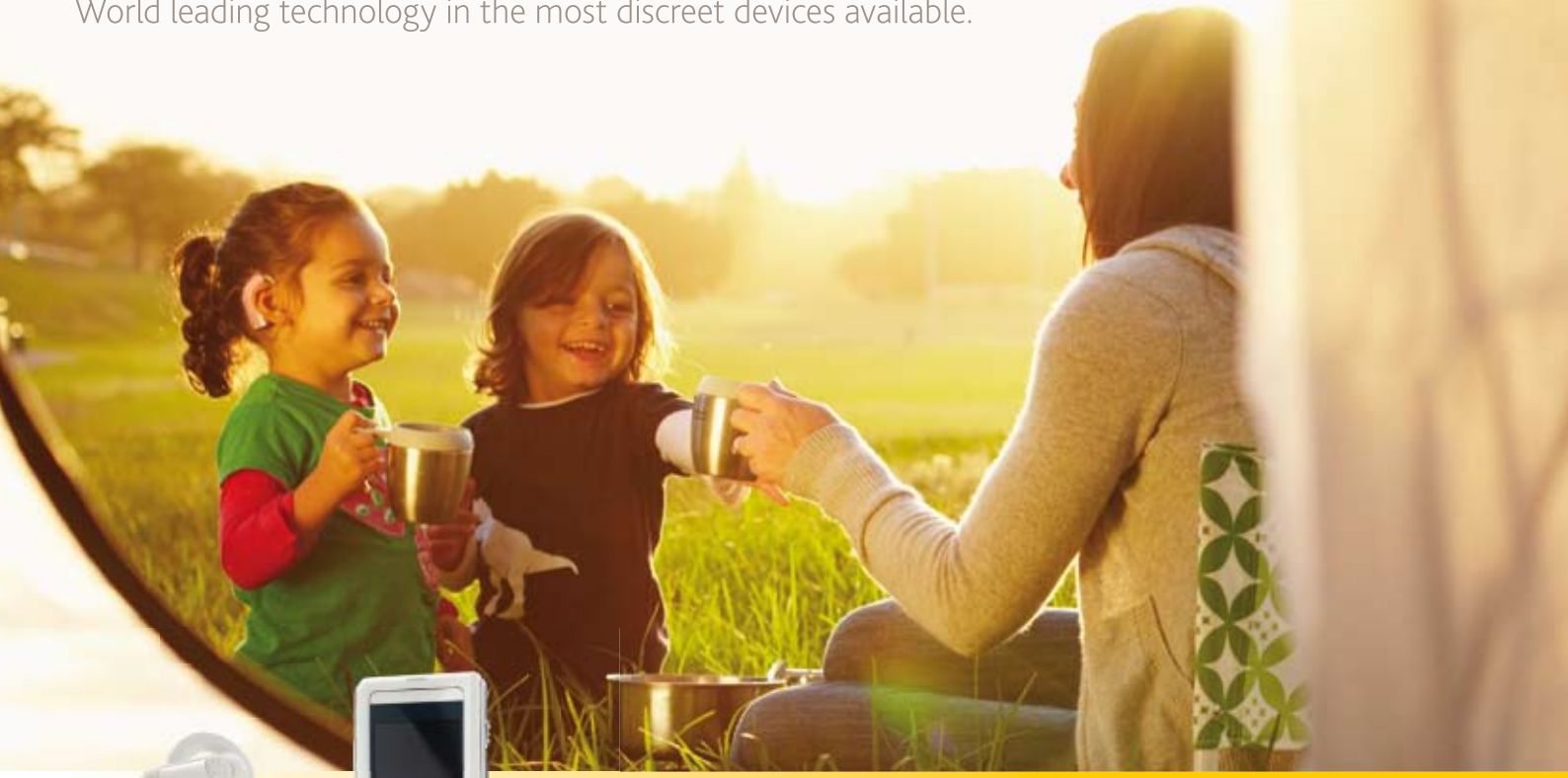

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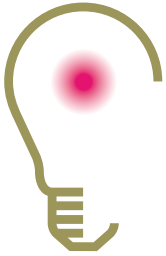

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Thursday 20 September 2012

Topic: eCAP and Cochlear Potentials

Thu01. Recordings to acoustic stimuli from the round window in cochlear implant patients

DCF Fitzpatrick, BC Choudhury, CAB Buchman, OFA Adunka
Univ. of North Carolina at Chapel Hill, CHAPEL HILL, United States of America

Knowledge of neural and hair cell physiology prior to implantation could be useful in treating individual patients and in understanding how different etiologies affect cochlea physiology. For this study, recordings were made from the round window of the general population of pediatric and adult cochlear implant recipients (N>50, one to >80 yrs). A monopolar probe was placed at the RW after surgical access was obtained. The cochlear microphonic (CM), summating potential (SP), compound action potential (CAP), and auditory nerve neurophonic (ANN) potentials were recorded in response to tone bursts at frequencies of 0.25 – 4 kHz at various levels. Together, these potentials provide information about the functional status of inner and outer hair cells and degree of neural survival and temporal synchrony of nerve firing. Measurable hair cell/neural potentials were detected in almost all subjects with a wide range of hearing loss etiologies. Phase-locked neural responses, or the ANN, could be isolated after averaging responses to alternating phase stimuli. The ANN showed a better match to the audiogram threshold than the CM, which could have a lower threshold, indicating more sensitive hair cell than neural responses. Conclusions are that acoustically-evoked cochlear potentials are present in candidates for cochlear implantation in all but rare cases, even if hearing is extremely limited. Many patients have stronger hair cell than neural potentials, a type of auditory neuropathy. The findings indicate that sensitive measures of cochlear and neural status can be obtained that may be useful in tailoring electrode type, placement and audiometric fitting.

Thu02. The effect of transition in pulse shape and polarity on psychoelectric and ECAP responses

AB Bahmer, UB Baumann
Clinic Gothe University Frankfurt, FRANKFURT, Germany

Triphasic pulses with adjustable phase amplitude ratio (PAR) can effectively reduce stimulus artifacts in the recording of electrically evoked compound actions potentials (ECAPs) (Bahmer et al. 2011a, b).
In addition, triphasic pulses with adjustable PAR can be used for the investigation of neuronal responses after stimulation with different pulse shapes and polarity (biphasic anodic first, biphasic cathodic first, triphasic pulse with PAR 0-1). The effect of pulse shape and polarity on neuronal responses are still under discussion (Bahmer et al. 2010a, van Wieringen et al. 2008, Macherey et al. 2008).
We investigated psychoelectric threshold levels and neurophysiologic response strengths (electrically evoked compound action potentials) after stimulation with different pulse shapes and polarities. The neurophysiologic measurements are a combination of unmasked and masked responses to calculate an artifact-free response. Measurements were accomplished in five human cochlear implant subjects. Neurophysiologic and psychoelectric measurements yield similar results: symmetric triphasic pulse show the lowest response strength, biphasic pulses with anodic first phase showed the strongest response strength. The response strength to biphasic pulses with cathodic first phase was in between. This is in line with experiment in animals (Sheperd and Javel, 1999). This is the first time to our knowledge that an investigation consisting of a combination of masked and unmasked responses and a quasi-continuous transition in pulse shape was accomplished in a neurophysiologic experiment with CI subjects.

Thu03. A convolutive ECAP model to assess the firing properties of the auditory nerve

SB Strahl, P Spitzer, K.E. Schwarz
MED-EL GmbH, INNSBRUCK, Austria

Introduction: The electrically evoked compound action potential (ECAP) is a routinely performed electrophysiological measure of the auditory nerve. This objective measure contains information on the firing properties of the auditory nerve for electrical stimulation, which is of interested in the context of neural health and cochlear implant coding and fitting strategies.

Methods: Using a convolutive ECAP Model following Goldstein & Kiang (1958) and Versnel et al. (1992), ECAP measurements from a large multi-center study (Hearring 2012) were categorized and analyzed by deconvolving them into their single fibre response and their compound discharge latency distribution.

Results: The compound discharge latency distribution found for a typical ECAP response can be described as a bimodal probability distribution consisiting of an early low variance Gaussian distribution (s ~ 0.13 ms) followed by a second Gaussian distribution delayed by approx. 0.75 ms with a higher variance (s ~ 1 ms).

Conclusion: A convolutive ECAP Model can be used to gain information on the firing properties of the electrically stimulated auditory nerve.

References: Hearring Group ‘Auditory Nerve Response Telemetry (ART) Study of the Hearring Group’; Dataset presented e.g. by P. Senn, Proc. of 12th International Conference on Cochlear Implants, Baltimore (2012)Goldstein, M.H.; Kian, N.Y.S. ‘Synchrony of neural activity in electric responses evoked by transient acoustic stimuli’ JASA, Vol. 30, p.107-114 (1958)Versnel, H.; Schoonhoven, R.; Prijs, V.F. ‘Single-fibre and whole-nerve responses to clicks as a function of sound intensity in the guinea pig’ Hearing Research, Vol. 59, pp. 138-156 (1992)

Thu04. Expanded objective measures in auditory neuropathy spectrum disorder

CLR Runge, KLR Rudman, SLF Fulmer, DRF Friedland
Medical College of Wisconsin, MILWAUKEE, United States of America

Introduction: Objective measures are essential for diagnosing auditory neuropathy spectrum disorder (ANSD), specifically outer hair cell (OHC) and auditory nerve function. While clinical measures inform general function, expanded objective assessment may reveal mechanisms underlying ANSD. The purpose of this study was to further characterize ANSD by testing distortion-product OAEs (DPOAEs) and electrically-evoked compound neural action potentials (ECAPs) using parameters beyond those implemented clinically.

Methods: Two experiments: 1) DPOAE input-output (I/O) functions; and 2) ECAP recovery functions. DPOAE I/O functions were measured in children with ANSD (n=12) and normal-hearing control subjects matched for age and gender (n=12). Functions were analyzed and categorized as normal, abnormal, or absent. In a separate experiment, ECAP recovery functions and speech recognition thresholds (SRTs) were measured in implanted children with ANSD (n=10) and sensorinerual hearing loss (SNHL, n=10) matched for implant type and age at implantation. Recovery function exponent was calculated to determine rate of neural recovery.

Results: DPOAE I/O – When functions were present, subjects with ANSD showed significantly more abnormal functions compared to normal-hearing peers ($p<.01$). ECAP recovery – Some individuals with ANSD demonstrated slower recovery, though there were no significant differences in average rate of recovery or SRT between groups. A significant relationship was found between recovery rate and SRT for all subjects ($p=.04$).

Conclusion: Presence of OAEs in ANSD may not indicate normal OHC function. Rate of neural recovery from electrical stimulation is similar between ANSD and SNHL, although individuals with ANSD may show slower recovery.

Thu05. Auditory neuropathy spectrum disorder is a misnomer

WPR Gibson[1], H Sanli[2]
[1]University of Sydney, BIRCHGROVE, Australia
[2]SCIC, GLADESVILLE, Australia

Introduction: The term auditory neuropathy spectrum disorder (ANSD) is misleading as it suggests that there is always a neuropathy present. This concept misleads clinicians.

Methods: Electrophysiological testing has been performed on 159 children who have been diagnosed with ANSD. These children have present otoacoustic emissions (OAE) ,absent auditory brainstem responses (ABR) and perform poorly using hearing aids. Transtympanic electrocochleography (TTECochG) and electrically evoked auditory brainstem potentials (EABR) have been obtained both pre-operatively and after cochlear implant surgery.

Results: TT ECochG shows an abnormal receptor potentials: a large cochlear microphonic and an abnormal positive potential (probably uncancelled cochlear microphonic). In 121 children tested the EABR were normal – these ears performed well with a cochlear implant. In 38 children had abnormal EABR and these ears were often associated with abnormalities on MRI testing – these ears performed poorly with a cochlear implant.

Conclusion: The electrophysiological studies support the concept the ANSD is primarily a haircell dysfunction in 80% of ears. There is outer hair cells survival but only patchy inner hair cell survival. The outer hair cells tune the basilar membrane inappropriately into areas which have no inner haircells. Only 20% of ears have an associated neuropathy. The correct term should be ‘haircell desynchrony spectrum disorder’ (HDSD)!

Thu06. Time dependent behaviour of the TECAP threshold post reimplantation

JMD Müller-Deile, GB Brademann, MH Hey
Christian-Albrechts-Universität zu Kiel, KIEL, Germany

Introduction: In a number of cochlear implant (CI) centres a patient has to wait at least one month after the implantation until the speech processor is fitted to his needs and he can start hearing via the CI.Amplitude and thresholds of telemetric recorded electrically evoked compound action potentials (TECAP) show significant differences between recordings in the operation theatre immediately after the implantation and at the time of first fitting as well as during long term use.

Methods: We investigated the course of the TECAP thresholds from intraoperative recordings to measurements during long term use. With 16 patients using Nucleus implants who had to undergo a reimplantation of their CI we recorded NRT thresholds (TNRT) in weekly sessions in the first month, starting the first day after implantation. These results were compared with measurements we conducted 1 month, 3 month and a half year after implantation.

Results: There was a significant change between the TNRTs recoded intraoperatively and those recorded during first fit. After the second week the thresholds stabilised and showed no significant change over the first year.The course of the TNRTs in those patients fitted starting the first day post implantation behaved very similar to those where we started the speech processor fitting more than one month after implantation.

Conclusion: It is possible to start the fitting the day after reimplantation without the risk of great fluctuations in the TECAP thresholds.

Thu07. Functional and histological characterization of the degenerating auditory nerve in deaf guinea pigs

D Ramekers[1], H Versnel[1], EM Smeets[1], SB Strahl[2], W Grolman[1], SFL Klis[1]

[1]University Medical Center Utrecht, UTRECHT, Netherlands

[2]MED-EL GmbH, INNSBRUCK, Austria

After severe hair cell loss, secondary degeneration of spiral ganglion cells (SGCs) is observed – a gradual process that takes years in humans but only weeks in guinea pigs. Being the target for cochlear implants, both the number and the physiological state of the SGCs are important determinants for the effectiveness of a cochlear implant. Therefore, our goal is to provide a comprehensive characterization of both functional and histological properties of the SGCs after deafening.Guinea pigs were deafened by co-administration of kanamycin and furosemide two or six weeks before acute experiments. We used a MED-EL PULSARCI[100] cochlear implant to electrically evoke and record compound action potentials (eCAPs). The following stimulus parameters were varied: phase duration, inter-phase gap, current level, inter-pulse interval and pulse train duration. The eCAP was evaluated with respect to amplitude, threshold, dynamic range and refractoriness. Immediately thereafter, the animals were sacrificed for histological analysis of the SGCs and their central and peripheral processes.With increasing duration of deafness eCAP amplitude, slope and latency decreased, while the dynamic range increased. In all animals eCAP amplitude, slope, dynamic range and latency increased with inter-phase gap, while threshold decreased. This effect diminished significantly after deafening, and correlated with the number of surviving SGCs. Whole-nerve absolute refractoriness did not change, while the relative refractory period was increased in deafened animals. The potential of these electrophysiological measures towards assessment of the condition of the auditory nerve can be of great benefit to clinical diagnostics.

Thu08. Electrically evoked compound action potentials in patients supplied with a cochlear implant

W. Vischer

Inselspital Bern, BERN, Switzerland

Background: The measurement of Electrically Evoked Compound Action Potentials (ECAP) is established to assess cochlear implant function by an objective method which is implemented in all CI devices. In a multicenter study the ECAP performance of Standard and FLEX^{SOFT} electrode arrays of Pulsar$^{CI100®}$ und Sonata$^{TI100®}$ cochlear implants (MED-EL, Innsbruck) was investigated using the auditory nerve response telemetry (ART) task of MAESTRO® software. Examining the underlying physiological background of neural responses from different regions, ECAPs elicited by stimulation in the most apical region of the cochlea were compared to potentials of the basal region of the CI.

Methods: 150 subjects are included from 16 centers worldwide. Implant integrity was tested by impedance telemetry immediately before performing the ECAP recordings. Two different ECAP measurements were preformed in order to assess different parameters of the neural response: A) Amplitude growth recordings by stimulating the apical electrode 2, the middle electrode 5 and the basal electrode 10, B) Recovery sequences stimulating the same respective electrodes with ECAP recording on adjacent electrodes.

Results: Data showing ECAP amplitudes, thresholds and latencies of the amplitude growth functions from three different regions will be presented. Analysis of the data shows similar thresholds but difference in latencies for stimulation in the apical region compared to stimulation in the middle and basal regions. These results will be discussed with respect to the data published by Brill et al. (2009). In addition the presence and incidence of double peaks in ECAP recordings will be discussed.

Thu09. Objective measures for vestibular dysfunctions after cochlear implantation

D Basta, I Todt, RD Battmer, A Ernst

BERLIN, Germany

Approximately 60% of the patients suffer from acute, reversible, short-term vertigo after cochlear implant surgery. The acute vestibular symptoms are related to the surgical trauma while inserting the electrode into the cochlea. This could be based on the loss of inner ear fluids, perilymphatic fistulae, and the occurrence of a benign paroxysmal positional vertigo. Persisting, chronic dizziness (spontaneous-episodic) was reported to occur in about 10% of all patients, which has been a matter of debate for a long time. On one hand, we could describe that in some particular cases the intra-cochlear electrical stimulation activates the vestibular system. On the other hand, vestibular receptor cells of the otolith organs as well as the semicircular canal seem to be largely affected by the insertion of the cochlear implant electrode. The most frequent influenced vestibular structure is the saccule. A loss of otolith function is difficult to compensate by the patients and can therefore induce a long lasting balance deficit.

A minimal pre- and postoperative vestibular test-battery should include the measurement of vestibular evoked myogenic potentials elicited by air- and bone-conducted sound stimulation. Furthermore, we suggest at least the determination of the subjective haptic or visual vertical and the caloric irrigation as simple utricle and horizontal semicircular canal function tests.

Our recent results show that chronic dizziness, induced by a vestibular receptor function loss, can be successfully treated with modern vibrotactile neurofeedback training.

Thu010. Spread-of-excitation measurements using masker and probe electrodes which are both current steered

LG Gärtner[1], AB Büchner[1], TL Lenarz[1], WN Nogueira Vazquez[2]

[1]Medizinische Hochschule Hannover, HANNOVER, Germany

[2]Universitat Pompeu Fabra, BARCELONA, Spain

Current steering strategies stimulate pairs of adjacent electrodes simultaneously. By doing so, intermediate pitches can be elicited between the stimulating electrodes. The aim of this study is to analyze the effects of channel interaction between current steering stimuli by means of electrophysiological measures.Data from eight subjects were collected, all using the HiRes90K or CII implant system with the current steering strategy 'HiRes with Fidelity 120'. Spread-of-excitation measures were taken with the research software BEDCS (Bionic Ear Data Collection System, Advanced Bionics). The forward masking paradigm was chosen with recording always on electrode 6. Additionally, recordings on electrode 1 were taken in 4 subjects. Both, the probe and the masker were generated by the current steering method. The probe location was steered between electrode 3 and 4 at the following positions: {3, 3.125, 3.25, 3.375, 3.5}. For each of these positions, the masker was also steered roving the following sites: {3, 2.875, 2.75, 2.625, 2.5}. The stimuli were presented at a comfortable loud level with equal loudness.As expected, the NRI amplitude decreased with increasing distance between masker and probe in 79% of our measurements. But in 8% we saw an increase of the NRI amplitude. In 13% no dependency was observed. Our data indicate that current steering may shift the excitation patterns along the electrode array.Supported by: 'Europa fördert Niedersachsen'

Thu011. The diagonal elements of the cochlear implant impedance matrix

RK Kalkman, JHM Frijns, JJ Briaire, DMT Dekker

LUMC, LEIDEN, Netherlands

Introduction: The electrode impedance matrix is used in techniques such as Phased Array (PA) stimulation to calculate optimized current vectors for simultaneous stimulation of multiple CI contacts. However, due to technical limitations it is not possible to measure the diagonal elements of the impedance matrix directly, so it is necessary to estimate their values. However, inaccurate estimation of the diagonal elements will lead to over- or under compensation of current in PA current vectors, potentially causing undesired effects during stimulation.

Methods: A computational model of the implanted human cochlea was used to calculate simulated impedance matrices for both lateral and medial wall placement of the array in several cochlear models. The rows of the impedance matrices, excluding the diagonal elements, were fitted with several functions in an attempt to find a function that can reliably predict the values of the diagonal impedance matrix elements from the non-diagonal elements.

Results: Exponential functions were found to consistently underestimate the values of the diagonal elements. Adding a radial component to an exponential function can serve as an accurately fit of the impedance matrix rows, but does not reliably predict the value of the diagonal elements.

Conclusions: Curve fitting alone was not sufficient for determining the diagonal elements. Results show that lateral-medial placement of the array affects the impedance matrices.

Thursday 20 September 2012

Topic: Plasticity

Thu012. Simultaneous bilateral cochlear implantation protects auditory pathways in children who are deaf

A Gordon, C Papsin

The Hospital for Sick Children, TORONTO, Canada

Introduction: Unilateral deafness restricts excitatory input to the auditory pathways from the deprived ear and removes inhibitory input involved in binaural processing. In developing animal models, this results in overexpression of neural connections from the hearing ear and compromises binaural responses. In the present study, we asked whether such reorganization occurs when children with bilateral deafness hear through unilateral cochlear implants and, if so, whether providing bilateral electrical input in early development protects them from such changes.

Methods: Cortical activity was measured by electroencephalography in: a) 34 children with early onset (typically congenital) deafness and implanted with unilateral or bilateral cochlear implants at <3 years of age and b) 7 peers with normal hearing. Twenty-four children received a right unilateral cochlear implant. Sixteen of this group later received a second cochlear implant in the opposite ear (inter-implant delay=3.57±0.72 years). Another group of 10 children received bilateral implants simultaneously. Bilateral cochlear implant use was at least 30 months at time of testing. A TRACS beamformer was used to suppress cochlear implant artifact and locate evoked activity in auditory cortices.

Results: Right sided cochlear implant use increased dipole moments in the left auditory cortex whereas simultaneous bilateral cochlear implantation promoted normal levels of activity in the two auditory hemispheres. Abnormal increases in contralateral activity were significant by 1.8 years of unilateral cochlear implant use and were not reversed even after > 30 months of bilateral implant use.

Conclusion: There is a sensitive period for bilateral input in the developing human auditory system.

Thu013. Does assessment of brain visual speech circuits in profound acquired deafness support the hypothesis of latent multimodal connectivity?

E Truy[1,2], L Hyo-Jeong[3,4], G Mamou[3], D Sapey-Marinier[5], A Giraud[3]

[1]CNRS, UMR5020 Neurosciences sensorielles, Comportement and Cognition . Université Claude Bernard Lyon 1, Lyon, F-69366, France

[2]Hospices Civils de Lyon, Hôpital Edouard Herriot, Département d'ORL, de Chirurgie Cervico-Maxillo-Faciale et d'Audiophonologie, Lyon, F-69003, France

[3]Ecole Normale Supérieure, INSERM U960 and Université Paris 6, Paris, F-75005, France.

[4]Hallym University College of Medicine, Department of Otorhinolaryngology-Head and Neck Surgery, 896, Pyeongchon-dong, Dongan-gu, Anyang-si, Gyeonggi-do, 431-070, Republic of Korea

[5]CERMEP, CHU Lyon, Lyon, France

Losing one sense provokes cross-modal plasticity of deprived cortical areas. After having published some works that demonstrated non auditory cortical areas activation in CI subjects, we put interest in deaf subjects before CI. This experiment depicts fMRI assessement in adults patients with acquired deafness (n=12) and in control subjects (n=15). The stimulus used was speach reading. Duration of deafness was carefully analyzed in order to assess the contribution of long-term versus short-term plasticity to the shift towards exclusive visual communication in deafened adults. So, we delineated brain regions that cross-modally reorganize after auditory deprivation. We did not observe an increase in neural activity in these regions between 4 and 48 months after deafness onset. Speech regions showed a progressive decerase in activity with the time elapsed since deafness. Their activity correlated positively but independantly with speechreading fluency scores. Multiple regression analysis done would indicate that auditorily deprived speech regions do not undergo progressive cross-modal reorganization, but rather express their underlying potential to respond to visual speech right at the onset of deafness. Cross-modal reoganisation relevant to speechreading could reflect the configuration of latent multimodal circuits that have been tuned by multisensory inputs preceding deafness.

Thu014. Bilateral reorganization of posterior temporal cortices in post-lingual deaf subjects

DL Lazard[1], HJL Lee[1], ET Truy[2], ALG Giraud[1]

[1]Ecole Normale Supérieure, PARIS, France

[2]Hospices Civils de Lyon, Hôpital Edouard Herriot, LYON, France

Introduction: Post-lingual deafness induces a decline in the ability to evoke phonological representations (Lazard et al, Neuroimage 2010). This decline is paralleled with abnormally high neural activity in the right posterior superior temporal gyrus/supramarginal gyrus (PSTG/SMG). As this neural plasticity negatively relates to cochlear implantation (CI) success, the neuro-functional mechanisms underlying this maladaptive phenomenon were explored.

Methods: Two memory tasks where subjects had to evoke phonological or environmental sound representations from visually presented items were compared using behavioral and fMRI data. Ten normal-hearing subjects and ten post-lingual deaf candidates for CI participated.

Results: Dissociations in the dynamics of right versus left PSTG/SMG neural responses as a function of duration of deafness were observed. Responses in the *left* PSTG/SMG to phonological processing and responses in the *right* PSTG/SMG to environmental sound imagery both declined. However, abnormally high neural activity was observed in response to phonological processing in the *right* PSTG/SMG, i.e., contralateral to the area where phonological activity decreased. In contrast, no such overactivation was observed in the *left* PSTG/SMG in response to environmental sound imagery.

Conclusion: This asymmetry in functional adaptation to deafness suggests that maladaptive reorganization of the *right* PSTG/SMG region is not due to balanced hemispheric interaction, but to a specific take-over of the *right* PSTG/SMG region by phonological processing, presumably because speech remains behaviorally more relevant to communication than the processing of environmental sounds. These results demonstrate that cognitive long-term alteration of auditory processing shapes functional cerebral reorganization.

Thu015. Improved detection of ASSRs with electrical stimuli in cochlear implant users

M Hofmann, J Wouters

ExpORL, Dept. Neurosciences, KU Leuven, LEUVEN, Belgium

For young children with a cochlear implant (CI), no conscious feedback about the perceived loudness of the stimulation is available, which severely complicates the fitting of CIs. Thresholds based on electrically evoked auditory steady state responses, stationary EEG potentials to periodic electrical stimuli presented through a CI, could provide a way to objectively determine the T levels of the implant. For 40pps pulse trains, thresholds correlate well with T levels at these rates (Hofmann and Wouters, 2010). For the fitting of T levels in young children, several challenges still need to be overcome. We report on the progress made towards that goal, by stimulating with modulated 900pps pulse trains and in monopolar stimulation mode.To improve the correlation between thresholds and T levels at 900pps, modulated 900pps pulse trains were used as stimuli (Hofmann and Wouters, 2012). To determine the presence of a neural response, a new statistical method was developed, and its ability to determine reliable thresholds even without any artifact removal was evaluated. The results showed that these stimuli result in improved thresholds. The proposed statistical method for response detection had comparable performance to previously used tests, and did not require stimulus artifact removal.In further research, a 64-channel EEG recording system was used to determine thresholds. Responses to monopolar stimulation could be reliably recorded, and thresholds for modulated 900pps pulse trains range were lower than for 40pps pulse trains.Together, these results represent important steps towards the objective fitting of CIs in young children.

Thu016. The listening brain

M Geal-Dor, R Jbarah, C Adelman, M Adler, S Rich, H Levi,
M Kaufmann-Yehezkely

Hadassah Medical Center, JERUSALEM, Israel

Cochlear implants activate the auditory pathways and allow sound to reach the brain. The optimal time for implantation is as early as possible, while maturation of the auditory pathways is maximally plastic. Cortical potentials are an objective measure of the development and plasticity of the auditory cortical pathways.We present a case study of an 11 year old girl with congenital bilateral profound hearing loss implanted on the right with CII Bionic Ear at the age of 2:09 who developed good speech and language. After device failure at age five she was re-implanted and resumed hearing as with her previous implant.However, at age 10, the electrode array was inadvertently pulled out of its position, causing failure of the implant. An attempt for third revision of the right ear implant failed due to severe ossification, and the decision was made to implant the left ear, although the outcome was uncertain as the left ear had been unaided and deprived of sound for seven years.Surprisingly, within a few months she achieved good speech perception even in noise. Cortical potentials were registered in response to 1kHz tone burst presented via free field and a clear P100 waveform was recorded, although at a later latency than in subjects with normal hearing or early implantation.This case may provide further evidence that unilateral CI at an early age activates bilateral auditory development in the brain and delays the end of the sensitive period for developing connections within the auditory cortex.

Thu017. Long term plastic changes in the auditory pathway related to cochlear implantation

A Del Canizo[1], **M Merchan**[2], J Rodrigo[3]

[2]University of Salamanca, SALAMANCA, Spain

[3]Med-El Spain and Portugal, SPAIN, Spain

ABR recording and method: Were carried out before and at 1, 7, 15 and 30 days after surgery using a close field real time signal processing system. To carry out the recordings, animals were anesthetized and placed in a stereotaxic frame with the aid of two hollow methacrylate bars. The stimuli was presented from a magnetic speaker through tubal earphones inserted into the external auditory chanel of a single ear via the methacrylate bar. Responses were averaged 1000 times. Evoked potentials were amplified and digitized with medusa RA16PA preamplifier and RA4LI headstage.

Results: Bilateral ablations of AC produces increases in the ABR threshold at 1 day post lesion (pl) that recovers at 7 days pl. However, unilateral AC ablations do not produce any change in the ABR threshold at any time pl.
After bilateral ablation of auditory cortex we found shortened wave I latency and shortened interpeaks I-II and II-III latencies at 15 days pl. that mainly recover at 30 days pl. Unilateral cortical ablations produce different ABR effects depending on the stimulated ear. In the ipsilateral side to the lesion we observe a decrease in ABR amplitudes and an increase in interpeak I-II latency at 1 day after injury. Theeses changes recover at 7 days, and nothing is observed at 15 or 30 days pl. No changes were found in the contralateral side of the unilateral ablated group.

Thursday 20 September 2012

Topic: Objective Evaluations (Long Latency, Cortical Potentials)

Thu018. Comparison of peripheral and central physiological responses in cochlear implant users

J Abbas[1], CP Etler[1], RA Sheperle[2], EK Jeon[1], CJ Brown[1]

[1]U of Iowa, IOWA CITY, IOWA, United States of America
[2]U of IIowa, IOWA CITY, IA, United States of America

Performance with a cochlear implant (CI) is characterized by large variance across implant users despite the fact that specific device characteristics are the same in individual users. This variance is likely due to peripheral factors that may affect current flow to target neurons, such as electrode placement, insertion trauma and neural degeneration. In addition however there are likely central auditory processing differences among individual users, as each has a different history of auditory deprivation. In this work we attempt to characterize peripheral responses in individual CI users with measurements of the electrically evoked compound action potential (ECAP) and to compare those results to cortical responses and perceptual measures in the same individuals. Peripheral measures include threshold, growth of response with level, channel interaction and temporal response (refractory recovery) properties. Cortical measures are derived from responses to stimulus onset and from responses to changes in stimulation parameters (level, electrode, spectral characteristics). In this talk we present data specifically comparing (1) ECAP growth with cortical responses to changes in current level and (2) ECAP channel interaction with cortical responses to changes in stimulation electrode. Both peripheral measures will be combined for comparison with cortical changes to stimuli presented through the CI processor that contain both amplitude and frequency changes. Finally, we will describe relationships of both physiological measures to perceptual measures such as intensity and electrode discrimination, discrimination of more complex stimuli, and speech perception in quiet and noise.

Thu019. Cortical evoked potentials: comparisons between NH listeners, HA and CI users

J Brown, EK Jeon, B. Kirby, R. Scheperle, C. Etler, P prof. Abbas

University of Iowa, IOWA CITY, IOWA, United States of America

In the early days of cochlear implantation many researchers focused on long evoked potentials as a way of getting around stimulus artifact contamination. However, as techniques for recording more peripherally generated responses like the electrically evoked auditory brainstem response and the electrically evoked compound action potential were introduced, the number of investigators studying middle and long latency evoked potentials declined dramatically. Today, there is a resurgence of interest in cortical evoked potentials. These responses have several advantages over more peripherally generated responses. For example, they can be readily evoked using long duration, spectrally complex acoustic stimuli presented in a sound field. They also reflect neural processing at a higher level in the auditory system and appear to have the potential to address clinically relevant questions such as 'What programming strategy is optimal for an individual CI user?' or 'Is this Hybrid CI user benefitting from the combination of acoustic and electrical stimulation in the same ear?'. This talk will focus on the cortical change response evoked using a range of different stimuli. The focus will be on comparing responses obtained from listeners with normal hearing with similar responses recorded from hearing aid users and cochlear implant recipients. Comparisons between unilateral and bilateral CI users will be presented as will comparisons of results obtained from CI users with and without residual acoustic hearing in the implanted ear. Finally, effects of training, development, and/or use of amplification with frequency compression technology will be described.

Thu020. Intracorporeal Cortical Telemetry (ICT): capturing EEG with a CI

AJ Beynon, BM Luijten, EAM Mylanus

University Medical Centre Nijmegen, NIJMEGEN, Netherlands

Background: We previously reported the feasibility to use the CI to capture/average Electrically-evoked Auditory Cortical Responses (EACRs) by extending NRT-recording windows up to 240 ms ('Intracorporeal Cortical Telemetry', Beynon et al, OM2010). ICT doesn't require any external EEG equipment. However, initial experiments revealed that window concatenation induced response drift and distorsion of the recorded potential, because it is composed of different neural event recordings. Besides, data communication of hardware required too much time, thus demanding long recording times.

Aims: Obtaining EACRs with preservation of response morphology using the CI for ICT without NRT window concatenation to increase recording quality and decrease recording times. Modified ICT responses are compared with original ICT based on window concatenation.

Materials and methods: Subcutaneous MP1 and MP2 of the Nucleus Freedom CI are used as reference electrodes to record EEG, while intracochlear electrodes act as a bipolar stimulator. By lowering NRT sample frequency (i.e. < 20kHz) and increasing the number of NRT buffers,artificial data as well as EEG data derived from subjects, are captured using ICT. Additionally, ICT responses are compared with simultaneously obtained (extracorporeal) EEG data.

Results and conclusions: Data show that it is feasible to increase the time domain using the internal CI amplifier. Location of subcutaneous recording electrodes, response morphology, clinical application (e.g. automatic processor fitting), and future implant design are addressed. The use of an implant as an EEG recording system might enhance the development of automatic objective fitting procedures based on cortical responses.

Thu021. Electrophysiological and behavioral manifestations of binaural processing in bilateral CI users

Y Henkin, YYS Yaar-Soffer, MH Hildesheimer

Tel Aviv University, RAMAT GAN, Israel

Cochlear implants (CI) are increasingly being implanted in both ears in order to provide benefits associated with binaural hearing. The use of bilateral CI, however, does not guarantee access to binaural cues that are critical for spatial hearing and speech understanding in noise. In the current study we explored binaural processing in children with bilateral CIs by means of a cortical binaural interaction component (BIC) and a behavioral spatial acuity task, both reflecting integration of information from each ear. Cortical potentials were obtained from children that were implanted bilaterally, simultaneously or sequentially while they performed a speech discrimination task (/ta/ vs. /ka/) in three listening conditions: monaural right, monaural left, and binaural. A binaural interaction waveform was derived by subtracting the binaural waveform from the sum of monaural waveforms. In addition, children performed a spatial acuity task where they were asked to locate a sound source to the right or left side of midline. The minimum audible angle (MAA), the smallest angle at which subjects can discriminate right versus left sound positions, was estimated. A Cortical BIC was evident in a small group of simultaneously implanted children. These children exhibited MAAs of 3-10° that were similar to those of 5 year-old normal hearing children. In contrast, the cortical BIC was absent in sequentially implanted children with long delay (>6.7 years) and MAAs were substantially larger (>40°), indicating poorer spatial acuity. While data collection is in progress, these preliminary findings suggest an association between electrophysiological and behavioral manifestations of binaural processing.

Thu022. Obligatory auditory evoked potentials in implanted children with ANSD

AC Ciprut, FA Akdas

Marmara Universiry Med School, ISTANBUL, Turkey

Introduction: Auditory neuropathy spectrum disorder is a hearing disorder characterized by poor speech discrimination disproportionate to the degree of hearing loss, abnormal or absent auditory brainstem response in the presence of normal otoacoustic emissions and cochlear microphonics, absent acoustic reflexes, absent efferent suppression of otoacoustic emissions, absent masking level difference.In this study we aim to explore the differences in obligatory auditory evoked potential measures in patients with auditory neuropathy spectrum disorder with either a conventional evoked potential system or an automated cortical potential system.

Study Design: 8 children who were diagnosed as having auditory neuropathy spectrum disorder were included in the study. The age range of all the subjects was 3 to 15 years. . P1N1 cortical auditory potentials were measured in these children with conventional evoked potential system or an automated cortical potential system. P1 latencies obtained with two measurement systems were compared.

Results: All children with ANSD who received a cochlear implant had P1 latency when tested with the speech precessor on position. No significant diffreneces were obtained in P1 latencies when the automated and conventional measurement systems were compared.

Conclusion: P1 latencies have been successfully recorded in children with ANSD who received cochlear implantation. The objective data obtained through cortical potentials also indicates that cochlear implantation can be an option to overcome auditory neuropathy spectrum disorder and to provide a potentially successful method of habilitation.

Thu023. Cortical activity in bilateral cochlear implant users

K Ciesla[1], R Aggarwal[2], J Matthews[3], K Green[2]

[1]KAJETANY/WARSAW, Poland

[2]Central Manchester University, NHS Foundation Trust, MANCHESTER, United Kingdom

[3]School of Cancer Enabling Sciences, MAHSC, University of Manchester, MANCHESTER, United Kingdom

Introduction: The study aimed to evaluate cortical responses in bilateral cochlear implant recipients (CI) and normal hearing individuals (NH) during auditory stimulation.

Methods: Six adult post-lingually deaf users of bilateral cis and 6 NH-volunteers had up to 12 [^{15}O]H_2O-PET scans, during which BKB Sentences, Reversed BKB Sentences or Silence were presented binaurally. Images were reconstructed using OSEM+PSF and analysed in SPM8. Additional analyses involved laterality of activations and Regions-Of-Interest. The implemented contrasts were: Sentences vs. Silence, Reversed Sentences vs. Silence, Sentences vs. Reversed Sentences. The experiment was approved by Ethics Committee and the UK ARSAC.

Results: Sentences vs. Silence/Reversed Sentences vs. Silence. Contrasts revealed large activations in bilateral temporal lobes in both groups, confirmed with ROI analysis. Activations in CI-subjects were more diffuse compared to NH individuals.Sentences vs. Reversed Sentences. In NH individuals activations were found in left temporal lobe, with CI-recipients recruiting bilateral temporal lobes. Left-hemisphere laterality did not reach statistical significance in either group.

Conclusions: Post-lingual users of bilateral cis process auditory speech similarly to NH-individuals, in bilateral temporal lobes but CI-patients recruit significantly larger areas. Left-hemisphere laterality is suggested for supra-phonological features of speech. [^{15}O]H_2OPET can be an objective evaluation tool of cortical responses pre- and post-CI.

Thursday 20 September 2012

Topic: Free Papers Binaural / Bilateral

Thu024. PET study of word recognition in binaurally implanted post-lingually deaf patients

PB Barone[1], KS Strelnikov[1], BF Fraysse[2], OD Deguine[2]

[1]CNRS UMR5549, TOULOUSE, France

[2]ORL-CHU Purpan, TOULOUSE, France

SourceURL:file://localhost/Volumes/Donnees/DATA/Meeting/Obj%20Measure%202012/Abstract-Bilateral-Obj%20Meas.doc

Introduction: Although it has been shown that speech comprehension through bilateral cochlear implants leads to better performances than after unilateral implantation both in quiet and in noise, the existence of neural underpinnings of this improvement remains to be studied. We hypothesized that bilateral stimulation through cochlear implants induces a brain activity pattern closer to the normal one than unilateral stimulation.

Methods: We performed an H_2O^{15} PET study of word recognition in patients with bilateral cochlear implants and normal hearing controls. Subjects had to distinguish words from non-words in binaural and monaural conditions.

Results: For monaural stimulation, patients demonstrated more activation contralaterally to the stimulation side in the posterior temporal cortex and in the cerebellum. They also exhibited a large network of hypo-activations in response to monaural stimulation, including frontal, pre-central and temporal regions.There was no over-activation in patients for binaural stimulation, with a hypo-activation in the right temporal cortex, which may be explained by the deficit in spectral processing.Thus, the brain activity differences 'bilateral CI vs. control' were large during monaural stimulation but almost disappeared when the same stimuli were presented binaurally.

Conclusion: The observed effect suggests that under binaural implantation, brain plasticity mechanisms lead to adaptive mechanisms close to the normal activation pattern.

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Thu025. Objectifying measures with young children who are fitted with bilateral cochlear implants

Y Litovsky

University of Wisconsin-Madison, MADISON, United States of America

Cochlear implants (CIs) are being provided at an increasing rate, in particular to young children. While many bilateral CI users attain spoken language skills that are well within the range of performance seen in normal-hearing (NH) peers, CI users generally perform significantly worse NH children on tasks that involve functioning in realistic, complex listening environments. This talk will focus on the need for utilizing standard objective measures as a way of accounting for the variability in performance and ideally improving fitting approaches for young children. Some of the factors to consider: CIs were not designed to provide binaural stimulation across the to ears, CIs in two ears may be surgically mis-matched by depth and therefore provide mis-matched information to the two ears, the two ears are likely to have mis-matched neural survival, the CI processors and microphones do not preserve spatial cues. Understanding limitations in today's clinical processors and developing best approaches for restoring binaural cues will be. This talk will focus on the way in which objective measures can ideally be implemented in order to provide better diagnostics, improved fittings and ideally better outcomes in this population.

Thu026. Binaural benefit and cortical effort in bilateral CI and bilateral bimodal CI simulations

KAB Buckley, CL Lobarinas, JP Pyo, LL Lewicki

University at Buffalo, BUFFALO, United States of America

Natural differences in auditory signals between ears are beneficial in perceiving the source of sound and understanding speech in noise. However, individuals with cochlear implants (CIs) experience artificial differences between ears whether listening with bilateral cochlear implants (BCIs) or bilateral-bimodal listening (one CI with a hearing aid on opposite ear (BimodCI)). These two options have been shown to afford comparable benefit in behavioral measures of speech perception and sound localization. However, behavioral measures may not be sensitive to subtle differences between these listening conditions, such as the level of cortical effort required to process the signals. We examined binaural benefit and cortical effort in normal hearing individuals listening to a mismatched BCI simulation (n=25), a BimodCI simulation (n=25), or natural speech (n=25). These groups were compared to four CI patients (2 BCIs; 2 BimodCIs). Behavioral measures of speech perception and an objective measure of cortical effort (P300 auditory evoked potential) were obtained in monaural and binaural conditions. Preliminary analysis with natural and CI simulation signals suggest that cortical effort required to process a CI simulation signal is greater than required to process natural speech. However, when comparing the reduction in cortical effort in the binaural compared to the best monaural condition, the mismatch BCI simulation shows greater binaural benefit than the natural signal. No difference in performance or effort is apparent between the BCI and BimodCI simulations. In CI participants, reduction in cortical effort in the binaural condition is evident even when no behavioral advantage in speech perception is present.

Thu027. Preserving binaural cues for bilateral cochlear implants

ZM Smith, CJ Long

Cochlear Ltd., CENTENNIAL, United States of America

Cochlear implantation of both ears has been shown to generally improve hearing outcomes over unilateral implantation in terms of both speech reception and sound localization. However, the degree of benefit associated with listening with two ears is not as large for cochlear implant recipients as that for normal hearing listeners. This difference is attributed to the limited transmission of accurate and consistent binaural cues to recipients of bilateral cochlear implants. In this talk, we present issues with current practices and devices and propose various changes to improve the delivery of binaural cues to the deaf brain. These improvements primarily consist of changes to the clinical fitting, input signal processing, and sound coding of bilateral devices, all with the goal of preserving interaural difference cues (ITD and ILD). We hypothesize that by making such changes, bilateral cochlear implant recipients will more accurately localize sounds in the horizontal plane and better understand speech in complex listening situations. Experimental results supporting this hypothesis will be presented.

Thu028. Use of NRT to balance bilateral sequential implants

FL Vickers, JB Bradley, MM Moore

Royal National Throat Nose and Ear Hospital, LONDON, United Kingdom

Aim: In the UK, there is variation in methodology in the mapping and balancing of the sequential implant with the first implant, particularly for young children who cannot reliably measure their C levels. The aim of the study is to look at NRT in Cochlear™ sequentially implanted children to determine if this should be used routinely to guide balancing of bilateral implants.

Materials and Methods: The presentation discusses cases of older children sequentially implanted with Nucleus 5, with a Freedom implant in their contra-lateral first ear. The study looks at the relationship of NRT with behaviourally measured C levels in the stable map, and how this relationship compares with that in the originally implanted ear.

Results and Conclusion: The outcome of the case studies will be discussed. The findings provide suggested guidelines on how we should set the range and C levels for young children implanted sequentially.

Thursday 20 September 2012

Topic: Free Paper Session Miscellaneous

Thu029. Impedance changes in paediatric cochlear implant re-implantations

CS Birman[1], E Elliott[1], WPR Gibson[2]

[1]University of Sydney, GLADESVILLE, NSW 2076, Australia

[2]SCIC, SYDNEY, Australia

Introduction: The aim of our study is to assess averaged impedance measurements over time in reimplanted paediatric cochlear implant cases and compared the initial cochlear implant impedance levels with the reimplant impedance levels. Impedance measurements are a method of measuring resistance at the electrode surface and this is affected by fibrosis around the electrode. Increased impedance measurements in explanted – reimplanted cases would represent increased fibrosis at the electrode level. Our aim is to assess if there is any increase in impedance measurements and if so, which cases are more likely to experience this.

Method: The data base at the Sydney Cochlear Implant Centre was searched for reimplanted paediatric cases. 97 cases were identified. Complete impedance measurements for the initial cochlear implant and reimplant were only found in 31 cases, due to changes in software and difficulty accessing the old data.

Results: Impedance did not significantly change in breakdown cases, but were increased in explant-reimplant cases due to infection.

Conclusion: Explant-reimplant cases do not cause marked changes in impedance levels, however cases of explantation- reimplantation due to infection are more likely to be associated with increased fibrosis.

Thu030. CI Suitability in ANSD: Imaging and objective testing in cochlear implant candidacy

JA Brew, K Gardner-Berry, H Sanli, WPR Gibson, C Birman

SCIC (Sydney Cochlear Implant Centre), SYDNEY, Australia

Sydney Cochlear Implant Centre (SCIC) actively manages over 2500 cochlear implants and has data on over 3,300 recipients. Almost 17% of paediatric patients have been diagnosed with auditory neuropathy spectrum disorder (ANSD). Of these cases we have found that approximately 26% have significant auditory nerve abnormalities and may also present with comorbidities impacting on these patients' outcomes with cochlear implants. We will look at how our clinic identifies auditory nerve abnormalities and significant comorbidities prior to a recommendation being given for or against cochlear implantation.For patients with ANSD, diagnostic electrophysiological tests such as acoustic ABR and ECochG are likely to provide absent or abnormal results which fail to provide information about the integrity of the auditory nerve and brain structures. High quality imaging, in particular MRI, can provide the information not provided by other sources.Imaging is used in conjunction with specialized objective tests such as CAEPs and trans-tympanic electrically-evoked ABR (TTEABR) to provide as much information as possible about the potential of the candidate's auditory system to benefit from a cochlear implant. Behavioural measures and other medical information also contribute to this decision-making process.We will present a range of imaging and electrophysiological results for ANSD patients and review how this information influenced the cochlear implant candidacy process.

Thu031. Cochlear implantation in children: Do the right choice

MM Mazzuca

Neuroscience Research Center DYCOG Team, Lyon, LYON, France

We present the analysis of a large data set collected on cochlear implanted patients at the Audiology Service of the Edouard Herriot Hospital in Lyon, France. The analysis on a reduced fraction of this data set has already been published elsewhere (Thai-Van et al., 2007). This retrospective analysis includes 232 patients (112 females and 120 males) all implanted with Cochlear devices, some of them implanted bilaterally. Electrically evoked compound action potentials measures were collected from one month after the surgery until 14 years and a total of over 13,000 independent measures have been analysed. Applying a back-fitting procedure to a mixed-effects linear model, (Newman et al., 2011), we could find evidence for the following effects: (1) a difference in the response of electrodes #5 and #20, related to the anatomical position in the cochlear modiolus; (2) a latency difference between males and females, that correlates with anthropometric data; (3) a fast maturational rate followed by a standing plateau and a later increase of the latencies along the duration of cochlear implant use; (4) a lack of later increase in the latency time with cochlear implant duration use when the interval III-V is considered; and (5) a difference in the behavior of right versus left implanted ears that interacts with the age at implantation. This later effect, confirmed in a subset of the data, where patients were selected to form matched groups in age and ear side, will be discussed in the light of maturational aspect of the language function.

Thu032. Cochlear implant mapping through Electrical Cochlear Response (ECR)

JMCC Cornejo, GTP Pilar, CVN Norma

Universidad Autonoma Metropolitana, MÉXICO, D.F., Mexico

Introduction: Cochlear Implant mapping may be a time consuming and a difficult task without proper patient feedback. Although objective measures like Electrical Compound Action Potential (ECAP) and Electrically Evoked Stapedial Reflex (ESR) allow an estimation of the T and C level respectively, these should be confirm by using some behavioral test. We've developed an objective methodology that using sound stimulus presented to implanted patient allows an electrode by Electrode T level adjustment for a desired threshold sound intensity. Through EEG scalp electrodes the residual auditory tissue electric response -we've called Electric Cochlear Response (ECR)-in the neighborhood of an intracochlear electrode is registered every time sound presented to implanted patient is processed by cochlear implant sound processor. ECR will be obtained whenever intracochlear electrode central frequency is equal to the external sound stimulus frequency and the corresponding stimulating electric current value is suitable to stimulating the residual auditory tissue in the intracochlear electrode neighborhood.

Objective: Comparison of Behavioral vs. ECR mapping through audiometry.

Study Design: Fifteen children, 8 to 15 y. o., behavioral fitted previously. ECR test and sound field audiometry performed inside an anechoic room in sound field condition. Modified audiometer was used to match intracochlear electrodes central frequency. A high sampling rate and suitable EEG filtering was used to reduce cochlear implant artifact.

Results: ECR audiometry estimation follows sound field audiometry profile. Audiometric thresholds differences are not greater than 10 dB.

Conclusion: Based on ECR detection and measure, results indicated the possibility of an implanted patient objective audiometry.

Thu033. Neural adaptation effects for high rates

M Hey[1], G Brademann[1], H Hessel[2], J Müller-Deile[1]

[1]ENT Department, University of Kiel, KIEL, Germany

[2]Cochlear Germany, HANNOVER, Germany

Introduction: It is known that neural adaptation and fatigue effects are important factors for the behavior of the auditory nerve due to multi-pulse electrical stimulation. For high stimulation rates also summation effects may have an influence on response properties.The objective of this study was to investigate intensity dependency of neural adaptation properties applying high stimulation rates.

Methods: A pulse train stimulation paradigm was used, consisting of multi maskers on the same electrode with equal amplitude separated by 43 μs inter-pulse intervals (10 kpps). Stimulation level was varied from +30CU down to -20CU relative to the thresholds of the amplitude-growth-functions (T-NRT). 12 CI patients using the CI24RE or CI512 implants were examined with CustomSound EP applying custom made protocols.

Results: The investigation of supra-threshold stimulation showed decreasing amplitudes of the ECAP for increasing numbers of high-rate maskers up to 1500 μs bursts and a regain in amplitude for longer pulse bursts. In contrast with stimulation levels at and below T-NRT the ECAP amplitude in general is growing with burst duration and superimposed with fluctuations. This has impact on the amplitude growth function: the steepness varies, the extrapolated threshold is lowered depending on the number of maskers and the dynamic range show a temporary compression due to supra-threshold stimulation.

Conclusion: For high rate stimulation there is interference of neural adaptation and summation, what becomes most obvious for low level stimulation. The neural response properties apparent in the rate adaptation observed for high stimulation rates show less deterministic and more stochastic firing patterns.

Thursday 20 September 2012

Topic: Imaging

Thu034. Preoperative imaging for patient-tailored surgical planning

BM Verbist[1], JJ Briaire[2], KS Van der Marel[2], L Ferrarini[3], JHM Frijns[2]

[1]Leiden University Medical Centre and Radboud University Nijmegen Medical Centre, LEIDEN, Nederland

[2]Leiden University Medical Centre, Dpt of Otolaryngology, LEIDEN, Nederland

[3]IFOM and Leiden University Medical Centre,Dept of Image processing, MILAN and LEIDEN, Italy

Preoperative imaging in cochlear implant candidates is mainly focused on assessment of pathological conditions of the temporal bone (in particular of the otic capsule and inner ear) and central auditory pathway to evaluate feasibility of implantation and to predict any risk for surgical complications. For truly patient-tailored surgical planning however, additional information on cochlear size and shape is required. Our group investigates non-invasive visualization, analysis and exploration of the inner ear. By means of virtual cochleoscopy and application of image processing techniques detailed information of 3-dimensional cochlear dimensions can be established on both micro computer tomography and multislice computer tomography images as used in clinical patient care. These non-parametric measurements of cochlear length and scalar dimensions may guide the choice of CI devices and surgical technique. Such image exploration also reveals that the spiraling path of the cochlea does not show a constant slope. This favors the idea that the intrinsic 3-dimensional cochlear morphology contributes to the risk for insertion trauma during cochlear implantation at specific locations. Evaluation of preoperative CT-scans of 323 CI-patients (646 ears) has shown that cochlear measurements can also be easily achieved in daily (clinical) practice. These preoperative measurements, combined with postoperative predictors served the development of an insertion model for prediction of angular insertion depth.

Thu035. Intraoperative CT scanning and image guided navigation to support cochlear implant surgery

K Stelter[1], G Ledderose[1], W Flatz[2], JM Hempel[1], E Krause[1], **J Mueller**[1]

[1]Department of Otorhinolaryngology, Head and Neck Surgery, Ludwig-Maximilians-University, MÜNCHEN, Germany

[2]Institute for Clinical Radiology, Grosshadern Medical Centre, Ludwig-Maximilians-University, MÜNCHEN, Germany

Introduction: For successful cochlear implantation in difficult ears, image guided navigation systems can help to identify surgical landmarks to confirm the surgeon's anatomical knowledge. In a pilot study, exact navigation based on intraoperative CT scanning was investigated for its use to confirm necessary landmarks for cochlear implantation, such as the facial nerve, basal turn of the cochlea, round window and intracochlear structures, and at least adequate placement of a straight electrode array (MED-El standard electrode).

Material and Methods: Intraoperative imaging was performed on a 40-slice sliding-gantry CT scanner (Siemens SOMATOM Sensation 40 Open) with an expanded gantry bore (82 cm). Raw image data were reconstructed with a slice thickness and increment of 0.6mm and were imported to a frameless infrared-based navigation station (BrainLAB VectorVision Sky). In a preoperative accuracy and feasibility study, a phantom skull was scanned and registered five times by the navigation system. Based on the encouraging results, the system was then applied to a male patient with post-traumatic sensorineural hearing loss. The intraoperative target positioning error was measured by a "blinded" colleague who defined the distance of the pointer from different sections of the facial nerve without seeing the intraoperative field. Results: The average deviation in the phantom skull was 0.91mm (SD 0.27mm) on the mastoid, 1.01mm (SD 0.21mm) on the round window, and 0.9mm (SD 0.18mm) on the inner ear canal. Surgery could be performed without major complications. The distance of the pointer from the facial nerve could be defined exactly using navigation in ten measurements. The cochleostomy and electrode insertion were performed with the aid of navigation. After insertion, direct intraoperative control of the electrode position was achieved by means of a low-dose CT scan. Two months postoperatively, the patient had a satisfactory open-set speech understanding of 85%.

Conclusion: With the use of intraoperative acquisition of CT images (or digital volume tomography devices) and automatic volumetric registration for navigation, surgical precision can be improved. It is usefull to assist in cochlear implant surgery in abnormal situations, i.e. in patients with complex malformations or patients who have undergone multiple previous ear surgeries and subsequently have a lack of anatomical landmarks. Our study shows that this high-technology combination is superior to other registration methods in terms of accuracy and precision. Further investigations should aim at developing automatic segmentation and applications for minimally invasive surgery of the lateral skull base.

Thu036. 'Imaging' electrode placement by analysis of the intracochlear electrical potentials

F Vanpoucke[1], PB Boermans[2], JHM Frijns[2]

[1]Cochlear Technology Center, MECHELEN, Belgium

[2]Leiden University Medical Center, LEIDEN, Nederland

Introduction: Correct placement of the electrode array into the scala tympani is crucial as it determines the access to the auditory nerve and ultimately influences hearing performance. The golden standard to monitor electrode insertion quality is CT imaging. However, also electrical field analysis can be used as a convenient and valuable verification tool.

Methods: Modern implants can measure the spread of the electrical fields at all contact sites; an objective measures technique known as electrical field imaging (EFI) or electrical voltage tomography (EVT). Here the resulting transimpedance matrix is further processed to derive an electrode image. First it is converted into an electrical dissimilarity matrix and then analyzed using multidimensional scaling (MDS). The result is a map of the electrode contacts in 2D where distance encodes for electrical difference.

Results: The normative map for a standard electrode insertion is an arc with electrode distances on the order of 200 O. Major issues affecting the electrical current flow, such as a tip foldover or partial ossification are readily detectable. At this point it is not known yet whether the method is sensitive and specific enough to detect lead buckling, migration into scala vestibuli or partial insertion.

Conclusion: Measurement and analysis of the intracochlear potentials may be an interesting tool for intra-operative insertion monitoring complementing traditional imaging modalities.

Thu037. Cone-beam versus multi-slice CT for postoperative imaging after cochlear implantation

HJ Theunisse[1], RMS Joemai[2], TJJ Maal[1], J Geleijns[2], EAM Mylanus[1], BM Verbist[2]

[1]Radboud University Nijmegen Medical Centre, NIJMEGEN, Nederland

[2]Leiden University Medical Center, LEIDEN, Nederland

Introduction: Cone-beam CT (CBCT) has lately been advocated as a low-dose alternative to multi-slice CT (MSCT) for postoperative imaging after cochlear implantation (CI). Our goal was to evaluate the reported advantages in comparison to both standard-of-care and low-dose MSCT.

Methods: Five formalin-fixed human temporal bones, implanted with a CI electrode, were scanned on 2 CBCT (Imaging Sciences i-CAT, 3M IMTEC ILUMA) and 2 MSCT systems (Toshiba Aquilion 64, Siemens Sensation 64). Four independent observers rated image quality on various 5-point scales. CBCT scans were compared to standard-of-care and equivalent-dose MSCT scans. Declining-dose MSCT protocols were compared to the standard-of-care protocol. A CT dose head phantom was used to calculate the effective dose for each acquisition protocol and resolution was determined using a PSF (point spread function) phantom

Results: Visibility of cochlear inner and outer walls and overall image quality were positively correlated with radiation dose, leading to better results with standard-of-care MSCT than with CBCT protocols. In the equivalent-dose comparison, no clear difference between CBCT and MSCT systems was found. For the identification of individual electrodes, determining scalar localization and artifacts, a difference between systems was found, but a distinction between CBCT and MSCT systems could not be made.

Conclusion: While some variables benefitted from higher radiation doses and several differences between systems were found, these differences were not attributable to the CBCT or MSCT technology. Both low-dose MSCT and CBCT are suitable for postoperative CI-imaging and depending on the subject of interest, an appropriate system should be selected.

Thu038. Electrode migration in patients with a cochlear implant

KS van der Marel, BM Verbist, JJ Briaire, R Wolterbeek, JHM Frijns

LUMC, LEIDEN, Nederland

Introduction: The position of the electrode array affects the performance of patients with a cochlear implant (CI). How stabile the position of the electrode array is after insertion, has never been studied before. This study investigates the occurrence of electrode migration in CI-patients.

Methods: Electrode position was evaluated in the 35 CI-patients from our clinic of whom two postoperative CT-scans were available. The study population consisted of 16 patients with a CII HiFocus1 and 19 patients with a HiRes90K HiFocus1J implant. The CT-scans were evaluated using an in-house developed MatLab-based script for measurement of angular insertion depth. In 5 patients a second CT-scan was obtained to evaluate complaints. Displacements of more than 1 mm were considered a migration. Possible correlations with implant type and insertion depth were investigated.

Results: Migrations were detected in 10 patients (29%). There was a significant effect of the implant type in favour of the HiFocus1, but no relation with the insertion depth was found. In the 5 patients who were scanned a second time because of complaints, two migrations were detected (both over 4mm).

Conclusion: In our patient population electrode migration was not uncommon and occurred in patients with and without complaints.

Thursday 20 September 2012

Topic: Fundamental

Thu039. Polarity sensitivity of the electrically stimulated human auditory nerve measured at central levels

A Undurraga[1], RP Carlyon[2], J Wouters[1], A Van Wieringen[1]

[1]KU Leuven, LEUVEN, Belgium

[2]MRC Cognition and Brain Sciences Unit, CAMBRIDGE, United Kingdom

Introduction: Recent studies have shown that Electrically evoked Compound Action Potentials (ECAPs) are mainly elicited by the positive (anodic) phase of the masker and the probe. However, ECAP responses may reflect action potentials travelling towards the periphery instead of the central auditory system (orthodromic). Here, we studied whether the anodic polarity causes potentials travelling orthodromically, and whether polarity sensitivity changes at different intensities.

Methods: Electrically evoked Auditory Brainstem Responses (EABR) were recorded for symmetric (SYM), pseudomonophasic (PS), reversed pseudomonophasic (RPS) and reversed pseudomonophasic with an inter-phase gap (6 ms) (RPS-IPG) pulses presented for both polarities. Additionally, polarity sensitivity at different intensities was studied by means of a loudness-balancing task between pseudomonophasic-anodic (PSA) and cathodic (PSC) stimuli.

Results: EABR to SYM pulses have similar amplitudes for both polarities. Responses to PS and RPS show higher amplitudes and shorter latencies when the high-amplitude is anodic than when it is cathodic. Latency differences between PS and RPS responses agree with the timing of the high-amplitude phase. Responses to RPS-IPG (second phase) pulses are similar to those obtained with PS and RPS. The loudness balancing task shows that PSC stimuli require higher intensities than PSA stimuli to reach the same loudness for current levels ranging from 10 to 100 % of dynamic range.

Conclusion: Anodic stimulation is more effective than the cathodic one. EABRs demonstrate that this is the result of auditory-nerve action potentials travelling orthodromically.

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Thu040. Centrally mediated masking release in electric hearing

SZ Zirn[1], JM Hempel[1], MS Schuster[1], WH Hemmert[2]

[1]ENT clinics, LMU Munich, MUNICH, Germany

[2]IMETUM, Technical University, MUNICH, Germany

The normal hearing (NH) auditory system has elaborated strategies to segregate different sounds with overlapping spectra occurring at the same time – a usually unsolvable task for cochlear implant (CI)-users. An important neural mechanism in this context is across-frequency processing: the comparison of temporal outputs across auditory filters. Many natural sounds including speech provide temporal structures with highly correlated temporal envelope fluctuations in different frequency bands, e.g. plosives. Common amplitude fluctuation across-frequency facilitates comodulation masking release (CMR) and may also contribute to auditory grouping. Our study, for the first time, measures CMR in unilateral cochlear implant (CI)-users via direct stimulation of inner ear electrodes with the nucleus implant communicator. 20 CI-users and 6 NH participated in the study. The measured mean CMR was strongly reduced in CI users (3.1 dB, $p<0.05$) compared to NH (12.0 dB, $p<0.01$). We measured neural spreads of excitation with electrically evoked compound action potentials to evaluate the influence of the individual excitation distribution of neural fibers on CMR. However, no significant relationship could be found. In contrast, CMR was strongly etiology-dependent: CI users with e.g. acute hearing loss or other sensorineural hearing impairment achieved much higher amounts of CMR (8.7 dB) than CI users with e.g. long-term progressive hearing loss or late-implanted congenital hearing loss (0.7 dB). We conclude that the ability for centrally mediated masking release depends on hearing loss history in electric hearing.

Thu041. Polyphonic pitch perception in CI. How to minimize the error with direct electrical stimulation

RT Penninger[1], EK Kludt[2], AB Büchner[2], KV Vermeire[3], ID Dhooge[3], ML Leman[1]

[1]University Gent, GENT, Belgium
[2]Medical University Hannover (MHH), HANNOVER, Germany
[3]University Hospital Gent, GENT, Belgium

In music, multiple tones often occur simultaneously, an essential feature of harmony. In the present study the authors assessed the ability of CI users to perceive polyphonic tones based on direct electrical stimulation on a single and on multiple electrodes.Six CI subjects were asked to identify monophonic and polyphonic tones on one, two and three different electrodes using sinusoidal amplitude modulation (SAM). The modulation rates ranged from 262 to 523 Hz. The carrier stimulation rate was 5 kHz. Using a method of constant stimuli, ability to identify monophonic and polyphonic tones was measured on three different electrode conditions for one pitch, two pitches and three pitches. For the one-pitch condition the tones were applied to a basal, a middle and an apical electrode. For the two pitch condition the tones were applied to basal and apical, basal and middle or middle and apical electrodes. For the three pitch condition the tones were applied to a basal, a middle and an apical electrode. This approach allows quantifying if it is possible for CI users to identify one- two- and three-pitch stimuli.Results demonstrate little variability across subjects. Although not all electrodes provide equal temporal resolution, most subjects seem to be generally able to identify the one, two and three pitch condition above chance. No effect of perceptual fusion was observed.If a sound processing strategy were to use polyphonic stimulation on multiple or single electrodes, then possibly polyphonic tones will be better perceived by implant users yielding better music perception.

Thu042. 8th nerve correlates of intensity dl and MDT functions of stimulus pulse-rate rate and amplitude

MW White[1], LH Heffer[2], JF Fallon[2], DJS Sly[2], RS Shepherd[3], SJO O'Leary[2]

[1]CARY, United States of America

[2]University of Melbourne, MELBOURNE, Australia

[3]Bionics Institute, MELBOURNE, Australia

We present an analysis of 8th nerve data that may improve our understanding of the neural basis of patient intensity difference limens (Idl's) and Modulation Detection Thresholds (MDT's). Speech reception in noise appears to be correlated with MDT's *if* the *modulation* frequency is low: Preferentially stimulating those electrodes that exhibit better MDT's has improved patient speech reception in noise (Pfingst, et. al. 2011). Furthermore, Galvin and Fu (2009) found that Idl's behave in a manner similar to MDT's.ANF responses to electrical stimulation were recorded in acutely and chronically deafened guinea pigs. Electrical pulse trains of 100 ms duration were delivered via an acutely implanted scala tympani electrode using a monopolar electrode configuration. Stimuli were presented at rates of 200, 1000, 2000 and 5000 pulses/s. From this data, we estimated each neuron's 'static,' stochastic Input-Output (IO) function.For a majority of fibers, the variance (i.e., noise) in a fiber's discharge-rate across stimulus bursts increased significantly as pulse-rate was increased. (A neural accommodation mechanism can account for such increases in variance). In general, the slope of the IO function decreased with increased pulse rate. This is consistent with behavioral measures of Idl and MDT, where performance often significantly decreases with increases in carrier pulse-rates above 200 pps. Furthermore, for-the-most-part, the variance in fiber discharge-rate decreased, and IO slope increased, as the stimulus level was increased – which is consistent with the observed performance improvements in Idl's and MDT's as loudness is increased.

Thu043. A dual-task paradigm as an objective measure of listening effort with cochlear implant simulations

C Pals[1], M Van Dijk[2], A Sarampalis[3], D Baskent[1]

[1]University Medical Center Groningen, GRONINGEN, Netherlands
[2]Research School of Behavioral and Cognitive Neurosciences, University of Groningen, GRONINGEN, Netherlands
[3]Department of Experimental Psychology, University of Groningen, GRONINGEN, Netherlands

Introduction: Cochlear implant (CI) fit is most commonly assessed using speech intelligibility measures and subjective self-report. However, these measures are not designed to reflect listening effort. A previous study [1] has shown that a dual-task paradigm can capture improvements in listening effort that are not reflected in speech intelligibility and subjective measures. The current study examines how combining CI with hearing aids (HA), or electric-acoustic stimulation (EAS) affects listening effort using this dual-task paradigm.

Methods: Normal-hearing participants listened to processed speech recordings simulating CI, HA, EAS, and bimodal hearing, and repeated back what was heard. Speech stimuli were presented in noise, with intelligibility fixed at speech-reception-threshold for 50% sentence recognition (SRT50). Listening effort was measured using a visual response-time (RT) task presented simultaneously with the listening task, and a subjective self-report scale.

Result: The results showed no significant difference in RTs between CI, bimodal, and EAS conditions presented at SRT50. RTs for HA only with cut-off frequency 300Hz were significantly longer, however, intelligibility was also lower for this condition.

Conclusion: Contrary to our expectations, no significant differences in listening effort were found between different configurations of CI, HA, and EAS at SRT50. An explanation could be that at this point in the psychometric curve a slight improvement in listening effort also results in improved intelligibility. A next step is to look for effects at higher fixed intelligibility levels.

Reference

[1] Pals, C., Sarampalis, A., Baskent, D., Listening Effort with Cochlear Implant Simulations, Submitted

Friday 21 September 2012

Topic: Speech Processing

Fri01. Improved coding strategies based on electrophysiological measurements and models

N Dillier[1], WK Lai[2]

[1]ZURICH, Switzerland

[2]Laboratory of Experimental Audiology, ENT Department, University Hospital Zuric, ZURICH, Switzerland

Background: Traditionally, coding strategies for cochlear implants were based on signal properties and concepts developed for communications systems. Implant-specific constraints such as current spread and limited electrical dynamic range were addressed by various methods. However, the detailed capacity of electrically stimulated neurons to convey spatio-temporal information on an individual basis has rarely been considered in practical applications. One way of tackling this problem is to combine a signal processing strategy with a model of auditory nerve fiber population responses to electrical stimulation via an implantable auditory prosthesis.

Methods: Rate dependent neural adaptation properties observed for stimulation rates up to several hundred pulses per second as well as the amplitude variations within pulse train stimulation of rates up to several thousand pulses per second point to the importance of improved neural excitation models in order to optimize coding strategies optimized for the complex neural firing patterns of an individual implant recipient.
A simulation model for auditory nerve responses to constant or time-varying electrical pulse train stimulation was implemented in Matlab and used to reproduce animal (literature) and human (own measurements) data and to propose new test protocols with human subjects. The model includes refractory and stochastic membrane properties of neuronal excitation and allows varying the electric field distribution along the basilar membrane.

Results and conclusions: Two variations of an excitability controlled processing model were integrated into a coding strategy and evaluated in pilot experiments with 10 subjects. Critical aspects turned out to be the loudness perception for complex time-varying sounds. Psychophysical tests using masking paradigms with various stimulation rates were inconclusive so far. Objective measures for amplitude growth, recovery functions, spread of excitation and pulse train responses may help to further optimize the processing algorithms on a patient-by-patient basis.

Contact address
E-Mail: norbert.dillier@usz.ch
Web: www.orl.uzh.ch

Fri02. Age-related effects with stimulation pulse rate on speech understanding and CAEPs in CI listeners

M Friesen[1], T Fujioka[2], S Joglekar[3]

[1]TORONTO, Canada

[2]Rotman Research Institute, TORONTO, Canada

[3]Sunnybrook Health Sciences Centre, TORONTO, Canada

Introduction: In normal hearing elderly listeners, temporal cue processing is one of the variables often attributed to decreases in performance. We hypothesized that temporal cue processing of stimulation pulse rate may contribute to decreased performance in individuals with cochlear implants (CIs) and reflect age-related changes in neural synchrony. Cortical auditory evoked potentials (CAEPs) can be used to measure age-related changes in neural activity due to stimulus processing in the auditory cortex. In particular, the N1-P2 complex (wave onset responses at 50-200ms after stimulus onset) is known to be sensitive to age-related changes in acoustic feature processing such as the temporal properties of the stimulus.

Methods: To date, we have tested 7 elderly CI listeners (65-80 years) who have been performing as well as could be expected given their history, and who have been happy with their performance since implantation. We manipulated the pulse rate from 500 to 3000 pulses per second per electrode to record CAEPs. Also, we measured speech understanding performance which followed CAEP recording.

Results: Generally for CAEPs, lower rates resulted in increased amplitudes and decreased latencies compared to higher stimulus pulse rates. This indicates that the lower rates encourage stimulus processing at the cortical level. Also, speech understanding generally improved with the lower rate conditions.

Conclusions: Our results suggest that higher-order perceptual processing for speech sounds may be affected by age-related neurophysiological changes which also play an important role in processing with stimulation pulse rate in CI listening.

Fri03. Conveying low frequency information through electrical stimulation

WN Nogueira[1], AS Saoji[2], LL Litvak[2], VH Hamacher[3], AB Buechner[4], TH Lenarz[4]

[1]Pompeu Fabra University, BARCELONA, Spain
[2]Advanced Bionics LLC, VALENCIA, United States of America
[3]Advanced Bionics GmbH, HANNOVER, Germany
[4]Medical University of Hannover, HANNOVER, Germany

Research in the field of combined electric and acoustic hearing (EAS) has shown that low frequency information even below 300 Hz perceived through the residual hearing can improve speech intelligibility and sound perception. Based on this finding we investigated whether the coding of low frequencies can be improved through electrical stimulation only, so that patients without sufficient residual hearing can benefit too.This work presents new signal processing strategies to convey low frequency information through a cochlear implant. A first approach tried to convey low frequency information using analog stimulation. The second approach uses an additional 'Phantom' channel (partial bipolar stimulation) which presents signal components below 300 Hz. In both approaches the transmitted frequency spectrum is expanded by about 2 octaves with respect to the clinical strategies. Psychophysical experiments, speech understanding, speech quality and music perception has been evaluated in a clinical study with Advanced Bionics cochlear implant users comparing their clinical strategy against the new low frequency strategies.In a preliminar evaluation we could not proof any benefit for analog stimulation with respect to monopolar biphasic stimulation. For this reason we focused on the Phantom stimulation strategy, which showed significant improvements in music perception while at least keeping the same speech performance as the clinical strategy. A music questionnaire revealed that the Phantom strategy produces a significant more balanced sound between high and low frequencies than the commercial strategy.

Fri04. Plasticity and perception in the human brain - investigating speech with functional imaging

S Scott

United Kingdom

Functional imaging techniques such as PET and fMRI allow us to investigate the cortical and subcortical networks recruited during the perception of sound and speech. In my talk I will review some recent studies from my lab, identifying a role for an anterior “what’ stream of processing in the perception of speech. I will show how these networks are influenced by linguistic context, and different masking sounds, and will discuss the neural systems recruited when listeners adapt to a cochlear implant simulation. I will address the ways that individual differences in this adaptation are associated with differences in higher-order cortical fields.

Fri05. Spread of excitation in single and dual electrode cochlear implant stimulation

J Snel-Bongers, **JHM Frijns**, JJ Briaire

LUMC, LEIDEN, Netherlands

Introduction: Defective contacts can seriously limit the applicability of simultaneous Dual Electrode Stimulation (DES). DES on non-adjacent contacts (spanning the defective ones) can offer a solution. In this study DES on adjacent and non-adjacent contacts was compared with Single Electrode Stimulation (SES) with respect to the site of stimulation in the cochlea (X) and the spread of excitation (SOE).

Methods: The eCAP-based SOE method with fixed probe and variable masker was used to determine the location of the neurons responding to SES or DES on adjacent or non-adjacent contacts with up till 4.4mm between contacts. Selectivity was determined as the width at 75% of the peak amplitude. The X was determined by the position of the peak of the graph. 10-12 Randomly selected users of the HiRes90K cochlear implant with HiFocus1J electrode participated in each experiment.

Results: DES was not different from SES in terms of spatial selectivity. The X of DES on adjacent contacts was 0.54 electrode contacts more basal compared with SES stimulation, and not different from the predicted shift of 0.5. Similar results were found with spanning up to 3.3mm between contacts. With wider spanning, however, the X showed a tendency to shift apically, which may be explained by the position of the recording contact. Psychophysically, the pitch followed the expected linear relationship with the current steering coefficient.

Conclusion: SES and DES are equivalent with regard to the spatial selectivity. The excitation site for DES on adjacent contacts and with spanning largely shifts in line with expectations.

Fri06. Event-related potential evidence for the perception of emotional prosody through cochlear implants

AB Buechner, DA Agrawal, LT Timm, LG Gärtner, TL Lenarz

Medizinische Hochschule Hannover, HANNOVER, Germany

In spoken language, emotionally salient information can be provided by variations in speech melody (prosody). However, in cochlear implant subjects, the perception of speech melody is usually hampered. On the other hand, it is known that the speech coding strategies used in these devices have a significant impact on sound perception. So far, these speech coding strategies were mainly evaluated with a clear focus on speech understanding by means of speech perception tests, i.e. word or sentence tests, or by subjective user preference.In this study, two speech coding strategies from Cochlear, ACE and MP3000, were compared using event-related potentials with the goal to quantify the subjects' ability to differentiate between the three emotional utterances: neutral, angry and happy. Ten experienced cochlear implant subjects were asked to recognize the emotional prosody using both the ACE and the MP3000 strategy while continuously recording the EEG. Those EEG recordings were acquired using a 32-channel BrainAmp EEG system and analysed offline using the open source EEGLAB software that runs within a MATLAB environment.The event-related potentials indicate that the MP3000 strategy has an advantage over the ACE strategy for the happy utterances, while the detection rate between the angry and neutral prosody was similar for both strategies. Detailed results will be presented at the conference.

Friday 21 September 2012

Topic: Free Paper Session Middle Ear Implants

Fri07. The capacity of new auditory implants for sensorineural and conductive hearing loss

AFM Snik[1], EAM Mylanus[1], J Noten[1], CS Stieger[2]

[1]UMC St. Radboud, NIJMEGEN, Netherlands

[2]ARTORG Center, Inselspital, BERN, Switzerland

The first step in the evaluation of a new hearing implant is to study its basic technical properties like gain, maximum output and input-output behavior. For acoustic devices, ear simulators are available, and for the Baha, the skull simulator. As for middle ear implants (MEI), simulators are not available, we developed a special protocol. In vivo, the performance of MEIs was studied by measuring sound levels in the (occluded) ear canal; the vibrating transducer causes the tympanic membrane to vibrate. The resulting acoustic signal can be recorded in the ear canal. This enables the study of input-output function and harmonic distortion, not absolute gain (Snik et al., 2003).With this set-up, the input level at which the MEI saturated was obtained. The maximum output was calculated by just adding the behaviorally obtained linear functional gain. Such evaluations enabled comparison of maximum output (MPO) of the Vibrant Soundbridge, the Otologics MET and the DACS. As these MEIs are also used in mixed hearing loss, we compared the MPO of MEIs with that of the most powerful Baha Cordelle. Psychophysical measurements and speech recognition data were obtained in 5 patients, for validation purposes.The study showed that, indeed, the limiting factor is the MPO and the related input dynamic range. In MEI, MPO depends on coupling effectiveness. Above approx. 60 dB sensorineural hearing loss component, MEIs have a higher potential than the Baha if the MEI is effectively coupled to the cochlea.

Fri08. Preliminary results on ASSR measurements in Codacs patients

N Verhaert[1], M Hofmann[2], C Desloovere[3], J Wouters[2]

[1]UZ Leuven / KU Leuven, LEUVEN, Belgium

[2]Research group of Exp ORL, Dept of Neurosciences, KU Leuven, LEUVEN, Belgium

[3]ENT, H&N Surgery, UZ Leuven, LEUVEN, Belgium

Introduction: Cochlear's Direct Acoustic Cochlear Implant (DACI) Codacs® Investigational Device provides a direct stimulation of cochlear fluid through a stapes piston coupled to an actuator. This could be indicated in patients with severe to profound mixed hearing loss. Little is known on objective intra-operative assessment of an accurate coupling to the inner ear. A phase Ib clinical study is ongoing in our center.

Methods: Intraoperative testing with auditory steady state responses (ASSRs) to determine the coupling to the inner ear. Two patients with advanced otosclerosis were investigated. Electric ASSR were measured with a single channel EEG set-up using SOMA [1] interface after complete implantation. Preoperative calibration and analysis was performed on the bench.

Results: Collected data show that stimulus-related artifacts complicate the interpretation of responses. Artifacts seem to be mainly due to the radiofrequency link of Codacs device. Amplitude-modulated ASSR on different frequencies have been successfully recorded during operation.

Conclusion: Preliminary results show that electric ASSR measurements, demonstrating coupling to the inner ear, are feasible intra-operatively.

References

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Fri09. Effect of round window stimulation on intracochlear pressure for superior canal dehiscence

MEF Niesten[1], DJL Lee[2], CS Stieger[2], SM Merchant[2], WG. Grolman[3], HHN Nakajima[2]

[1]UMC Utrecht and Massachusetts Eye and Ear Infirmary Boston, EINDHOVEN, Nederland

[2]Otology and Laryngology, Harvard Medical School, Massachusetts Eye & Ear Infirm, BOSTON, United States of America

[3]UMC, UTRECHT, Netherlands

Superior canal dehiscence (SCD) syndrome can mimic otosclerosis in patients presenting with conductive hearing loss and no dizziness. In the past, some of these patients underwent stapes surgery without hearing improvement. Today, surgical intervention for SCD patients is generally not indicated when the only finding is conductive loss in the absence of debilitating vestibular or auditory symptoms, due to risks of SCD repair. Amplification may also be undesirable if Tullio phenomenon results. In this study, we explore round window (RW) stimulation as a treatment for SCD-associated conductive hearing loss.In cadaveric human temporal bones, we measured intracochlear sound pressures in scala vestibuli and scala tympani with micro-optical pressure sensors. We explored the effect of RW stimulation with an actuator on the differential pressure across the cochlear partition, the input to the cochlea, for an ear with experimentally-induced SCD.Previous sound-stimulation experiments show that SCD introduces a significant decrease in scala vestibuli and scala tympani sound pressures as well as in the differential pressure. Our preliminary results for RW stimulation in SCD temporal bones also demonstrate decreases in scala vestibuli and scala tympani sound pressures; however, the differential pressure is barely affected.SCD decreases differential pressure due to forward sound stimulation. However, differential pressures produced by RW stimulation with and without SCD are similar. Therefore, RW stimulation may be a feasible treatment for patients with SCD-induced conductive hearing loss and no other complaints. Further studies are required before such a procedure is implemented in patients.

Fri010. Intra-operative measurement of a floating mass transducer at the round window

J Guignard[1], MD Caversaccio[2], M Kompis[2], C Stieger[3]

[1]University of Bern, BERN, Switzerland

[2]University Department of ENT, Head and Neck Surgery, Inselspital, BERN, Switzerland

[3]Artificial Hearing Research, ARTORG Center, University of Bern, BERN, Switzerland

Introduction: The MED-EL Vibrant Soundbridge (VBS) is an active middle ear implant using a Floating Mass Transducer (FMT). For mixed hearing loss, the FMT is typically placed at the round window. We investigated the use of Laser Doppler Vibrometry (LDV) as an instrument for the surgeon during operation by comparing hearing thresholds with intra-operative LDV measurements.

Methods: Four patients were included in the study. During the surgery, after placement of the FMT at the round window, the implant was stimulated with pure tones at 1, 2, 3 and 4 kHz using the so-called vibrogram (MED-EL Connex Software with Amadé sound processor). LDV was used to measure the velocity of the FMT and the resulting velocity of the stapes. Post-operative audiograms and vibrograms were reviewed. For each frequency, the difference between both thresholds was calculated. We assumed that a good coupling results in a small difference in thresholds.

Results: For all frequencies, the difference between the velocity of the stapes and the FMT was -17 ± 6 dB on average and ranged from -8 to -30 dB. A higher velocity difference was related to a higher difference between thresholds of bone conduction and the vibrogram for the frequencies 1 and 3 kHz. The velocity of the stapes at 90 dB HL was lower with the FMT stimulation as reported for natural transmission.

Conclusion: The results suggest that intra-operative measurements of VBS implants with LDV could assist surgeons confirm the coupling of the FMT.

Fri011. Can we predict the influence of a ossicular sensor on the mobility of the ossicular chain?

J-M Gerard[1], J Walraevens[2], P Van Gerwen[2]

[1]Saint-luc university hospital, BRUSSELS, Belgium

[2]CTC Belgium, MECHELEN, Belgium

Introduction: In totally middle implantable hearing device, the ossicular sensor coupling inherently affects the mobility of the chain. A correct impedance matching is therefore vital.

Methods: A middle ear sensor and its influence on the mobility of the ossicular chain is first modeled and then validated using 38 fresh frozen cadaver heads.The analogue circuit model and two-port model of Rosowski et al. 1996, was implemented and extended to allow coupling of a sensor lumped element model calculated and optimized using a validated 3D acoustostructural finite element model,The mobility of the ossicular chain was measured using a laser Doppler vibrometer at the incus head and stapes posterior crus prior and post implantation of the sensor.

Results: The model predicted no influence of the sensor on the mobility of the ossicular chain from 100 Hz up to 2 kHz. From 2 to 10 kHz, the model forecasted a decrease in mobility of both the incus and stapes footplate with 4 to 8 dB.The cadaver validation experiments confirmed the model results. On average, the mobility of the chain decreased with 1.8 +/- 4.2 dB for frequencies between 100 Hz up to 2 kHz after implantation. For higher frequencies, this difference increased up to 4.7 +/- 5.9 dB.

Conclusion: An impedance optimized middle ear sensor had little to no influence on the mobility of the ossicular chain for frequency below 2 kHz. Above 2 kHz, the influence is less than 5dB.

Friday 21 September 2012

Topic: Implant Biology

Fri012. Reduced impedances and fibrous tissue growth using dexamethasone eluting cochlear implants in vivo

V Scheper[1], ME Wilk[1], M Fehr[2], T Lenarz[1]

[1]Hannover Medical School, HANNOVER, Germany

[2]University of Veterinary Medicine, HANNOVER, Germany

Introduction: The efficiency of cochlear implants (CIs) is affected by postoperative connective tissue growth around the electrodes and by increased electrical impedances. Dexamethasone (DEX) eluting CIs may reduce impedances and fibrous tissue growth around the CI.

Methods: DEX was incorporated in the CIs silicone in different concentrations: A) 1% DEX, n=10; B) 10% DEX, n=10; C) 0% DEX, n=9. Guinea pigs were provided with those CIs via round window approach. Impedances were measured before and after an electrical stimulation of 60 minutes to investigate a potential additive effect of DEX and electrical stimulation. Measurements were performed on days 0, 7, 14, and then weekly for 11 weeks. Histology was performed on epoxy embedded samples by measuring the area of scala tympani filled with fibrous tissue.

Results: In all experimental groups the amount of fibrous tissue was the highest in the basal region of the cochlea, close to the round window niche. Both DEX concentrations significantly reduced fibrosis around the electrode part of the CI. After 3 month the impedance levels in both DEX-groups were significantly lower than in the control group – before and after electrical stimulation. Cochlear implants containing 10% DEX showed better results than 1% DEX CIs.

Conclusion: DEX significantly reduced impedances after 3 month observation and a significant reduction of fibrosis was detected in DEX treated animals. CIs medicated with 10% DEX showed better results than those containing 1% DEX. DEX eluting CIs are a promising device for impedance and fibrosis reduction in cochlear implant patients.

Fri013. Hearing measurement during and after cochlear implantation – experimental and human studies

OFA Adunka, BC Choudhury, CAB Buchman, **DCF Fitzpatrick**

University of North Carolina at Chapel Hill, CHAPEL HILL, NC, United States of America

Monitoring of hearing during cochlear implantation could improve electrode placement and hearing preservation efforts. Such monitoring requires the identification of physiological markers of cochlear trauma and electrode positioning. For this study, ECoG-type measurements were made in an animal (gerbil) model of cochlear implantation and in human subjects at various stages during cochlear implantation. Normal-hearing animals provided the most sensitive preparation, but animals with hearing loss provide a better correlate of human candidates. Hearing loss can be produced with high-pass noise exposure to preserve low-frequency hearing. The hearing loss configuration can be varied simply by modifying the cut-off frequency of the noise. With these two models, reductions in cochlear potentials, primarily the cochlear microphonic (CM) and compound action potential (CAP) were closely correlated with the amount of cochlear trauma. A reversible physiological reduction typically showed no anatomical damage, while large and irreversible reductions were associated with visible trauma such as a breach of the basilar membrane. Large potentials and detectable reductions were recordable at the round window even with substantial high-frequency hearing loss. In human patients, the current goal is to measure pre-and post-insertion levels of the same cochlear potentials, and note reductions as in the animal model. Most patients showed a modest reduction at the time of surgery. Increases could occur at some frequencies, suggestive of a mechanical effect on basilar membrane motion with the electrode present. These results show that robust cochlear measurements are available during surgery, and that the effects of insertion are can be recorded.

Fri014. The peripheral processes of spiral ganglion cells in guinea pigs: deafening and neurotrophic factors

SFL Klis, L Waaijer, MHW Van Deurzen, D Ramekers, EGJ Hendriksen, W Grolman

UMC Utrecht, UTRECHT, Nederland

Objective: To characterize effects of deafening and subsequent treatment with brain-derived neurotrophic factor (BDNF) on the peripheral processes (PPs) of spiral ganglion cells in guinea pigs. BDNF prevents degeneration of neural structures after loss of hair cells, with possible relevance for cochlear implant candidates (Agterberg et al., 2009).

Methods: Guinea pigs were pharmacologically deafened. Two weeks after deafening, intracochlear BDNF-treatment was started (Agterberg et al., 2010). After cessation of BDNF-treatment the cochleae were prepared for analysis. PPs were counted and morphologically characterized with respect to myelinisation, size and shape.

Results: Deafening dramatically reduced the number of PPs. BDNF-treatment significantly reduced this degenerative effect of deafening. The remaining processes showed an altered morphology; compared to normals the size in deafened untreated animals was reduced and was increased in BDNF-treated animals. The myelin sheath appeared reduced in size in BDNF-treated animals.

Conclusion: Deafening evokes degeneration of peripheral processes. BDNF-treatment not only reduces this degeneration but also induces morphological alterations in the processes. Translation of these findings to the clinic remains a challenge.

References

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Fri015. Systemic is more effective than local administration of dexamethasone for reducing the tissue response to cochlear implantation

S O'Leary, J Lee, H Ismail, H Eastwood, G Kel, JH Lee

Department of Otolaryngology, University of Melbourne Royal Victorian Eye and Ear Hospital, East Melbourne 3002. sjoleary@unimelb.edu.au

Aims: To compare the efficacy of systemic and local administration of dexamethasone (dex) at (a) preserving hearing after experimental cochlear implantation and (b) affecting the tissue response to cochlear implantation.

Background: Glucocorticosteroids are strong contenders for improving hearing preservation after cochlear implantation, but the best route of administration remains uncertain. Both local delivery and systemic administration preserve hearing, and here we compare these directly. In addition, the extent of the tissue response is examined, in order to test whether one route of administration is better than another at reducing the fibrotic reaction to the intracochlear electrode. Reducing fibrosis will likely minimise the disruption to cochlear mechanics that can accompany implantation.

Methods: All procedures were performed under general anaesthetic (ketamine/xylazine) under the auspices of the Animal Research Ethics Committee of the Royal Victorian Eye and Ear Hospital, Melbourne. Guinea pigs with normal hearing prior to implantation (<43 dB peak-to-peak equivalent on auditory brainstem response [ABR] following a 100μs rarefaction click stimulus) underwent implantation of a banded electrode array (platinum dummy electrodes on a silastic carrier) via a cochleostomy. Prior to implantation a single dose of dexamethasone was administered either intravenously (2 mg/kg, 1 hour before surgery), or locally to the round window (either 2% dex for 120 min [local 2/120), or 20% dex for 60 min [local 20/60]), with saline to the round window acting as the control. ABR threshold-shifts ("thresholds") were calculated in response to tone pips (2,8,24, 32 kHz) between pre-operative levels and those at 1, 4, 8 and 12 weeks after surgery. The animals were then euthanized, perfused and fixed with paraformaldehyde after which the cochleae were decalcified and embedded in Spurrs resin for serial sectioning at 125 μm.

Results: A repeated measures ANOVA with ABR thresholds as the dependent variable revealed a significant main effect of treatment group ($p<0.000$) and time of testing after surgery ($p<0.000$). Post-hoc analysis demonstrated that systemic and the local 2/120 groups had significantly lower ABR thresholds than controls, but did not differ from each other. Thresholds in the local 20/60 group did not differ from controls. In all groups, mean thresholds improved over the 3-month observation period. The area occupied by fibrosis was lower in the steroid groups than the controls, but the difference was significant only for the systemic steroids.

Conclusions: While the administration of either local or systemic steroids preserve hearing after cochlear implantation, systemic steroids more effectively minimised the tissue response.

Friday 21 September 2012

Topic: Functional Imaging

Fri017. Visual cross-modal reorganization of phonological pathways in post-lingual deaf subjects

DL Lazard[1], EB Bertasi[2], BM Meyer[3], OS Sterkers[3], BF Frachet[4], ALG Giraud[1]

[1]Ecole Normale Supérieure, PARIS, France

[2]Institut du Cerveau et de la Moelle, CENIR, PARIS, France

[3]AP-HP, Hôpital Beaujon, CLICHY, France

[4]AP-HP, Hôpital Rotschild, PARIS, France

Introduction: Part of the variability of cochlear implantation (CI) outcome may be attributed to brain reorganization during deafness. Detecting CI candidates who may present with detrimental plasticity is appealing. This study aimed to design such behavioral tests and investigate the mechanisms involved.Methods: 35 subjects (Ss) were recruited to participate in a phonological reading task (rhymes of misspelled words). Among them, 22 Ss performed the tasks during an fMRI session. The sample was divided into a group of post-lingual deaf secondarily implanted, and a group of matched normal-hearing subjects.

Results: Deaf Ss presented with poorer phonological performance. However, for equal performance, they performed the tasks more rapidly than controls. A positive correlation was observed between reaction times (RT) and speech understanding after CI. fMRI data showed that deaf Ss overactivated the right posterior superior temporal sulcus (pSTS), whose neural activity enhancement was associated with faster RT. Conversely, the contralateral activation of the left pSTS was associated with slower RT, and better lip reading abilities.

Conclusion: A longitudinal study exploring lipreading in CI recipients (PET) showed bilateral pSTS activation that decreased on the right and increased on the left when good speech understanding was acquired (Rouger et al., 2011). Both studies suggest that two different visual cross-modal reorganizations take place within the pSTS: on the right, a reading-based plasticity involving fast networks, and on the left, a lipreading-based plasticity involving more physiological auditory pathways. The right reading-based reorganization impacts negatively CI outcome, preventing auditory inputs from being efficiently processed.

Fri018. Comparison of resting state activity in individuals with unilateral hearing loss and normal hearing

B Firszt, Prof Burton, Mr. Holden, Mr. Agato

Washington University School of Medicine, ST. LOUIS, MO, United States of America

Introduction: Contralateral and ipsilateral hemispheric activation patterns reorganize in individuals with unilateral hearing loss (UHL) compared to normal hearing (NH). In the current study, we examined the consequences of unilateral deafness on correlated activity between selected auditory cortex regions and the rest of the brain (i.e., functional connectivity).

Methods: We collected resting state, spontaneous activity from 50 participants: 13 UHL with intact right ears (RE), 13 UHL with intact LE, and 12 each monaurally RE and LE stimulated NH. Whole brain blood oxygenation level dependent (BOLD) contrast images of low frequency spontaneous activity were obtained while participants remained awake during three successive BOLD runs. Temporal correlations were computed between activity in a seed region and voxels throughout the brain and corrected for spurious physiological, head movement, whole brain signals, and autocorrelations before converting the coefficients to z-scores to evaluate correlations.

Results: The functional connectivity analyses showed significant differences in connectivity between the frontal eye fields in the dorsal attention network and primary visual cortex (RV1), RV1 and motor cortex, and left posterior inferior parietal lobe (LpIPL), a component region in the default mode network, and motor and auditory cortex. Results suggested that these connectivity differences reflected compensatory utilization by UHLs of their visual system for spatial localization and self-referential activity, leading to stronger functional connectivity than in NH, with left-sided deaf UHLs showing the greatest difference.

Conclusions: Results provide evidence for differences in functional connectivity in the right and left hemipsheres of individuals with UHL.

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Fri019. New insights on the tonotopy of the human auditory cortex

P van Dijk

UMC Groningen, GRONINGEN, Netherlands

Introduction: Tonotopy is an overarching organizational principle of the auditory system. Yet, the tonotopic organization of the human auditory cortex has not yet been clearly identified.

Methods: We mapped the tonotopic organization of the cortex using minimally salient tonal stimuli, in order to avoid extensive spread of excitation. Cortical responses were measured by functional magnetic resonance imaging (fMRI). MRI images were analyzed by principal component analysis, in order to assess response profiles of voxels in the MRI scans.

Results: The results indicated two tonotopic gradients on the caudal and rostral bank of Heschl's gyrus, with abutting low-frequency areas on the superior crest of the gyrus. There was evidence for a third tonotopic gradient on the planum temporale.

Discussion: In contrast to results in previous reports, these results show robust mulitple gradients approximately perpendicular to Heschl's gyrus. This result appears homologous to animal studies, and provides a new robust framework for interpreting cortical responses to auditory stimuli in humans.

Fri020. Electrophysiological signatures of cortical plasticity in cochlear-implant users

PS Sandmann[1], ND Dillier[2], TE Eichele[3], MM Meyer[4], AK Kegel[2], RDP Pascual-Marqui[5], VLM Marcar[6], LJ Jäncke[7], SD Debener[1]

[1]University of Oldenburg, OLDENBURG, Germany

[2]ENT Department, University Hospital Zurich, ZURICH, Switzerland

[3]Department of Biological and Medical Psychology, University of Bergen, BERGEN, Norway

[4]Research Laboratory for Learning and Neuroplasticity in the Healthy Aging Brain, ZURICH, Switzerland

[5]The KEY Institute for Brain-Mind Research, University Hospital of Psychiatry, ZURICH, Switzerland

[6]School of Health Professions, Zurich University of Applied Sciences, WINTERTHUR, Switzerland

[7]Institute of Psychology, Division of Neuropsychology, University of Zurich, ZURICH, Switzerland

Introduction: Hearing with a cochlear implant is highly unnatural and impoverished, but many cochlear implant users adapt to the artificial signals provided by the implant and learn to recognize meaningful sounds. However, there is a high degree of variability in speech perception outcomes across cochlear implant users. The current study examined whether this inter-subject variability in auditory speech comprehension is related to reorganization in the auditory cortex of these individuals.

Methods: Cochlear implant users (N=11) and normal-hearing controls (N=11) were presented with parametrically modulated reversing checkerboard images while electroencephalography (EEG) was continuously recorded. EEG source localization was applied to perform a spatio-temporal evaluation of visual-evoked potentials to the reversing stimulus patterns.

Results: The analysis of visual-evoked potentials revealed smaller P100 amplitudes and reduced visual cortex activation in cochlear implant users compared with normal-hearing listeners. At the P100 latency, cochlear implant users also showed activation in the right auditory cortex. This visual activation of auditory cortex was more pronounced in individuals who had a moderate rather than a good ability to recognize speech.

Clonclusion: Our results show visual activation of auditory cortex in cochlear implant users and suggest a visual take-over type of reorganization in the auditory cortex of these individuals. This cross-modal reorganization of the auditory cortex might be maladaptive in CI users and may reflect incomplete reversal of compensatory reorganization induced by auditory deprivation. Further evidence regarding the role of cortical reorganization for auditory speech comprehension in CI users will be presented.

Fri021. Functional near infrared spectroscopy: A novel imaging technique for cochlear implants

R Kileny, Asst. Pro Kovelman

University of Michigan, ANN ARBOR, United States of America

Brain function imaging with diffuse light – near-infrared spectroscopy (NIRS), is a novel technique that can be used to study brain activity associated with different motor and sensory functions, including auditory function including cochlear implants. Optical imaging at centimeter depths is made possible by the relationship of the absorption spectra of water, oxygenated hemoglobin (HbO2) and deoxygenated hemoglobin (Hb), at near-infrared wavelengths. The spectra of oxy- and deoxy- hemoglobin are distinct enough to allow spectroscopic imaging of separate concentrations of both types of molecules. These principles, provide the basis for a novel brain imaging trechnology – Functional Near Infrared Spectroscopy. This type of optical imaging can be obtained through the scalp and skull into the cortex. This imaging is related to changes in blood flow and oxygen consumption during brain activation resulting in an increase in blood volume and oxygenated hemoglobin and a decrease in deoxygenated hemoglobin. By performing measurements with multiple optical sources and detectors distributed over the scalp to coincide with different cortical regions, it is possible to obtain spatial localization of absorption changes within the brain. This presentation will summarize the principles of FNIRS, and address the future of this imaging technique for cochlear implant applications. The discussion will include advantages of this technique over electrophysiological measurements such as the absence of contamination by an electrical artifact, and other functional imaging techniques, as well as possible pitfalls and deficits.

Friday 21 September 2012

Topic: Free Paper Session (Functional) Imaging

Fri022. Neural correlates of tinnitus improvement by cochlear implant in patients with single-side deafness

JJ Song[1], S Vanneste[1], D De Ridder[2], A Kleine Punte[3], A Gilles[3], G Mertens[3], P Van de Heyning[3]

[1]University Hospital Antwerp, EDEGEM, Belgium

[2]Brai²n, TRI & Department of Neurosurgery, University Hospital Antwerp, EDEGEM, Belgium

[3]Brai²n, TRI & ENT, University Hospital Antwerp, EDEGEM, Belgium

Introduction: Recent reports indicated that electrical stimulation via a cochlear implant (CI) can be a treatment option for unilateral tinnitus resulting from single-sided deafness (SSD). To measure objective cortical changes, we attempted to elucidate quantitative electroencephalography (qEEG)-driven neural correlates associated with tinnitus and its improvement by CI in these SSD subjects.

Methods: Eight SSD subjects whose tinnitus has been improved by CI and 8 controls matched for sex and age were recruited. For intra-group analysis, qEEG findings of the CI on- and off states in the SSD subjects were compared. In addition, qEEG findings of the CI group with CI on- and off states were compared to those of the control group for inter-group analysis.

Results: Compared to CI-off state, CI subjects demonstrated decreased dorsolateral prefrontal cortex (dlPFC) and increased postero-inferior prefrontal cortex (piPFC) alpha 2 band activities. When compared to the control group, the CI group revealed increased synchronized theta- and gamma band activity (GBA) on the right auditory corticies and increased GBA on the left orbitofrontal cortex under CI-off state and increased alpha-2 band activity on the right auditory cortex.

Conclusion: The current study suggests decreased dlPFC and increased piPFC alpha 2 band activities as the possible neural correlates responsible for tinnitus improvement in CI patients with SSD.

Fri023. CT-analysis of intrascalar position of cochlear implants: Relation with clinical stimulation levels

FB van der Beek, JHM Frijns, JJ Briaire

LUMC, LEIDEN, Netherlands

Introduction: This study investigated the relation between the intrascalar position of cochlear implant electrodes (in terms of insertion depth and distance to the modiolus) and clinical stimulation levels.

Methods: Measurements were performed on postoperative HRCT-scans in 151 users of the Advanced Bionics HiRes90K cochlear implant with a HiFocus 1J electrode. Insertion depth and distance to modiolus were determined for each separate electrode contact. Stimulation levels were obtained during routine clinical follow-up. T-levels were measured for each active electrode contact separately. For the M-levels a profile was used with a slightly increasing emphasis for the higher frequencies. Mixed linear models were used to analyze the data. A comparison was performed of the dynamic range in the group with 50% shallowest insertions versus the 50% with the deepest insertions.

Results: In our population T-levels were shown to be significantly influenced by insertion depth and not by the distance to the modiolus. Especially below 200 degrees from the round window T-levels gradually became more elevated. The profiles of the M-levels were neither significantly influenced by the insertion depth nor by the distance to the modiolus. The group with the shallower insertions showed a significantly smaller dynamic range for the basal electrode contacts (12 vs. 10 dB).

Conclusion: The main factor influencing T-levels is the insertion depth, rather than the distance to the modiolus. Moreover, shallow insertions are associated with a reduced dynamic range for the basal part of the array.

Fri024. Music perception by normal-hearing and cochlear implant children: A neuroelectrical imaging study

PM Marsella[1], AS Scorpecci[1], GV Vecchiato[2], AC Colosimo[3], AGM Maglione[3], PM Malerba[4], FB Babiloni[5]

[1]Bambino Gesù Pediatric Hospital, ROME, Italy

[2]Department of Physiology and Pharmacology, University of Rome "Sapienza", Italy, ROME, Italy

[3]Department of Anatomy, Histology, Forensic Medicine and Orthopedics, University, ROME, Italy

[4]Cochlear Italia s.r.l., BOLOGNA, Italy

[5]Neuroelectrical Imaging and BCI lab, IRCCS Fondazione Santa Lucia, Italy, ROME, Italy

Introduction: It is well-known that adult, post-lingual cochlear implant users have remarkable difficulties with music perception and often report disliking the music they hear (Gfeller, 2007). Much less is known about child cochlear implant recipients, also because measures of music perception in this population. In the last years, an objective measure of cerebral activity has been put in close relationship with the perceived pleasantness of a stimulus (Davidson and Irwin, 1999). Aim of the present preliminary study is to investigate, by means of neuroelectrical imaging, the differences in the perceived pleasantness of music in normal hearing and in cochlear implant children.

Methods: 3 normal hearing and 4 unilaterally implanted children underwent electroencephalographic (EEG) recordings while listening to a musical cartoon. For each subject, the music was presented in three different versions: NORMAL, DISTORT and MUTE (i.e. cartoon without music). The scalp Power Spectral Density (PSD) has been calculated in order to investigate the frontal EEG alpha asymmetry in the three experimental conditions.

Results: In the normal-hearing children, the alpha EEG asymmetry patterns were consistent with the Davidson's theory: alpha imbalance was greater in the NORMAL condition than in the DISTORT and MUTE conditions. Conversely, the scalp topographic distribution of the EEG power spectrum in the alpha band showed no significant variations of such cerebral activity in cochlear implant users.

Conclusion: The findings are consistent with the approach-withdrawal theory and support the hypothesis that unilateral cochlear implant users perceive the pleasantness of music differently from normal hearing subjects.

Fri025. The use of cone beam CT to determine electrode position in human temporal bones

SR Saeed

UCL Ear Institute / RNTNEH London, LONDON, United Kingdom

Introduction: Detailed radiology forms an integral part of the process of candidacy selection for cochlear implantation as well as for surgical planning. More recently it has become apparent that atraumatic surgery and intracochlear electrode array position has a bearing on outcomes. This in part is the driver behind exploring new imaging modalities to evaluate electrode position in the cochlea.

Method: Fresh frozen human temporal bones underwent electrode array insertion by 2 surgeons. Post-implant cone beam CT was then evaluated independantly by one of the surgeons and a neuro-radiologist. The temporal bones were then sectioned for histological electrode position and these compared with the cone beam scan results.

Results: There was a close correlation between the cone beam CT scan results and the histology result for each cochlear implant.

Conclusion: Cone beam CT allows scalar differentiation and represents a useful imaging modality for the post-operative evaluation of electrode array position in cochlear implantation.

Fri026. Automated registration and superimposition of multiple CBCT volumes of the temporal bone

G Dees, M Hoof van, RJ Stokroos

MUMC, MAASTRICHT, Nederland

Affiliation: [1]Department of Otorhinolaryngology, Head and Neck Surgery, Maastricht University Medical Center, Maastricht, The Netherlands

Introduction: Registration and superimposition using high-resolution cone beam computed tomography (CBCT) is a potential valuable clinical and research tool making it possible to accurately detect and visualize changes in anatomy and implant position in the middle and inner ear. We validate a protocol using pre-validated registration techniques aimed to assess changes in the temporal bone.

Methods: Multiple CBCT volumes of a cadaver temporal bone and a healthy volunteer are made and registered using Slicer 4 software with custom settings. Using a gold-standard marker-based fiducial technique, the intrinsic error of the registration process is assessed and expressed in multiple outcome measures (TRE, MMI, MSD, robustness). Other relevant outcome measures are the time needed to do the registration.

Results: An automated standardized method using Slicer 4 software show no significant difference compared to the gold standard marker-based fiducial technique in terms of outcome measures. However, the time needed to do the registration is significantly reduced.

Conclusion: Automated rigid registration and superimposition of multiple CBCT volumes of the temporal bone using Slicer 4 software is a validated and fast tool applicable to daily clinical practice.

Friday 21 September 2012

Topic: Free Paper Session eSRT

Fri027. Postoperative stapedius reflex tests for CI fitting in children with bilateral cochlear implants

K Stephan, V Koci

Innsbruck Medical University, INNSBRUCK, Austria

Introduction: Fitting of CI speech processors is a very challenging task in children with bilateral cochlear implants as the auditory system can react quite differently depending on the site of electrical stimulation and the condition of the ear. In some cases this may even lead to a long and annoying period of familiarization for the child. Due to the high correlation between postoperative electrical stapedius reflex threshold (ESRT) with subjective comfort levels in single sided implants, we also applied this fitting technique for bilaterally implanted cases.

Methods and Results: 20 bilaterally implanted children with MED-EL devices C40+, Pulsar & Concerto were fitted using postoperative ESRT values for setting the comfort levels of the map. In all patients except 2 the implantation was performed sequentially with sequential activation of the implant using behavioral methods one month after implantation. After 3 weeks of CI use, reflex testing was performed and comfort levels were set based on channel specific ESRT. In order to account for loudness summation a reduction of 10% of volume was introduced. In all cases the acceptance of both CIs improved according to the reports of the parents. In addition the aided thresholds appeared very symmetrical when tested under free field conditions.

Conclusions: Electrically elicited stapedius reflex thresholds ESRT appear to be very useful for balancing of bilateral cochlear implants. The period of familiarization of the second implant can be dramatically reduced. Postoperative reflex testing is particularly useful for fitting of bilateral CIs in young and non cooperative children.

Fri028. Fast fitting procedures for ci by electrical stapedius reflex thresholds (ESRT)

VK Koci

Innsbruck Medical University, INNSBRUCK, Austria

Introduction: Postoperative electrical stapedius reflex thresholds (ESRT) show a good correlation to psychoacoustic loudnessscaling. This is the main reason why ESRTs are used for CI fitting in children for the estimation of comfort levels (c-levels, m-levels, MCL). The application of this objective fitting procedure is particularly helpful in patients who cannot provide reliable behavioural response. Fast fitting can be performed by online and/or offline evaluation of the reflex recordings.

Methods: By means of a new setup, ESR measurements were performed in children and adults. Stimuli were generated by the standard fitting software. Repetitive stimulation with increasing and decreasing stimulation intensities was applied to elicit the reflex in the vicinity of reflex threshold. Reflex detection was performed by impedance audiometry of the ipsi- or contralateral ear using a new PC-soundcard based fast response impedance meter. All 12 electrodes of the Med-El implants were stimulated. The median of the recorded ESRT was calculated offline. These values were compared to the MCL value subjectively set by the investigator during the fitting session (‘online’).

Results: The comparison of subjectively set MCLs and offline calculated ESRTs shows a variability in between the normal distribution of the collected ESRT values.

Conclusions: ESRT values for online and offline evaluation show a good correlation. If there is no more time (approx. 15 min) for a more accurate fitting, ESRT values canbe set directly to MCL values by a experienced investigator online during the fitting. Nevertheless for a high quality fitting offline evaluation of ESRT is recommended.

Fri029. Multimodal electrophysiological tests: A guideline to program 'Difficult to MAP' cochlear implantees

S Raghunandhan[1], Prof. Kameswaran[1], Prof. Ravikumar[2], Mr. Ranjith[1]

[1]Madras ENT Research Foundation, CHENNAI, India

[2]Sri Ramachandra University, CHENNAI, India

Introduction: Indications for Cochlear Implantation have expanded to include very young children and those with multiple handicaps/syndromes. Programming such children using behavioral responses, requires an experienced audiologist, who may find it a daunting task to optimally program a child, in whom behavioral responses are inconsistent. Multi-modal electrophysiological tests provide a vital guideline to predict behavioral levels in 'Difficult to MAP' scenarios. Our study highlights a statistical method for predicting ideal comfort levels using multimodal EP thresholds.

Methods: Prospective study in 30 pre-lingual Implantees aged 2-10 years (Group-1: 20 implantees using MedEl Combi40+ device + Tempo Plus processor and Group-2: 10 implantees using MedEl Pulsar/Sonata device + Opus 2 processor). All children underwent multi-modal electrophysiological tests (Group-1: ESRT & EABR and Group-2: ESRT, ART & EABR) at intervals of 1, 4, 8 & 12 months after surgery, in addition to behavioral mapping.

Results: Trends in various parameters were recorded, normative data for electrophysiological tests and behavioral levels were generated and correlations were derived over time. Using a multiple regression analysis model, predictive formulae were derived for calculating optimal MCL, using the electrophysiological parameters.

Conclusion: These formulae may be clinically used as a statistical guideline to predict behavioral thresholds for programming future 'Difficult to MAP' Implantees. Objective measures of implant function become paramount in predicting ideal behavioral thresholds, especially in 'Difficult to MAP' individuals. In such cases, following a protocol of sequential programming in conjunction with electrophysiological correlates will provide the best outcomes.

Fri030. Objective registration of stapedial reflex during cochlear implantation by impedance technique

SM Petrov, JK Yanov, IA Anikin, WE Kuzovkov, HM Diab, AA Shchukina, GR Azizov

ENT Institute, ST.-PETERSBURG, Russian Federation

Introduction: Results of intraoperative registration of stapedial reflex are used at first fitting of cochlear implant. Routine visual registration (by surgeon) has limitations (bad visuality of tendon, liquid, anatomic anomalies and so on). Aim of study is objectivisation of intraoperative reflex registration.

Methods: We used AA220 impedancemeter. We inserted additional volume with syringe in pneumatic circuit of this device. When tympanometry gives flat curve owing to large pressure in middle ear (more than 300 daPa) we add pressure (by syringe) in outer ear in order to shift a peak of tympanogram to screen of device. Registration of reflex was done contralaterally by SWEEP procedure: stimulus-response or no response and appropriated change of stimulation level in direction to reflex treshold level. 12 patients participated.

Results: In 8 patients visual and objective results were similar ones. In 4 patients objective results were less than visual ones, sometimes significantly.

Conclusion: Objective registration of stapedial reflex during cochlear implantation gives more right results than visual observation of tendon's movement by surgeon. It is significant factor during first fitting.

Fri031. A comparison of stapedial muscle activity during measurement of ECAP with two strategies

B Medikeri[1], **S Gore[1]**, A Deshpande[1], R Swaroop[2]

[1]Dr. Medikeri's Super Speciality ENT Centre, BANGALORE, India

[2]Dept of ENT, Siddhartha Medical College, TUMKUR, India

Electrically evoked stapedial reflex (ESR) has been used to check device function intra operatively. Parameters that influence the ERS are intensity, mode of stimulation and electrodeplace. ESRs have been evoked during measurement of Electrical compound action potential (ECAP). This paper compares ESRs evoked with two strategies- forward masking and alternating polarity.

Methods: 50 recipients of nucleus cochlear implants served as subjects in this study. Testing was done intraoperatively in the O.T. The out put of the operating microscope was connected to a DVD recorder and monitor. The magnification was set to 12.5x10. ESRs and ECAPs were obtained just after insertion of implant. The ESRs were visually monitored by the surgeon, anesthetist and audiologists. ESR thresholds (ESRts) were obtained on one electrode each in the apical, middle and basal regions of the cochlea with default stimuli *and* during the measurement of the ECAP. Stimuli for ECAP were pulses at a rate of 250/sec. ECAP thresholds were measured with both the forward masking paradigm and alternating paradigm.

Results: ESRTs were observed in all except in 10 with anomalies. ESRTs obtained with alternating polarity were significantly higher than those for forward masking paradigm in all electrodes.

Conclusion: Temporal integration evokes the ESR during measurement of ECAP. Better ESRt obtained with forward masking paradigm may be due to the presence of the masker along with the signal. It is suggested that the presence of ESR during the process of measurement of ECAP verifies device function.

Friday 21 September 2012

Topic: Diagnostics

Fri032. Electrocochleography responses in infants with auditory neuropathy spectrum disorder (ANSD)

K Gardner-Berry[1], WPR Gibson[1], H Sanli[1], SC Purdy[2], H Dillon[3]

[1]Sydney Cochlear Implant Centre, ROZELLE, Australia
[2]University of Auckland, AUCKLAND, New Zealand
[3]National Acoustic Laboratories, CHATSWOOD, Australia

Introduction: Abnormal electrocochleography (EcochG) responses have been reported in adults and children with ANSD however results for infants are limited. Further, the underlying pathophysiology of ANSD may differ between adults and infants. This study characterizes the patterns of cochlear and neural responses in infants with ANSD, and relates the findings to measures of audiometric thresholds.

Methods: EcochG was measured using clicks and 8k, 4k, 2k and 1k -Hz tone burst stimuli at intensities of 50 to 110 dB HL on fifteen infants with ANSD using a trans-tympanic 'golf-club' electrode. The latency-intensity functions for the onset of the summating potential (SP-onset), and combined SP compound action potential (SP-CAP) were measured.Results from audiometric testing were obtained and infants were separated into those with a pure-tone average threshold <80 dB HL (group ANSD1) and >80 dB HL (group ANSD2).

Results: Using linear regression slope calculations a significant difference was seen for SP-onset between the click and 1 kHz stimulus for infants in group ANSD1 but not ANSD2. No significant difference were seen for SP-CAP within or between groups, however the absolute latencies of the SP-CAP for infants in group ANSD1 were more typical of those seen in subjects with normal hearing and sensorineural hearing loss.

Conclusion: Characteristics of the SP-onset and SP-CAP latency-intensity functions for infants with mild to moderately-severe audiometric thresholds (ANSD1) differed to those with a severe to profound loss (ANSD2). Potential underlying mechanisms and implications for cochlear implantation will be discussed.

Fri033. Neural diagnostics using psychophysics, CT scans, and electro-anatomical modeling

J Long[1], BDB Buechel[1], ZMS Smith[1], WSP Parkinson[1], TAH Holden[2]

[1]Cochlear, CENTENNIAL, United States of America

[2]Washington University School of Medicine, ST. LOUIS, United States of America

Introduction: We examined a method to diagnose local neural density based on psychophysical focused thresholds, forward masking, and CT scans. Focused thresholds give a measure of the efficacy of stimulation for a given channel and may give insight into the local state of neural tissue. For example, a high threshold could indicate (1) poor neural survival near a channel; and/or (2) a greater electrode-to-modiolus distance. The electrode-to-modiolus distance, can be directly measured from high-resolution CT scans and thereby controlled for in the analysis, allowing inferences about the neural state near each electrode.

Methods: We analyzed high-resolution CT scans of eight cochleae of CI users who had also undergone extensive psychophysical and speech testing. In particular, focused-stimulation thresholds were measured for all channels. Subject-specific linear models of electrode-to-modiolus distance versus threshold were derived and used in subsequent analyses. In addition, patterns of forward masking were measured. Finally, electro-anatomical modeling was used to examine potential contributors to focused threshold and forward masking patterns.

Results: Distance significantly affects focused thresholds (11dB/mm; R^2=0.88; F(1,7)=49.4; p=0.0002; N=8). In addition, CNC Word Scores were significantly correlated with how well a linear, distance model explained the threshold data (R^2=0.76; F(1,6)=19.5; p=0.0045; N=8). Other analyses are ongoing.

Conclusion: High focused thresholds, not explained by electrode position, correlate with poor speech understanding by CI recipients. The mechanism most consistent with our results is that threshold and speech understanding are negatively impacted by neural loss.

Fri034. Neuropathy of the auditory system due to Infantile Thiamine Deficiency: Eight years of follow-up

AJ Attias[1], RE Raveh[2], AD Aizner-Danon[3],
AM Bloch-Mimouni[4], AV Fattal-Valevski[5]

[1]University of Haifa, HAIFA, Israel

[2]Department of Pediatric Otorhinolaryngology, Schneider Children's Medical Center, PETACH TIKVA, Israel

[3]Department of Imaging, Schneider Children's Medical Center of Israel, PETACH TIKVA, Israel

[4]The Pediatric Neurology and Development Unit, Loewenstein Rehabilitation Hospit, RAANANA, Israel

[5]Pediatric Neurology Unit, Tel Aviv Sourasky Medical Center, TEL-AVIV, Israel

Introduction: Thiamine plays a central role in cerebral metabolism and development. Body storage is minimal and clinical symptoms appear in adults after 2 to 3 weeks of a thiamine deficient diet. The association between infantile thiamine deficiency and auditory neuropathy spectrum disorder (ANSD) was for the first time, studied in eleven infants that were fed accidently during a mean of 3 month with a thiamine deficient formula.

Method: The immediate and long term auditory sequelae were studied, using, electrophysiology, behavioral measures, otoacoustic emiisons, acoustic reflexes, speech development tests, and MRIs.

Results: In 5 infants the ANSD at presentation was resolved with supplementary thiamine injections (Transient ANSD). In two infants the ANSD was permanent and deteriorated in one patient who died at the age 7 years. An additional patient had an auditory pattern corresponding to that of auditory neuropathy of brain stem origin. The two remaining patients demonstrated unilateral cochlear hearing losses. Six to eight years later, all patients with transient ANSD had a normal pure-tone audiogram with the presence of acoustic reflexes, 2 had unilateral cochlear hearing loss and the rest had neural hearing losses. All survivors had a language development delay and impaired speech intelligibility of varying degrees, especially in noise. MRIs showed abnormalities in the brain stem, mid brain including the inferior colliculus and medial thalamus.

Conclusions: Thiamine is crucial component for normal auditory development and function, and its deficiency may be considered an acquired cause of ANSD in infants.

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Fri035. Stimulus intensity influence on the characteristics of speech auditory brainstem responses

AM Moulin[1], AJ Jeanvoine[1], LT Tordella[2], CR Richard[2]

[1]Lyon Neuroscience Research Center, LYON, France

[2]Saint-Etienne University Hospital, SAINT ETIENNE (42), France

Introduction: Speech auditory brainstem responses (SABR) are a very promising tool for investigating a wide range of speech perception and language impairments, as it represents a unique objective, non-invasive means of auditory brainstem timing exploration in humans. However, such SABR responses are very sensitive to parameters changes. The present study analysed systematically changes in both onset responses (OR) and Frequency Following Responses (FFR) of SABR as a function of stimulation intensity, to determine SABR detection threshold, compared to subjects's auditory and click evoked ABR thresholds.

Methods: SABR and click evoked ABR were collected during the same session using the same electrode placement, in ten native-French-speaking and normally hearing adults, as a function of stimulus levels ranging from 0 dB SL to 50 dB SL, using a monaural stimulation.

Results: Latency intensity functions showed variations of 0.6 ms per 10 dB for CABR, more than 1 ms per 10 dB for OR, and between 0.7 and 1 ms per 10 dB for the different peaks of the FFR. The threshold allowing to record SABR was 20 dB SL. At moderate intensities (20 to 30 dB SL), the representation of SABR was bilateral (with a monaural stimulation). Above that, the SABR response increased its amplitude linearly with the stimulation intensity only for the stimulated side.

Conclusion: A standardized speech ABR response is difficult to obtain at stimulus levels lower than 30 dB sensation level, which could limit speech ABR applications in hearing impaired subjects.

Fri036. Automated measurement of ECAP threshold using Smart-NRI: normative data

Saidia[1], IA Akhoun[2], **D Gazibegovic**

[1]CHU Annaba, ANNABA, Algeria

[2]Advanced Bionics European Research Centre, HANOVER, Germany

Introduction: ECAPs measure the auditory nerve (AN) activity on intracochlear electrodes following CI stimulation. ECAP thresholds (T-NRI) have been used as an objective measurement of electrical thresholds in CI fitting procedure. Recent automated algorithms have been implemented to automatically measure T-NRI (AB Smart-NRI and Cochlear Auto-NRT). The relationship between behavioural thresholds and TNRI has been discussed. It is not only influenced by the physiological AN function but also by the ECAP data analysis. Here, a normative post-analysis of Smart-NRI data is presented identifying current limitations. This will be compared to recent recordings obtained with an upgraded version of this algorithm.

Methods: Smart-NRI data were obtained in 113 Advanced Bionics HiRes 90K users at four electrodes locations (3, 7, 11 and 15) using the Research Software Platform for Objective Measurement (RSPOM 1.3). T-NRI and slopes were calculated from linear fit of ECAP growth functions. T-NRI is compared to the current unit where the first ECAP could be recorded. The denoising effect of Smart-NRI algorithm is compared to regular-filtered ECAPs. Entirely automated new Smart-NRI 2.0 implemented in RSPOM 2.0 will be recorded from HR 90K users.

Results: Smart-NRI could be recorded in an average of 1 min 7s. NRI noise was lower than 20 µV in 97% of the cases, it was lower in Smart-NRI (average of 7 microvolts) than with filtered ECAPs (12) and unfiltered ECAPs (23).

Discussion: In this study, ranges of T-NRI and slope parameters are described. Parameters influencing the clinical relevance of Smart-NRI are discussed.

Friday 21 September 2012

Topic: Middle Ear Implants

Fri037. Intra-cochlear pressures elicited by forward sound stimulation and reverse round-window stimulation

H Nakajima, C Stieger, J Rosowski

Harvard Medical School, Massachusetts Eye and Ear Infirmary, BOSTON, MA, United States of America

Experimental data suggest that 'forward' sound stimulation at the ear canal with its coupled motion of the oval (OW) and round window (RW) results in sound pressure differences across the cochlear partition. Alternate sound paths, third windows, may exist but are unimportant because the impedances of these paths are high relative to the series-path impedances of the cochlear partition and round window. During 'reverse' RW stimulation, the flow of sound starting at the RW does not necessarily take the same path as during OW stimulation due to differences in the relative impedance of the possible sound paths. Because the impedance looking out the oval window is much higher than the round-window impedance, sound generated at the RW may not just flow across the cochlear partition to the stapes, but may also branch and flow through third window(s). Such branching will be exacerbated when the stapes is fixed. We measured ear-canal pressure, stapes velocity, RW velocity and intra-cochlear pressures in scala vestibuli and scala tympani of human temporal bones, while stimulating the ear with sound at the ear canal or at the RW with an actuator. Our data suggest that the sound path differs between forward and reverse stimulation, such that flow through third-window(s) is more significant during reverse stimulation. Stapes fixation results in large intra-cochlear pressures that produce significant differential pressure owing to phase shifts between intracochlear pressures; this likely relies on a third window on the scala vestibuli side of the inner ear.

Fri038. Functional assessment of implantable hearing device using a Laser Doppler Vibrometer

JHS Sim, CR Röösli, MC Chatzimichalis, YZX Xie, AMH Huber

University Hospital Zurich, ZURICH, Switzerland

Introduction: Laser Doppler Vibrometer (LDV) systems have been widely used to measure motions of ear structures due to their reliability and accuracy in measurement. This study aims to assess performance of reconstruction with implantable hearing device, by measuring vibrational motion of the reconstructed ears.

Methods: Functional outcomes of reconstruction with various passive and active stapes prostheses were assessed by measuring 1) volume displacement of the round window and 2) relative motion between the incus and the prostheses, using a LDV system. The approach was applied to intra-operative measurement as well as temporal bone measurement. Performances of two bone conductive hearing aids (BB type BCI-601, Med-El and BAHA BP-100, Cochlear) were compared by measuring accelerations of promontories on both ipsi- and contra-lateral sides, which were conducted in cadaver heads.

Results: The measurement of round window motion showed that the Direct Acoustic Cochlear Stimulation Partial Implant has equivalent sound pressure levels of more than 110 dB SPL up to 1.5 kHz and 90 dB SPL at 8 kHz. The best coupling quality between the incus and the stapedial prosthesis was achieved with shape-memory alloy prostheses. The BB had higher promontory acceleration than the BAHA at the ipsi-lateral side. At the contra-lateral side, the promontory acceleration was lower for the BB than for the BAHA. The contra-lateral attenuation of the promontory acceleration for the BB was higher than for the BAHA.

Conclusion: Functional outcomes of reconstruction with implantable hearing device can be assessed by vibrational measurement using LDV systems.

Fri039. Assessment of reconstructed hearing based on measurements

AE Eiber[1], DB Beutner[2]

[1]University of Stuttgart, STUTTGART, Germany

[2]ORL Clinic University Hospital Cologne, COLOGNE, Germany

Introduction: Measurements have to regard the sensitivity of sensors and their reaction to the object as well as the accessibility. Laser Doppler Vibrometry (LDV) is widely used to measure motions on temporal bones or living subjects. The assessment of such measurements is based on appropriate theoretical models.

Methods: Volume displacements were measured on temporal bones by 3-D-LDV at the oval and by scanning LDV at the round window. For assessment of coupling an implant to the round window membrane, measurements on temporal bones and experiments in the lab were done and compared with simulation on mathematical models.

Results: In temporal bones, a frequency dependent difference of volume displacements between oval window and round window was observed below 1.5 kHz. Similar results were obtained from an acrylic model. These results could be verified with a mathematical model regarding ducti and fistulae or a dehiscence in a semicircular canal. This effect is considerably less prominent in the natural situation where the temporal bone is covered with tissues and embedded in liquid.The transfer of vibrations from an actuator like FMT at the round window to the inner ear is very sensitive on the static preload between actuator and membrane. A high preload cause attenuated motion due to nonlinear stiffening. In the frequency domain prominent distortions due to lift-off effects in the contact area appear.

Conclusions: Assessing the fluid dynamics of inner ear based on volume displacements, both windows have to be considered. To guarantee a proper sound transfer, sufficient preload has to be given in reconstructions.

Fri040. Ear-canal acoustic reflectance monitoring during middle ear implant surgery: A feasibility study

ST Tringali[1], BL Laulagnet[2], PB Berger[1], CD Dubreuil[1], AM Moulin[3]

[1]Université de Lyon, PIERRE BENITE, France

[2]INSA, LYON, France

[3]INSERM U1028, CNRS UMR5292, Lyon Neuroscience Research Center, Brain Dynamics an, LYON, France

Introduction: The aim of this study was to investigate the feasibility of ear-canal wideband energy reflectance measurements during active middle ear implant (AMEI) surgery, and to assess its potential value in monitoring middle ear function under increasing static loads by the AMEI.

Material and methods: Six patients (46-67 years old) with moderate to severe sensorineural hearing losses were implanted with an AMEI (Carina, Generation 4, Otologics°). Acoustic reflectance was obtained using Mimosa Acoustics HearID system, using a probe fitted in the outer ear canal of the patient. Acoustic reflectance was repeatedly measured over a frequency range of 0.25 to 6 kHz during surgery, for different loadings of the transducer of the AMEI. After initial loading (first contact), additional increases in incus load were induced by turning an adjustment screw in quarter turn steps (62 µm increments).

Results: Good reproducibility was achieved for frequencies above 1.5 kHz but it was difficult to achieve stable responses under 1 kHz due to the noisy environment. When averaged across a frequency band centered on 2.8 kHz, a weak (<5%) but statistically significant and systematic increase in energy reflectance was observed with increasing loads in several patients.

Conclusion: Ear canal Acoustic reflectance measurement can be performed intraoperatively during AMEI surgery. However, additional studies are needed to further adjust recording parameters to the noisy theater environment and a long-term follow-up must be carried out to determine if the optimization of AMEI with ear canal acoustic reflectance can increase the AMEI performance.

Saturday 22 September 2012

Topic: Objective Measures and Future Technologies

Sat01. Advances in integrity testing for nucleus implants

BB Böhnke[1], HM Mauch[2], UH Hoppe[3], GE Eskilsson[4], ND Dillier[5], AS Sjö[5], JM-D Müller-Deile[1]

[1]Christian-Albrechts-University, KIEL, Germany

[2]Cochlear AG, BASEL, Switzerland

[3]ENT University Clinic, ERLANGEN, Germany

[4]Karolinska Hospital Huddinge, STOCKHOLM, Sweden

[5]University Hospital, ZÜRICH, Switzerland

Introduction: The integrity of the electrode array in cochlear implants can be tested with different methods. Most devices support electrical impedance measurements via implant telemetry. Averaged Electrode Voltages (AEV) as available with the Nucleus 'Crystal' test system provide a more specific investigation method, however requires dedicated equipment and the montage of surface electrodes. Novel telemetry based test paradigms have been developed, using the impedance and neural response telemetry capabilities of Nucleus implants, to gain diagnostic information on device integrity using the standard clinical programming hardware.

Methods: As part of a multi-centric normative study, 176 implants have been measured using clinical research software CS19. 18 of these devices underwent one or more repeated testing sessions. Statistical analysis on the data has been performed to establish normative results and identify outlying electrodes. For some of the implants comparative AEV measurements were available.

Results: In addition to detect short or open circuit electrodes, telemetry based implant testing is able to provide diagnostic information on electrode anomalies and detect extra-cochlear current flow. Furthermore, information on the properties of the tissue around the electrode array can be obtained.

Conclusion: Advanced, telemetry based implant testing provides useful diagnostic information without the need for surface potential recordings. The new algorithms show potential to improve implant testing capabilities of future clinical software. Longitudinal test data could give an indication on the progression of alterations in the adjacencies of the electrodes (e.g. ossification) over time.

Sat02. Intra-Operative Techniques for the Measurement of Residual Hearing During Cochlear Implant Surgery

HS Sanli[1], WPR Gibson[2]

[1] The Sydney Cochlear Implant centre, Royal Prince Alfred Hospital, NEWPORT, Australia
[2]University of Sydney, Royal Prince Alfred Hospital, SYDNEY, Australia

Introduction: It has been demonstrated that patients who have some residual hearing at lower frequencies (<2kHz) benefit from electro-acoustic stimulation provided that the residual hearing is preserved. Implant manufacturers have developed new electrode arrays to preserve residual hearing and surgeons have developed atraumatic array insertion techniques. In this presentation we describe two methods of measuring residual hearing during cochlear implant surgery.

Methods: Before the surgery an insert earphone is placed in the ear canal of the ear to be implanted. The earphone is used to deliver sound during measurements. Method 1: A ball electrode was placed near stapes through the attic to pick up the acoustically evoked compound action potentials. During the progress of the surgery at every stage responses were recorded. Method 2: Following closure of the wound a modified version of the Nucleus NRT software was used to record acoustically evoked compound action potentials.

Results: To date 41 ears with low frequency residual hearing better than 90 dBHL have been tested. All ears were tested using the method 1. 8 ears were also tested using both methods.

Conclusions: Methods 1, was successfully employed to measure residual hearing at different stages of the surgery in all ears. Using method 2 we were able to measure residual hearing in 5 of the 8 ears tested.

Sat03. Infrared Stimulation of the Cochlear Nucleus: Implications for the ABI

RU Verma

Harvard Medical School, BOSTON, United States of America

Introduction: Outcomes of auditory brainstem implants (ABI) are limited in many users, perhaps due to the poor spatial selectivity of electrical methods. Recent work (Richter C-P et al 2011) demonstrates activation of the auditory periphery via infrared neural stimulation (INS), with improved spatial specificity when compared to electrical stimulation. In our study we investigated INS as a means to activate the central auditory pathways when applied to the dorsal cochlear nucleus (DCN).

Methods: In Sprague-Dawley rats, we exposed the DCN via posterior craniotomy and cerebellar aspiration. Using a laser (Capella R-1850, Lockheed Martin Aculight, USA) we delivered pulsed INS to the DCN surface via an optical fiber. We measured auditory brainstem responses (ABR) and activity from the central nucleus of the inferior colliculus (ICCN) using a 16-channel probe (NeuroNexus Technologies, Inc., USA.). The parameters varied included wavelength, peak laser power and pulse rate.

Results: In hearing subjects, INS generated robust ABRs with broad activation along the ICCN's tonotopic axis. Responses were sensitive to the site of stimulation on the DCN, with larger responses at sites closer to the temporal bone. Mechanically deafening the animal eliminated ABR and IC responses.

Conclusion: The epi-phenomenon of 'optophonic' activation (Teudt I.U. et al 2011) appears to account for responses in the hearing subject. While INS of the deafened cochlea seems to provide robust responses, its action at least on the DCN does not generate responses that are synchronized enough to be detected by our recording methods.Supported by MED-EL Corporation & Fondation Bertarelli

Sat04. Estimating neural threshold without artefact subtraction from the linearity of the eCAP recording

RP Morse[1], SD Holmes[1], DM Landsberger[2]

[1]Aston University, BIRMINGHAM, United Kingdom

[2]House Ear Institute, LOS ANGELES, United States of America

Background: Standard methods for electrically evoked compound action potentials (eCAPs) require artefact subtraction, which reduces the signal-to-noise ratio and prevents the method being used at high stimulus rates. To obviate artefact subtraction, we have proposed a variability method, but this does not work consistently with the current generation of cochlear implants. Here, we introduce a new method of estimating NRI threshold based on the linearity of the recordings that exploits the artefact rather than removing it.

Method: For subthreshold stimuli, the probe alone recordings consist of artefact and noise. At each sample, the mean amplitude across multiple trials is proportional to the stimulus level, once the amplifier has come out of saturation. For each sample, we find the best linear fit to the recordings across subthreshold levels. For suprathreshold stimuli, the neural response adds to the artefact causing the recording to deviate from linearity; the sign of the deviation depends on the eCAP phase, e.g. P1 or N1. At each stimulus level, we find the square error between the best fit line and the recording amplitude and we sum these errors across all the samples. In a preliminary study we have applied this method with patients fitted with the Advanced Bionics HiRes90K implant or the Cochlear Corporation Freedom implant.

Results: We have found that deviation from linearity occurs close to the behavioural threshold.

Conclusions: Linearity analysis provides a new way to estimate behavioural threshold that does not require artifact subtraction and should not be limited to low pulse rates.

Sat05. An additive instantaneously companding readout system for cochlear implants

CJ Bes, WA Serdijn

TU Delft, DELFT, Netherlands

Major Cochlear Implant manufacturers have included the possibility of recording neural responses. However, the possibilities are severely restricted due to the occurrence of saturation in the single channel amplifier and analog to digital converter (ADC), and the relative high noise levels. This is most clearly illustrated by the fact that objective neural thresholds are mostly found at the upper end of the subjective electrical dynamic range (Hughes, Brown, Lopez and Abbas, 1999). Recording on these relative high levels has as major drawback that different neural waveforms originating from different fibre populations are combined (Briaire and Frijns, 2005). Potentially the neural response data, thresholds, but also the spread of excitation and neural recovery functions, could provide insight in what the optimal stimulation strategy should be, and how to program the current levels of the implant for individual patients. Especially in very young children this should lead to increased performance. Researchers are now confronted with the limitations of existing neural response readout systems needed for reading out the evoked compound action potential (eCAP). These limitations urge the need for a new neural response readout system having a dynamic range of 126dB, that is small, low noise, power efficient and can handle input signals exceeding the supply voltage. Existing techniques do not offer solutions to meet the above specifications. An overall readout system design is proposed containing an additive instantaneous companding input system, multiplexer, compensation circuit, amplifier and an ADC in order to record the eCAPs from the stimulated auditory nerve.

Sat06. Comparison of ECAP measurements using traditional and novel equipment

GT Tavartkiladze[1], VB Bakhshinyan[1], SR Rose[2]
[1]National Research Center for Audiology and Hearing Rehablitation, MOSCOW, Russian Federation
[2]Cochlear Ltd, BASEL, Switzerland

Introduction: A wireless handheld device to intra-operatively measure Evoked Compound Action Potentials (ECAP's) has been produced by Cochlear Ltd. The aim of this device is to remove the need for bulky clinical equipment in the operating room. Such a handheld device should also make the process of measuring ECAP's more convenient and therefore quicker. This study aimed to validate that the results achieved with the handheld device were equivalent to those achieved using the standard clinical equipment.

Methods: A prospective between subject comparison study was conducted up to 50 subjects. ECAP threshold measurements were performed intra-operatively using the handheld device for all electrodes along the electrode array. The same measurements were repeated using the standard equipment and then compared to the handheld device measurements. A Student's t-test analysis was conducted to evaluate whether there were any significant differences for the two sets of thresholds obtained.

Results: ECAP thresholds were obtained for the recipients and for the majority of electrodes in the array. The statistical analysis indicated that there were no significant differences between the thresholds obtained using the handheld device and those obtained using the standard clinical equipment. Further, no differences were observed between the two systems for the number of thresholds obtained for a particular recipient.

Conclusion: This study evaluated the intra-operative ECAP's thresholds obtained using a wireless handheld device. A comparison was performed with thresholds obtained using standard clinical equipment. It was found that there were no significant differences between the two sets of threshold measurements.

Saturday 22 September 2012

Topic: Free Paper Session Objective Evaluations

Sat07. Detecting and avoiding cochlear implant artifacts in cortical auditory evoked potential recordings

B Van Dun[1], R Lin[2], T Loi[1], S Purdy[2], HA Dillon[1]

[1]National Acoustic Laboratories, CHATSWOOD, Australia
[2]The University of Auckland, AUCKLAND, New Zealand

Introduction: CAEPs are used as an objective electrophysiological measure in (aided) hearing-impaired individuals. Currently the clinical application of CAEPs to CIs is impeded by the presence of an electrical CI artifact.MethodsTo reduce artifact presence, a passive low pass filter was integrated in the recording electrodes of the clinical HEARLab system. To identify the characteristics of the remaining artifact after filtering, 25 adults with CIs were evaluated at two different sites. Three speech sounds /m/, /g/, and /t/ were applied in free field at suprathreshold intensities. All CAEP recordings were run twice to check for reproducibility. CAEPs were detected automatically. An automatic artifact detection algorithm was developed, and compared with visual artifact identification.

Results: The reproducible artifact with the longest latency was 94 (105) ms for contralateral (ipsilateral) electrode positioning. This resulted in the modification of the automatic CAEP detection (starting analysis from 117 ms), which didn't result in a significant reduction of CAEP detection sensitivity. Automatic artifact detection detected all visually detectable CI artifacts with a false alarm rate of about 10%. Based on the above results, a larger study with modified CI mappings to completely disentangle CI artifacts from CAEPs was devised. Initial results will be presented.

Conclusion: Combined with hardware-based low pass filtering, the modified software generally avoided CI artifacts and automatically detected presence of CAEP without loss of detection sensitivity. An automatic artifact detector can be incorporated to alert the clinician that a non-CAEP-like artifact is present.

Sat08. Electrically-evoked auditory change complex in children with auditory neuropathy spectrum disorder

SH He, JHG Grose, HFBT Teagle, CAB Buchman

University of North Carolina at Chapel Hill, CHAPEL HILL, United States of America

Objectives: This study aimed to assess the feasibility of measuring the electrically-evoked auditory change complex (EACC) in response to changes in 1) stimulating electrode position; and 2) temporal continuity (i.e. gap) in children with auditory neuropathy spectrum disorder (ANSD) using direct electrical stimulation.

Study Design: The EACC in response to changes in stimulating electrode was measured from 11 ANSD children ranging in age between 5.5 to 17.1 years. The EACC in response to temporal gap was measured from 15 ANSD children ranging in age between 5.5 to 17.2 years. For each patient, the speech processor was bypassed and an 800-ms train of biphasic current pulses, in two sequential segments, was delivered to individual electrodes through a direct interface with the cochlear implant. The two 400-ms segments were delivered sequentially either to the same or different electrodes. When delivered to different electrodes, the separation between electrodes was systematically varied. When delivered to the same electrode, the duration of temporal gap was systematically varied.

Results: The EACCs were recorded from all ANSD patients by both changes in stimulating electrode position and temporal discontinuity. Patients with only fair speech perception performance (less than 70% correct on PBK Words) needed larger electrode separations and/or longer temporal gaps to elicit the EACC than patients with better speech performance.

Conclusions: It is feasible to recording the EACC from ANSD patients. Temporal processing and/or spectral resolution deficits as evidenced by the EACC might partially account for poor speech perception performances of a subgroup of ANSD patients.

Sat09. Application of ASSR for evaluating the hearing preservation in cochlear implantations

S Haumann, J Blanke, A Büchner, T Lenarz

Medical University of Hannover, HANNOVER, Germany

Introduction: Recently designed cochlear implant electrodes aim to preserve the residual hearing during implantations, succeeding in most cases. For the remaining cases the question arises whether the impairment is caused by the intrinsic surgery or by processes initiated postoperatively.

Methods: Within the implantation routine of devices aiming to preserve the residual hearing ASSR were registered intraoperatively. Therewith the hearing threshold was evaluated under anaesthesia directly before and after surgery. Up to now registrations were done with 45 subjects (14 m, 21 f, Ø 57.2 yrs). 20 of them were implanted with a Nucleus Hybrid-L device and 15 of them with a Nucleus SRA device. The obtained ASSR thresholds were compared with each other and with the pre- and postsurgically measured behavioural thresholds.

Results: On average, the difference between pre- and postsurgically measured behavioural thresholds was 11.4 dB ± 14.8 dB (mean ± standard deviation), the difference between pre- and postsurgically obtained ASSR thresholds was 5.0 dB ± 13.1 dB, the difference between presurgically obtained behavioural and ASSR thresholds was 17.2 dB ± 14.5 dB and the difference between postsurgically obtained behavioural and ASSR thresholds was 15.0 ± 20.4 dB.

Conclusion: The ASSR thresholds were found to be highly reproducible before and after surgery. Thus, the method can be applied for the desired purpose. The differences between ASSR thresholds were detected to be smaller than the differences between the behavioural thresholds. This indicates that impairments of the residual hearing during surgery are primarily caused by postoperative processes.

Sat010. Cortical processing of changes in music and speech in children with cochlear implants: Role of music

RT Torppa

University of Helsinki, HELSINKI, Finland

Introduction: Compared to normal hearing, a cochlear implant (CI) provides weak cues to F0 and timbre. Here we examine cortical responses to investigate pitch and timbre perception and the hypothesis that musical experience enhances perception.

Methods: Unilateral CI users and normal hearing (NH) controls were aged 4-14. Changes in F0, musical instrument, vowel, duration, intensity and temporal gap were presented in a rapid multi-feature paradigm amongst 295 Hz piano tones or pseudo-words /tatata/. Stimuli were familiar sounds with natural harmonics and envelope.

Results: For the CI group mismatch negativity (MMN) to deviants from piano standards showed poorer detection of changes of instrument, duration and the presence of gaps, and faster processing of intensity changes; P3a suggested less accurate attention switching to change of instrument. MMNs for F0 deviants and overall ERPs to musical tones were surprisingly similar between CI and control groups. However, for speech, responses to F0 and vowel changes differed between groups, while MMNs to gap, duration and intensity changes were more similar. Also some connections were found to musical activities.

Conclusions: CI children do detect changes in F0 at the neural level, but only in speech stimuli and younger CI recipients process these changes differently to NH children. The neural detection of changes in duration and gaps also differs between speech and piano tones.

Torppa, R., Salo, E., Makkonen, T., et al., Clinical Neurophysiology. In press.*Supported by S & A Gyllenberg Foundation, Finnish Concordia Fund, Lindfors Foundation, E & G Ehrnrooth Foundation and Langnet.*

Sat011. Cochlear implant artifact cancellation using a high bandwidth high sample rate approach

MMc Laughlin[1], A Lopez-Valdes[2], RB Reilly[2], FG Zeng[1]

[1]UC Irvine, IRVINE, United States of America

[2]Trinity Centre for Bioengineering, TCD, DUBLIN, Ireland

Introduction: The artifact caused by electrical stimulation severely limits the use of evoked potential (EP) measurements in cochlear implant (CI) users. To reduce the artifact, specially modified stimuli are often employed. Hofmann et al. (JARO 2010) outlined an artifact cancelation approach using low pulse rate stimuli on one electrode: a medium bandwidth (2-20kHz) high sample rate (96kHz) acquisition system was used to resolve the artifact and remove it using linear interpolation. Building on this, we developed a method which can be used with a range of stimuli played through the clinical processor.

Methods: We built an EP acquisition system that uses a high-bandwidth amplifier (1-100kHz) and high-sample rate A/D converter (125kHz). We acquired EPs in 5 CI users (1 Med-El, 4 Cochlear) to long duration broadband stimuli played through the normal clinical processor. The CI artifact was clearly visible as a train of stimulation pulses. This was restricted to the frequency range (>900Hz) and removed using a 2nd order Butterworth filter (2-35Hz).

Results: Artifact free long latency cortical EPs were recorded in all 5 subjects. The normal P100, N100, P200 and N200 peaks were present.

Conclusion: A high bandwidth high sample rate acquisition system provides a robust approach to artifact cancelation for cortical EPs. This system has been used with complex broadband stimuli which can provide an estimate of a CI user's speech perception (Lopez Valdes et al. OM Conference 2012). It represents a generalized approach which can be used with many types of stimuli and EP measurements.

Saturday 22 September 2012

Topic: Free Paper Session Fitting

Sat012. ESR, ECAP and MCL: Their relation for charge-based fitting in implants with 31,5 mm electrode

AW Walkowiak[1], AL Lorens[1], AW Walkowiak[1], MP Polak[2], HS Skarzynski[1]

[1]Institute of Physiology and Pathology of Hearing, WARSAW, Poland
[2]Med-El, INNSBRUCK, Austria

Aim: The aims of the study was to compare eSR and eCAP thresholds for the apical, medial and basal electrodes, recorded using charge units on experienced Med-El Pulsar cochlear implant users with standard 31,5mm electrode

Methods: Fourteen children and 16 adults participated in the study, all implanted with the Medel Pulsar system with the Opus II speech processor. ESRT and eCAP thresholds were measured for both groups using the Auditory Nerve Response Telemetry (ART) algorithm, with Most Comfortable Level (MCL) being used only for the adult group. The subjective judgment of MCL was achieved using a loudness scaling procedure that ranged from 'first hearing' to 'uncomfortably loud'.

Results: The mean eSR threshold, the mean ART threshold, and the mean MCL was 19.80 nC, 14,38 nC and 21.37 nC, respectively. No statistical difference was found between the means of any of the electrode pairs (electrodes 2, 6, and 11) for eSR thresholds, ART thresholds or MCLs.

Conclusions: The results of present study indicated that all parts of long 31,5mm electrode could be effectively stimulated

Sat013. Fitting optimization through de-activation of electrodes based on NRI recordings

E Zir[1], A Gault[2], F Vanpoucke[3], I Akhoun[3], P Govaerts[4], A Nehme[1]

[1]Sacred Heart Hospital, BAABDA, Lebanon

[2]Advanced Bionics, RIXHEIM, France

[3]European Research Centre Advanced Bionics, HANNOVER, Germany

[4]Eargroup Deurne, ANTWERP, Belgium

Introduction: In some occurrences stimulation of a functioning electrode may elicit non-auditory sensations. In such cases it is generally advised to de-activate the electrode of concern. This sometimes significantly improves user performance. Up to now the selection of electrodes to de-activate was solely based on a simple audiometric analysis. The aim was to determine objective parameters based on standard NRI measurements to assist the audiologist in the selection of one or more electrodes to de-activate.

Methods: 30 experienced Advanced Bionics HiRes 90K users were studied. NRI measurements were performed on the 16 electrodes of the HiFocus 1j array. NRI threshold (tNRI) and slope values were extracted from the NRI recordings. Based on the analysis of these data and the clinical experience from experts an electrode exclusion rule was defined for extreme slope and tNRI values, which were considered incompatible with normal functioning of the implant. This rule made it possible to identify some deviating values for 9 out of the 30 subjects. The identified electrodes were then de-activated, independently from the sound sensation perceived by the user.

Results: In three out of nine subjects where electrodes were de-activated performance was significantly improved. Two other subjects reported an improvement in sound quality. The four remaining subjects did not mention improvement nor decrease in sound perception.

Conclusion: NRI measurements generate relevant information regarding neural responsiveness in each electrode's neighbourhood. This study highlights a possible application of NRI recordings in fitting optimization and particularly in electrode de-activation to improve user performance.

Sat014. Future Fitting Methods for clinicians with limited Cochlear Implant experience

S Maruthurkkara[1], A Plasmans[2]

[1]Cochlear Ltd, MACQUARIE UNIVERSITY, Australia

[2]Cochlear Technology Centre, MECHELEN, Belgium

Globally the number of cochlear implant recipients is growing rapidly and there is a growing need for clinicians to provide care for cochlear implant recipients. If the cochlear implant fitting process can be automated such that novice clinicians can reliably fit cochlear implants and at the same time learn further skills, this may help address the clinic capacity issue in CI clinics.A new cochlear implant fitting method that uses the shape of the AutoNRT profile and recent advances in NRT based programming has been designed by Cochlear. The aim of this study was to assess the outcomes when this fitting method is used by novice clinicians.

Methods: Clinicians who had no prior experience or training on programming cochlear implants received self learning training material followed by face to face training. They were then asked to use research software implementing the new fitting method to program adult cochlear implant recipients. The performance of the programs created by the novice clinician was compared to the performance of those programs created by an experienced CI clinician using the current fitting best practices.

Results: The results will discuss the performance and satisfaction ratings with this new fitting methodology.'

Conclusions: The new fitting method will enable experienced CI clinicians to delegate the fitting of recipients without complex needs to less experienced clinicians allowing them to focus of recipients with complex needs. The implications of the use of new fitting methods to assist in scaling the clinical pathway while maintaining expected outcomes will be discussed.

Sat015. Comparison between objective and subjective methods of the Comfortable Balanced Profile (C-Profile)

DA D'Elia[1], AS Scorpecci[2], PM Malerba[3], IC Cantore[4], NQ Quaranta[5], GS Succo[6], FT Trabalzini[7], GP Paludetti[2]

[1]UNiversity of Bari, BARI, Italy

[2]Institute of Otorhinolaryngology,A.Gemelli University Hospital, ROME, Italy

[3]Cochlear Italy, BOLOGNA, Italy

[4]ENT Department, San Carlo Hospital, POTENZA, Italy

[5]University Institute of Otorhinolaryngology, Azienda Ospedaliera Policlinico, BARI, Italy

[6]ENT Department, Martini Hospital, TORINO, Italy

[7]Policlinico Santa Maria alle Scotte, Azienda Ospedaliera Universitaria Senese, SIENA, Italy

Introduction: In uncooperative patients using cochlear implants, objective methods are necessary to set threshold (T) and comfort (C) levels of a map. Electrical compound action potential (ECAP) thresholds are reliable in predicting T-Levels, but are not much reliable in predicting C-Profile.This study aims to assess if the C-Profile can be predicted by a novel objective procedure (C-NRT) which uses the Amplitude Growth Function (AGF) and relies on the assumption that equal ECAP amplitudes elicit equal loudness sensations.

Methods: 21 postlingually deafened patients received two maps: a behavioral, bitonal balanced (BB) map and an objective map, in which T-Levels were the same as in the BB map, and C-Levels were obtained with C-NRT. C-NRT consisted of analyzing the AGF of 9 electrodes, and of setting the current level eliciting at 100μV ECAP amplitude as C-Level in the map. AutoNRT was also measured. Performance with both maps was assessed with a word recognition test and a questionnaire, in an A-B-AB design.

Results: Both 'overall' and 'per electrode' statistical analysis showed a strong correlation between behavioral and C-NRT-derived C-Levels (overall Partial Correlation with T-Level as Control Variable: $r=0.6565$, $p<0.001$; mean per electrode Partial Correlation: $r=0.705$, $p<0.001$). Moreover, AutoNRT isn't correlated with behavioral C-levels (overall Partial Correlation: $r=-0.015$, $p=0.3764$). Word recognition was significantly better with BB maps in quiet ($p=0.0007$), no significant differences in Noise. Only 8 patients preferred the BB map.

Conclusion: C-NRT is more accurate than AutoNRT in predicting the C-Profile. This finding encourages future application in uncooperative patients, especially young children.

Saturday 22 September 2012

Topic: Objective Measures in Bone Conduction

Sat017. A novel bone conduction implant (BCI) device

BEV Håkansson[1], **TAS Reinfeldt**[1], HR Taghavi[1],
MT Eeg-Olofsson[2], KJ Fredén Jansson[1]

[1]Chalmers University of Technology, GÖTEBORG, Sweden
[2]ENT Dept, Sahlgrenska University Hospital, GOTHENBURG, Sweden

Introduction: A novel Bone Conduction Implant (BCI) device with an implanted transducer that is not percutaneous has been developed and adapted for long-term implantation. One objective with the BCI implantation is that the surgical procedure should be similar or less invasive compared with the Bone Anchored Hearing Aid (BAHA) surgery. Another objective is that the BCI device should have similar current consumption and maximum power output as the BAHA.

Methods: The BCI system consists of an external sound processor (with a sophisticated digital signal processor (DSP) and an efficient application specific integrated circuit (ASIC)) and an implanted unit called the BCI Bone Bridge that comprises a passive implanted transducer in the temporal bone and an inductive link similar to those used in middle ear implant devices. Objective measurements of the BCI system have been performed on a Skullsimulator, a dry skull, cadaver heads and in an animal (sheep) study.

Results: It was found that the BCI device has similar maximum power output at the cochlear level as the BAHA devices and the surgical procedure is regarded as minor invasive and safe for the patients. Also, the output was found to be robust for skin thickness range of 2 to 10 mm. Moreover, transmission and attachment properties of the BCI transducer to the bone were found to be efficient and long term stable in the sheep study.Conclusion: The BCI device is ready now for implantation in candidate patients. Regulatory works and patient recruitment is proceeding.

Sat018. Clinical utility of resonance frequency analysis (RFA) for bone conduction auditory implants

C Flynn

Cochlear Bone Anchored Solutions AB, MÖLNLYKKE, Sweden

Introduction: Recently, published data has reported on the safety and efficacy of reducing the loading time of Bone Conduction Audiory Implants to 3 week post surgery for a healthy adult. Given this change in practice, some surgeons have requested an objective measurement tool to estimate implant stability. Resonance Frequency Analysis (RFA) has been used with dental implants for a number of years and is increasingly being used in the application of bone conduction implants. With RFA, the stability of the implant is indicated by the Implant Stability Quotient (ISQ) value from 1 to 100.

Methods: This presentation will discuss the principles of Resonance Frequency Analysis, and analyse the published data from a number of pre-clinical and clinical studies using RFA and bone conduction implants. The analysis has been conducted in close cooperation with the manufacturer of the RFA measurement equipment (Osstell, Sweden) and a number of clinical sites in Europe.

Results: The results indicate that RFA is a suitable tool for calculating the stability of a bone conduction implant. Similarly, the data shows, that when used in combination with clinical knowledge the measurement of RFA can provide the clinician with reassurance on the suitable loading time.

Conclusion: This presentation highlights how RFA can be used as a clinical and research tool to enable surgeons to determine the stability of an extra-oral osseointegrated implant. We will discuss how such a measurement tool and the results of evaluations can be used in clinical practice.

Sat019. Transcranial attenuation as a measure to predict the outcome of a BCD trial in SSD patients

JD Desmet, MDB De Bodt, PV Van de Heyning

Antwerp University Hospital, EDEGEM, Belgium

Introduction: Different authors studied possible factors influencing the decision of a bone conduction device (BCD) candidate to opt for BCD surgery or not. However, there is no consensus amongst authors that transcranial attenuation (TA) has a significant influence on this decision. We aim to verify if the measurement of TA can have a clinical implication in the decision of a SSD BCD candidate after a BCD trial.

Methods: Data of 58 SSD BCD candidates were analyzed. All patients had (sub)normal hearing at the contralateral side and did a trial with a BCD for at least two weeks. Unmasked bone conduction thresholds between 0.25 and 4kHz were measured ipsi- and contralaterally using a type B-71 bone vibrator. Consequently, TA could be calculated in all patients.

Results: 21 SSD patients decided to get a BCD implant after the trial period (BCD+) whereas 37 patients declined BCD surgery (BCD-). TA was statistically significantly higher in the BCD- group at 0.5kHz (BCD- 4.19dB (SD 9.24); BCD+ -3.1dB (SD 8.29), *p=0.013*) and 2kHz (BCD- 7,43dB (SD 7.87); BCD+ 0.48dB (SD 5.68*), p=0.002*). At other frequencies, no significant differences were found.

Conclusion: The perceived benefit with a BCD on a test band was higher in the group with lower TA at 0.5 and 2kHz. Consequently, TA does seem to play a role in the decision of a SSD patient whether or not to undergo BCD surgery after a trial with a BCD.

Sat020. Mechanical measurement of frequency response in Baha implants in the live skull

NN Nishizawa[1], HM Maeda[1], ET Tamashige[1], SK Kasai[1], NT Takeichi[2]

[1]Health Sciences University of Hokkaido, SAPPORO, Japan

[2]Graduate School of Medicine, Hokkaido University, SAPPORO, Japan

Introduction: It is known that the sound conduction system of the bone-anchored hearing aid (Baha) has a wider frequency responsibility than that of indirect (trans-cutaneous) bone-conduction hearing aids as the absorption of the high-frequency range by the soft tissue between the vibrator and the skull is avoided in the Baha sound pathway. In order to confirm this, mechanical measurement of frequency response using a live head was performed to compare direct pathways of the bone-conduction system with trans-cutaneous pathways.

Method: Adult patients who underwent Baha implantation were enrolled as the subjects. Simultaneous recording of bone-conducted sound during skull vibration was made via direct and trans-cutaneous pathways using piesoelectric transducers.

Results: When the bone-conducted sound was picked up by the trans-cutaneous pathway attached to the mastoid skin, linearity of the input-output relationship was maintained within the frequency range of 250 to 1000Hz. In the frequency range higher than 2000Hz, no linear input-output relationship was seen. When the bone-conducted sound was picked up directly from the Baha implant, a linear input-output relationship was found up to 4000Hz.

Discussion: Direct pick-up of bone-conductive sound from a Baha implant showed wider frequency responsibility compared to that observed with trans-cutaneous pick-up. Mechanical measurement of skull vibration via the bone-anchored implant of the Baha enabled the objective evaluation of the bone-conduction hearing aid system.

Saturday 22 September 2012

Topic: Robotics, Surgery, Navigation

Sat021. A self-developed and constructed robot system for cochlear implantation

MC Caversaccio[1], BB Bell[2], CS Stieger[3], NG Gerber[4], LN Nolte[5], SW Weber[3]

[1]BERN, Switzerland
[2]ARTORG center, BERN, Switzerland
[3]ARTORGcenter, BERN, Switzerland
[4]Institute for Surgical Technologies, BERN, Switzerland
[5]Institute for Surgical Technologies and Biomechanics, BERN, Switzerland

Objectives: Industrial robots can perform minimally invasive access to the inner ear in an experimental setup with a target error below 1 mm and an angular misalignement slightly larger than 1 mm. But they are not designated for the use in the Operational theater. A purpose built lightweight system could be beneficial for clinical integration into the Operation theater. Therefore we designed a robot based on clinical requirements. The aim of this study was to determine and compare the accuracy of the purpose built robotic systems based on industrial robots in a experiment comprising a minimally invasive approach to the inner ear.

Methods: The robotic system is consists on a lightweight (5.5 kg) design. 15 ears of anatomical whole head specimens were used to drill a minimally invasive approach to the inner ear using the robotic system. The test protocol included preoperative Cone beam CT scan, manual segmentation, pair-point matching registration, drilling with the robot, postoperative Cone beam CT scan for numerical validation and manually performed mastoidectomy for qualitative verification.

Results: The accuracy at the target point (round window) was 0.56 mm ± 41mm with an angular misalignment of 0.88° ± 0.41°. Besides one facial nerve leasion all anatomical vital structures have been conserved.

Conclusion: A purpose built lightweight robotic system achieves similar or slightly higher accuracy than industrial robotic systems in an experimental setup for a minimally invasive access to the inner ear.

Sat022. Measuring insertion forces for CI Implantation in cadaveric human temporal bones

OM Majdani, PM Mane, FE Eckardt, JL Lexow, TL md, phd Lenarz, TR Rau

Hannover Medical School, HANNOVER, Germany

Introduction: For the residual hearing preservation cochlear implant surgery the integrity of the intracochlear structures, in particular basilar membrane, is decisive. Among others one possible measure of the intracochlear damage are forces acting on the cochlea. In this study we wanted to examine the forces that occur during insertion of the CI electrodes in the cochlea.

Materials and methods: 3 fresh cadaveric human temporal bones were initially prepared for insertion and fixed on the load cell (XF 3030). A total of 3 Contour Advance practice electrodes (Cochlear,Sydney,Australia) were used, each electrode was utilized up to 10x. The forces occurring during the insertion and explanation were measured.

Results: In the first experiments maximum forces of 0.16N to 0.19N were measured. After the third insertion the forces were reduced to 0.03N to 0.09N. Once the surgeon slipped during insertion process, forces of 0.1N to 0.2N were measureable. In the 2nd temporal bone only 3 insertions were performed. Again, the first forces were definitely higher than the later trials. At the third temporal bone (10 insertions) also at the first attempt measured higher forces (0.44N to 0.46N) and at the subsequent attempts the force to values went down to 0.08N 0.15N.

Discussion: Insertion and extraction forces are decisive for the assessment of the violation of the intracochlear structures. For this reason, we want to continue this series of experiments with atraumatic electrodes. So far, we have a first record for insertion forces raised by conventional electrodes.

Sat023. Future impact of miniaturized approaches in cochlear implantation

S Hansen[1], I Stenin[1] , M Nau[2], M Becker[3,] J Schipper[1], T Klenzner[1]

[1]ENT-Department, University of Düsseldorf

[2]Laboratory for Machine Tools and Production Engineering (WZL) of RWTH Aachen University

[3]Interactive Graphics Systems Group, TU Darmstadt

Computer-assisted surgery (CAS) can provide a possibility for minimally invasive or „keyhole“ cochlear implantation without a conventional mastoidectomy. The precision of new techniques in imaging like DVT and navigation systems may support the requirements these minimally invasive approaches. A keyhole access from the mastoid surface to the cochlea, mostly with a single drilled channel, has been attempted by several groups under neuronavigated control. Here, we present the feasibility of multi-port strategies with up to 3 drilled channels to an „rendezvous“ point like the round window.

We used a newly generated software program called SOFA to calculate 3 drilling channels. Twenty CT scans of patients who underwent conventional cochlear implantation were tested concerning channel diameter and angles of the three channels. Secondly, we transferred standards from non-medical fields (ISO and DIN) to calculate a predictive value for complications depending on the radius of the drilled canal, accuracy of CT scan, and accuracy of the segmentation of the CT scan.

The results demonstrate a practicable software-based planning tool and the possibility of 3 individual drilling channels to the round window. The diameters of the channels ranged around 2-4 mm. These data would enable the use of two different instruments together with an endoscope. The calculation of the so called „minimum process capability index“ (ISO 3534-2) allows to evaluate the safety distance to avoid damaging neurovascular structures in the temporal bone for each single drilled channel and can, therefore, serve as a decision guidance to identify suitable patients for a keyhole strategy in cochlear implantation or other temporal bone surgery.

Sat024. Mechatronic electrode array insertion: Experimental results

YN Nguyen, MM Miroir, GK Kazmitcheff, ABG Bozorg-Grayeli, OS Sterkers

Inserm / University Paris 7 UMRS-867, PARIS, France

Introduction: Today, the surgical challenge in cochlear implantation is the preservation of the anatomical structures and the residual hearing after cochlear implantation. Electrode array insertion force appears to be related to the array collision and friction to intracochlear structures. Hence, it is potentially related to cochlear damage. However, this force is small and can hardly be perceived by the surgeon's hand. Its intraoperative monitoring and reduction will probably reduce the extent of intracochlear lesions.

Methods: We designed and manufactured synthetic transparent models of *scala tympani* allowing the visualization of array progression during its insertion. In human temporal bone specimens, we also developed a microdissection technique to open the *scala vestibuli* in its whole length and to preserve the basilar membrane. The electrode array insertion in the *scala tympani* could be monitored visually under the partially transparent basilar membrane. We designed a tool allowing motorized insertion with forces measurements.

Results: The force measurement recordings could not detect the collision of the array on the lateral wall nor the basilar membrane perforation. However, they showed a progressive increase due to the friction on the lateral wall. Folding tip or array blocking could be detected by analysing friction force profiles.

Conclusion: Insertion force measurements during array insertion provide valuable information on the array's mechanical behaviour inside cochlea. This work validated a simple procedure for array insertion force measurement and opens insights to a force-controlled array insertion.

Posters

P01. Comparing electrically evoked brainstem and cortical potentials in pre- and postlingually deafened

MJW Lammers, H Versnel, GA Van Zanten, W Grolman

UMC Utrecht, UTRECHT, Nederland

Introduction: The variability in performance between good and poor performing cochlear implant users, might be related to the extent of plasticity of the auditory brainstem and cortex. Electrically evoked cortical auditory evoked potentials (eCAEPs) and auditory brainstem responses (eABRs) have been suggested as biomarkers for this plasticity, since peak latencies are found to decrease after cochlear implantation in early implanted children. Our aim was to characterize eCAEPs and eABRs in subjects with and without substantial auditory stimulation before cochlear implantation.

Methods: eCAEPs and eABRs were obtained in late implanted cochlear implant users who were either pre- or postlingually deafened. The eCAEP and eABR waveforms and accompanying peak and trough latencies were compared between the pre- and postlingually deafened group.

Results: Typical eCAEP waveforms were found in both groups of CI users. There is a considerable variability in the N1 and P2 peak latencies among subjects within both groups. Latencies of the prominent eABR peaks (III and V) did not significantly differ between the two groups.

Conclusion: Although the prelingually deafened patients had no normal early cortical development like the postlingually deafened patients, the neural plasticity triggered after several years when auditory input was provided by the CI, was apparently sufficient to enable development into a ‘postlingual’ neural system, compensating for the early loss.

P02. Auditory cortical maturation in children with bilateral cochlear implants implanted sequentially

M Sparreboom, AJ Beynon, AFM Snik, EAM Mylanus

UMC St. Radboud, NIJMEGEN, Nederland

Introduction: Deaf children with sequential bilateral cochlear implants show bilateral advantages in localization and speech perception but the auditory performance of the second implant often lags behind with that of the first implant. The purpose of this study was to objectively determine whether auditory neural processing by a second implant would become comparable with that of the first implant and whether there was an effect of inter-implant delay.

Methods: Thirty children received bilateral cochlear implants sequentially. The mean age in receiving the first implant was 1.8 years and the mean age in receiving the second implant was 5.3 years. Electrically evoked auditory cortical responses (EACRs) were evoked by the first and second implants separately after 12 and 24 months after the second implantation. P1 and N2 latencies and RMS amplitudes were compared between both implant sides.

Results: EACR latencies diminished over time for both implant sides. RMS amplitudes and P1 latencies elicited by the second implant were still significantly prolonged after 24 month. After 24 months, the difference in N2 latencies between both implant sides was no longer significant. Inter-implant delay had an adverse effect on RMS amplitudes and waveform morphology.

Conclusion: Auditory cortical maturation is possible after extended unilateral cochlear implant use, although inter-implant delay has an adverse effect on symmetry of auditory cortical maturation between stimulation of both implant sides. Whether auditory neural processing by the second implant would become comparable with that of the first cochlear implant after longer periods of bilateral implant use remains the question.

P03. Auditory and visual activity in auditory cortex of cochlear implant users measured with NIRS

MM van Wanrooij, HY Hu, LV Straatman, AF Snik
UMC St. Radboud Nijmegen, NIJMEGEN, Nederland

Introduction: Early hearing loss will disrupt normal development of the auditory system. It remains to be seen whether later restoration of peripheral hearing by implanting a cochlear implant (CI) would also restore normal auditory processing within the central auditory system. Traditional neuroimaging methods such as fMRI, MEG and EEG are impractical to study such processing because of artifacts induced by the CI, while PET has the disadvantage of being a highly invasive technique. Here we investigate the suitability of another imaging technique, near-infrared spectroscopy (NIRS) as a non-invasive method to study the impaired auditory system of CI users. NIRS is a low-cost, low-maintenance, highly-mobile, user- and patient-friendly technique. Because NIRS detects blood-oxygen changes due to absorption of near-infrared light, it does not produce or is affected by a magnetic field.

Methods: We recorded auditory cortical activity by positioning NIRS lasers at the right or CI-contralateral hemisphere (T3 or T4 accordng to the 10-20 system) for 10 normal-hearing subjects and 5 CI-users, respectively, for three types of stimuli: auditory, visual and audiovisual speech segments of a video recording of a female Dutch speaker.

Results: A clear hemodynamic response was observed during auditory stimulation in both normal-hearing subjects and CI-users. A weak effect of visual stimulation was observed, that tended to be larger in the CI-user group.

Conclusions: The NIRS technique is not standard and as well-documented as other neuroimaging techniques. Despite this limitation, it is a promising technique to measure hemodynamic activity in the impaired central auditory system.

P04. Auditory evoked responses to pitch matched stimuli in cochlear implant users with residual hearing

C-T Tan[1], B Martin[2], B Guo[1], K Prosolovich[1], M Svirsky[1]

[1]New York University, School of Medicine, NEW YORK, United States of America

[2]City University of New York, Graduate Center, Speech and Hearing Sciences, NEW YORK, United States of America

Introduction: It is now common for some cochlear implant (CI) users to have enough residual hearing in the unimplanted ear to compare the pitch percepts elicited by electrical stimulation with those elicited by acoustic hearing. We propose to use the changes in pitch percepts elicited by a given electrode as a metric to examine the perceptual adaptation process after implantation.

Methods: Pitch percepts were evaluated psychoacoustically and physiologically in 7 CI users and 6 NH (normal hearing) listeners. CI users adjusted the frequency of an acoustic tone presented to the non-implanted ear to match the pitch percept elicited by electrical stimulation delivered to the implanted ear. Auditory Evoked Potentials (AEP) were recorded in CI users in response to interleaved presentations of electrical stimulation of a single intracochlear channel and acoustic tones delivered contralaterally. One of these tones was pitch-matched to the electrode and the other tones were not. For normal hearing listeners, a 500 Hz acoustic tone replaced electrical stimulation.

Results: For both CI users and NH listeners, N1 latency was minimized when both ears were presented with stimuli that had the same pitch. In this case of NH listeners, this was when both ears were stimulated with the same frequency. In the case of CI users, N1 latency was minimized when the acoustic and the electrical stimulus were pitch-matched.

Conclusion: N1 latency could be a potential marker of acoustic-electrical pitch matching in CI users and help in interpreting the behavioral results.

P05. The clinical feasibility and value of various postoperative electrophysiological measures

MJW Lammers, H Versnel, GA Van Zanten, W Grolman

University Medical Center Utrecht, UTRECHT, Nederland

Introduction: Objective peripheral and central auditory responses may be useful in the postoperative speech processor programming of specific patient populations or as a tool to evaluate cochlear implant malfunctioning. For this it is essential that these measures can be reliably recorded postoperatively in virtually all patients. The aim of this study, therefore, is to investigate the postoperative success rate of recording of the electrically evoked compound action potential (eCAP), the electrically evoked auditory brainstem response (eABR) and the electrically evoked cortical auditory evoked potentials (eCAEP).

Methods: In a series of adult Cochlear Nucleus Freedom and CI512 users eCAPs, eABRs and eCAEPs were postoperatively evoked on a basal, medial and apical electrode. Stimulation level was confined to the maximum acceptable loudness level (C-level). The success rate of recording was registered for all three measures.

Results: The eCAP success rate of recording was poor to moderate, especially for the more basally located electrodes. In the unsuccessful cases the intraoperatively recorded eCAP thresholds had been above the postoperative C-level. The success rate of the eABR and eCAEP recordings was high on the middle and apical electrodes, and poor to moderate on the basal electrodes.

Conclusion: The poor to moderate success rate of recording of the postoperative eCAP threshold limits the clinical value of this measure. We suggest to obtain postoperatively eABR and eCAEP recordings in cases in which eCAPs are not measurable or if additional information of the auditory pathway is required.

P06. Reliability of a 3D digitiser with cochlear implants: Optimising EEG source localisation

DA Vickers[1], T Medeiros Deperon[2], I Yasin[2]

[1]CAMBRIDGE, United Kingdom

[2]UCL Ear Institute, LONDON, United Kingdom

EEG source localisation (EEG-SL) may be conducted using an adult-head model with standard-EEG electrode positions. However due to individual scalp variations the average-head model for estimating x,y,z coordinates may produce inaccuracies in estimating the underlying neural-source generators. Individual estimates of x,y,z coordinates can be obtained using a 3D digitizer (3DD) to record exact scalp positions prior to EEG-SL recording. Accurate estimates of EEG-SL are valuable for cochlear-implant (CI) research but distortion caused by interference and changed head shape (due to CI), may compromise accuracy in EEG-SL. Since the 3DD contains a magnetic component, it is critical to determine if this magnetic field interferes with the accuracy of determining the x.y.z coordinates of scalp positions.A reliability study of 3DD measurements using a dummy head was conducted to determine repeatability and distortion in coordinate measurements. There were three conditions: without a CI, with one CI and two CIs placed on the side(s) of the head. All conditions were repeated five times.An inter-class correlation looking at consistency of scalp measurements across repetition, showed a high Cronbach's Alpha (> .90). A repeated measures ANOVA (repetition as subject, and centroid estimates as outcomes) with factors: CI configuration and x,y,z coordinates, showed no significant differences for CI configuration ($F(2,8)=1.56, p=.27$) or x,y,z coordinate ($F(2,8)=1.92, p=.21$).This suggests that the 3DD has potential for improving EEG-SL accuracy with CI users. It has a high test-re-test reliability and measurements are not affected by CIs. Results will be compared to 'real' and 'CI' heads.

P07. Cortical binaural interaction component: Binaural fusion of complex tones at a 20-Hz modulation rate

I Yasin[1], D Vickers[2], V Drga[2], S Rajasingam[2], K Garrick[2], D Naik[2], I Sharif[2], A McMahon[2], A Faulkner[3]

[1]LONDON, United Kingdom

[2]Ear Institute, University College London, LONDON, United Kingdom

[3]Dept. Speech, Hearing and Phonetic Sciences, University College London, LONDON, United Kingdom

In normal hearing much of the benefit of two ears derives from central auditory analyses of interaural differences. For bilateral cochlear implant (CI) users with typical fittings, in which the two devices are fitted largely independently, binaural processing is constrained by factors such as limited spectral and temporal resolution, a lack of temporal synchronisation between devices and interaural mismatches in frequency-to-place maps. There is a need both to identify the potential for CI users to benefit from binaural processes and to develop objective fitting methods that exploit this potential. EEG may be an effective means to assess cortical binaural processing.One measure of binaural fusion is the cortical Binaural Interaction Component (cBIC). The BIC has traditionally used transient or steady-state stimuli. However, it may be more appropriate to obtain a measure of the BIC to modulated stimuli similar to that produced by the speech processor of a cochlear implant.Cortical responses to 2-tone stimuli were obtained from fourteen normal-hearing listeners. Carrier frequencies were 1 and 1.82 kHz, with sinusoidal amplitude modulation, where present, at 20 Hz. The two carriers were presented either monaurally (left or right ear) or to both ears. Conditions included both carriers unmodulated, both carriers modulated, and one carrier modulated and the other unmodulated. Preliminary autocorrelation analyses suggests that the cBIC to 20 Hz modulation may depend on the presence of modulation at matching carrier frequencies in both ears, and could provide a means of establishing the degree of interaural correspondence in dynamic-stimulus processing.

P08. Audiologic manifestation in pediatric patients diagnosed with Leigh syndrome

EJS Son, YML Lee, SAH Hong, EJL Lee

Yonsei University College of Medicine Gangnam Severance Hospital, SEOUL, South Korea

Background: Leigh syndrome is a neurodegenerative disorder characterized by consistent brain changes, but presents with a broad spectrum of clinical manifestation. It is associated with the largest genetic heterogenitiy among mitochondrial disorders. In addition to muscular and neurological deficits, hearing loss is often associated in mitochondrial disorders. This study aims to investigate characteristics of hearing loss in children with Leigh syndrome.

Methods: Leigh syndrome was diagnosed in 18 unrelated children by clinical and laboratory testings including muscle biopsy histology and enzymology. We retrospectively reviewed their clinical and audiological characteristics. Audiologic evaluation included pure-tone audiometry, tympanometry, transient evoked otoacoustic emissions and auditory brainstem response.

Results: Some degree of hearing impairment was identified in 12 of 18 children (66.7%). Hearing loss varied in severity from mild to profound. Audiological evaluation suggested cochlear lesions as well as retrocochlear origin of hearing loss, suggested by abnormal brainstem responses with preservation of otoacoustic emissions in 4 patients. Progression of hearing loss was identified in 2 patients.

Conclusions: Our study reports the audiologic characteristics of Leigh syndrome in the largest number of patients, that range from normal hearing to profound hearing loss. Audiologic evaluation suggests possible involvement of peripheral auditory system in addition to the central nervous system. Since hearing loss presents additional challenge in rehabilitation, hearing evaluations will be helpful for these children with Leigh syndrome.

P09. Can Auditory Steady-State Responses objectively measure risk for dyslexia in preschoolers?

SV Vanvooren, HP Poelmans, MH Hofmann, HL Luts, PG Ghesquière, JW Wouters

KU Leuven, LEUVEN, Belgium

Introduction: Temporal modulations below 40Hz have been shown to be important for speech understanding. Modulation frequencies near 4 and 20Hz represent the rate by which syllables (±250ms) and phonemes (±50ms) appear in speech, respectively. It has been hypothesized that a neural deviance in the processing of these modulations relates to the reading and spelling problems in dyslexia, a specific learning disorder. The neural correlates of temporal auditory processing at specific resonance frequencies can be investigated by recording Auditory Steady-State Responses (ASSRs) in the electroencephalogram (EEG). ASSRs measure the ability of the auditory system to follow the rate of temporal information and may therefore provide an objective measure to determine the sensitivity for important acoustical-phonological elements in language.

Methods: In the present longitudinal study, auditory processing was investigated in a group of 45 preschoolers with and 45 preschoolers without an increased risk for dyslexia. ASSRs were recorded in a 64 electrode configuration using 100% amplitude-modulated speech-weighted noise stimuli at 4, 20 and 80Hz. The 80Hz ASSR is known to be evoked in the brainstem, while the 4 and 20Hz ASSRs are generated in the cortex. Response strength is examined with response amplitudes and signal-to-noise ratios. In addition, hemispheric response asymmetry is assessed with a laterality index. The underlying neural sources are fitted using brain source analysis methods.

Results: Preliminary results indicate differences between syllable and phoneme level for children with and children without an increased risk for dyslexia. Analyses are ongoing. Further results and implications will be discussed at the conference.

P10. The binaural interaction component of the cortical auditory evoked potential in children

SH He, JHG Grose, HFBT Teagle, CAB Buchman

University of North Carolina at Chapel Hill, CHAPEL HILL, United States of America

Objectives: This study aimed to investigate developmental effects on the binaural interaction component (BIC) of the cortical auditory evoked potential (CAEP) in normal-hearing children and in children with cochlear implants (CIs).

Study Design: The BIC of the CAEP was recorded in normal-hearing children and children with bilateral CIs using a multi-channel Neuroscan system. Listeners participated in this study ranged in age between 1.5 and 18 years. In normal hearing children, the stimulus was a narrow-band Gaussian noise presented at 70 dB SPL. In CI children, the stimulus was a 100-ms train of biphasic current pulse delivered to individual electrodes at the C level. The CAEP was recorded in response to left monaural, right monaural and bilateral stimulation for each listener. The BIC of the CAEP was computed by subtracting the CAEP recorded in response to binaural stimulation from the algebraic sum of the two monaural evoked potentials.

Results: The BIC of the CAEP was recorded from listeners as young as 1.5 years. Our preliminary suggested that the BICs of the CAEPs recorded from young listeners showed longer latencies than those recorded from older children.

Conclusions: The BIC of the CAEP can be recorded from children as young as 18 mos. Similar to the onset CAEP, the BIC of the CAEP demonstrates maturational changes.

P11. Using Cortical Evoked Potentials to Estimate Speech Perception in Cochlear Implant U**sers**

ALV Lopez-Valdes[1], M Mc Laughlin[2], L Viani[3], J Smith[3], F Zeng[2], R Reilly[1]

[1]Trinity College Dublin, DUBLIN, Ireland

[2]Hearing and Speech Laboratory, UCI, IRVINE, United States of America

[3]National Cochlear Implant Programme, Beaumont Hospital, DUBLIN, Ireland

Introduction: Firszt et al. (JARO 2007) reported a correlation between cochlear implant (CI) user's speech perception and mid-latency cortical evoked potentials (CEP) elicited to simple stimuli. Psychoacoustic studies have shown that CI user's ability to discriminate spectrally rippled noise stimuli is correlated with their speech perception (Won et al. JARO 2007). Such complex stimuli may be better at characterizing a CI user's neural processing abilities but are normally not used in CEP studies due to experimental artifact. We have developed a method which allows acquisition of artifact free CEPs using complex stimuli (Mc Laughlin et al. OM Conference 2012) and demonstrate how CEPs to spectrally rippled noise may be used to estimate speech perception in CI users.

Methods: We measured mis-match negativity (MMN) responses in 5 CI subjects (1 Med-El, 4 Cochlear) and 1 normal hearing. The standard stimulus (90%) was spectrally rippled broadband noise; the deviant (10%) was the inverted version, having an equal number of ripples per octave (RPO). To define a neural RPO detection threshold we increased the number RPOs until the MMN response was no longer greater than a noise floor determined using a boot-strap method.

Results: A significant correlation ($p=0.01, r^2=0.77$) was found between the neural RPO detection threshold and the behavioral RPO detection threshold.

Conclusion: CEPs can estimate the spectral processing abilities of CI users. Given the known correlation between speech perception and the behavioral RPO detection threshold, we expect to see a correlation with neural RPO detection threshold but this remains to be tested.

P12. Aided cortical auditory evoked response in pediatric auditory brainstem implants

R Rajeswaran, K Kameswaran, K Kalvakoti

MERF institute of speech and hearing., Madras ENT research foundation (p) LTD, CHENNAI, India

Introduction: Auditory Brainstem Implants (ABI) in children is challenging and the outcomes are variable, still more children are being implanted. Programming ABI is challenging especially in very young children due to the reduced feedback about sound and non auditory sensations. Despite good intra-operative EABR, occasionally few electrodes may function post-operatively due to displacement of electrode pad. CAEPs reflect functioning of auditory cortex. CAEPs were used in this study to evaluate the subjects with ABI.

Methods: CAEP done in 2 children with ABI using speech stimuli /m/, /t/ and /g/. Electrodes were categorically activated before recording the CAEP. Latency of P1, amplitude of P1N1 and morphology of the responses were analyzed. The responses are significantly different from noise (i.e. p<=0.05). Behavioral measures were obtained to correlate with CAEPs.

Results: The responses obtained from the subject 'B' showed more noise compared to subject 'A'. Subject 'A' showed non auditory sensation which correlated well with the CAEPs. Aided responses are within speech spectrum in both the subjects. Latency of P1 in both subjects were between 100 ms to 150 ms. Amplitude of P1N1 and morphology of the response varied between groups of electrode activated.

Learning Outcomes: CAEP may shed some light in identifying the electrodes that evoke non auditory sensation.Amplitude of the CAEP may help to program young children with ABI. CAEP latencies and amplitude will help to monitor the maturation of the auditory cortex in children with ABI and can be correlated with the outcome.

P13. Presence of ringING COCHLEAR MICRophonics is not restricted to click evoked ABR

S Gore, Megha Sashidharan

Dr. S.R. Chandrasekhar Institute of Speech and Hearing, BANGALORE, India

Introduction: The pathology in an Auditory neuropathy spectrum disorder(ANSD) has been hypothesized to occur at the level of Inner hair cell, synapse, tectorial membrane or the nerve itself. This has led to a plethora of symptoms the main being loss of the auditory brain stem response.Ringing cochlear microphonics have been described earlier to clicks. This study explores the presence of ringing cochlear microphonics to other stimuli.

Methods: Tone burst and click ABRs were obtained for 73 ears of 36 adults diagnosed with ANSD disorder. The tone burst were at 500Hz, 1kHz and 4kHz. Duration of the disorder ranged from 6 months to 18 years. All participants underwent pure tone audiometry, immittance test, otoacoustic emission tests along with speech perception tests.

Results: Ringing cochlear microphonics to clicks in 33 ears. Of these 16 had ringing microphonics to at least one of the tone burst. In all 56 participants had ringing microphonics. Ringing cochlear microphonics were more likely to be associated with poor speech perception.

Conclusion: A large number of the persons with ANSD disorders may have ringing cochlear microphonics. This may be linked to mechanical properties of the cochlea, specifically the tectorial membrane

P14A. Binaural integration acoustical and electrical signals in bimodal patients

LVY van Yper

UZ Ghent, GHENT, Belgium

Introduction: Bimodal hearing' refers to the condition in which electrical hearing via a cochlear implant (CI) is combined with acoustical, residual hearing in the non-implanted ear. Previous research demonstrated improvements in speech perception in noise and sound localization. Mechanisms underlying these benefits are still unclear. The objective of this study is to gain insight into binaural processing in bimodal listeners.

Methods: Binaural hearing is assessed by means of behavioral measures, e.g. speech in noise tests, sound localization tests and questionnaires. Additionally, binaural interaction is investigated using auditory brainstem responses (ABR). Three stimulus conditions are applied: monaural left (L), monaural right (R) and binaural (B) stimulation. A binaural interaction component is derived from the ABR (ABR-BIC) by subtracting the response elicited during binaural stimulation from the sum of both monaural responses [(L+R)-B].

Results: In order to obtain normative data, 15 normal hearing subjects are tested. Furthermore, a protocol for ABR-BIC recording in bimodal patients will be presented.

Conclusion: The ability to combine electrical and acoustical signals determines outcome with bimodal fitting. As the ABR-BIC represents binaural interaction, it is expected that the presence of an ABR-BIC and good performance on binaural tasks are associated.

P15. 10 Years of cochlear implantation in india: Trends and outcomes

Ms Asha[1], Arora[1], Sharma[2], Lahiri[2]

[1]Asha Speech & Hearing Clinic, NEW DELHI, India

[2]Sir Ganga Ram Hospital, NEW DELHI, India

Introduction: The growth of cochlear implantation in India has been prodigious, particularly in the last 5 years. In 2010, there were approximately 1000 implant surgeries in the country, with many clinics conducting approximately 100 surgeries per year. Cochlear implantation commenced around 1996**,** and there are currently over 10000 recipients, with 90-95% of these being children.

Methodology: This is a retrospective analysis of the data for all the patients who received rehabilitation at Asha Speech & Hearing Clinic in Delhi, India that commenced implantation in 2001.

Results: The presentation will show the trends in implantation over the 10-year period for factors such as the age of implantation, the number of surgeries, the age hearing loss was diagnosed, the number of cases seen each year, and staff numbers including audiologist & SLP, rehabilitationist, etc. Further, outcomes for the patients over this time frame will be reported, along with any trends. The results show the tremendous growth in the number of surgeries and children seen per year, particularly in the last 5 years, with over 85% of the patients having been implanted since 2006.The age of implantation has decreased over this time, with a consistent improvement in outcomes.

Conclusions: Despite the tremendous growth of implantation in India in the last 5 years, patient outcomes have not been affected, and are as good as those in many developed countries. As this growth is expected to continue, monitoring outcomes and trends is critical, and has large implications for clinics, surgeons, audiologists, therapists, the Government, and health insurance.

P16. Can a simple inverse variance estimator predict performance for bilateral CI users?

C Backus

Neurelec & UCL Ear Institute, LONDON, United Kingdom

Background: The increase in performance of bilateral CI users over monaural users is traditionally talked about in terms of head shadow, binaural summation and the binaural squelch effect (spatial release from masking). Measuring the speech reception thresholds in bilateral CI patients can be used to quantify the benefits of each of these effects over monaural CIs. Typically the head shadow effect is largest (advantage of 4-6 dB) followed by binaural summation (1-3 dB) and the squelch effect (0-2 dB).

Objective: Although these effects are well understood and often measured a mathematical framework for understanding them is not often offered.

Study Design: Here we introduce a theoretical inverse variance estimator (I-PI) processing model to explain the effects in SNR terms and test it to see if the model can quantitatively account for measurement data.

Results: The model was able to use the head shadow information to make quantitatively accurate (within +/- 1 dB) predictions of the magnitudes of the binaural and squelch effects observed in patients.

P17. Temporal interruptions and speech intelligibility with cochlear implants

P Bhargava, D Baskent

UMCG, Groningen, GRONINGEN, Nederland

Introduction: Speech interrupted with silent intervals remains highly intelligible for normal hearing (NH) listeners if the interruption rate is fast (6Hz and higher). We explored if the intelligibility of interrupted speech remains relatively unaffected at higher interruption rates for the CI (cochlear implant) users as it is for the NH. We further explored the role of spectral degradation in the perception of interrupted speech.

Methods: Eight CI users and 8 NH control listeners (also tested with CI-simulations; NHsim) participated. Intelligibility of sentences interrupted at faster (syllabic and phonetic) and slower (word) rates was measured. Baseline was measured without interruptions.

Results: For all listeners, sentences with faster interruptions sentences were more intelligible than sentences with slower interruptions. The pattern appeared most distinctly in NH listeners and least distinctly in CI listeners. NH listeners (but not NHsim) scored as well as their baseline at syllabic and phonetic interruption rates.

Conclusion: Speech remains more intelligible at faster interruption rates even for CI users; yet performance by CI and NHsim groups were poorer than the NH group and than their own baseline scores. In both groups, speech was spectrally degraded. Hence, spectral degradation is detrimental to intelligibility, when combined with interruptions.

P18. Towards CT-based prediction of cochlear implant electrode insertion

KS van der Marel, BM Verbist, JJ Briaire, R Wolterbeek, JHM Frijns

LUMC, LEIDEN, Nederland

Introduction: Clinical studies suggested that cochlear implant (CI) performance can be improved by gathering more knowledge and control over the position of the electrode array. The position is influenced by three factors: cochlear size, insertion by the surgeon (distance round window to most basal contact) and electrode design. These three factors determine linear and angular insertion depth. This study investigates in a large patient population how cochlear size varies among subgroups (earside, gender, age). Several parameters based on cochlear size and surgical insertion were used to develop an insertion model that can predict angular insertion depth.

Methods: For this study 646 ears were analyzed using multiplanar reconstructions. The position of the inner and outer walls of the basal turn of the cochlea was measured on 8 angles. In the postoperative images the position of the individual electrode contacts was determined, including their distances to the modiolus. The preoperative data were evaluated with linear mixed models. The postoperative predictors were determined using linear regression models.

Results: The morphometry of the cochlea showed a significant size difference depending on gender (male 4% larger cochlea). A linear regression model was developed with 4 input parameters based on cochlear size and surgical insertion distance predicting up to 72% of variation in final insertion depth.

Conclusion: Cochlear size differs between males and females. A few input parameters are sufficient to predict insertion depth with substantial accuracy.

P19. Cone beam CT in assessing cochlear implant electrode array position in humans: A pilot study

SR Saeed, Lj James, TB Beale, SS Saleh, DV Vickers

UCL Ear Institute / RNTNEH London, LONDON, United Kingdom

Hypothesis: We aim to use Cone Beam CT to measure the scalar position and the angular depth of insertion of the electrode array within the cochlea. The relationship between the positioning of the array and the speech perception score of the patient, measured by the BKB sentence test, will be assessed. We hypothesise that postoperative radiological assessment with CBCT will allow reliable prediction of outcome through assessment of electrode placement.

Method: Six adult patients with profound sensorineural hearing loss. All patients had a minimum of six months experience with their implant to make sure that performance had stabilised.ResultsHigh quality images were obtainable from the CBCT protocol used in this study.Image distortion was present in two patients.

Discussion and Conclusion: CBCT allows a more accurate assessment of electrode position, both in terms of angular insertion depth and scalar position and this study demonstrates that the mean scalar position of the electrodes of an implant has an effect on the BKB score, with a mean placement in the scala tympani resulting in a more favourable outcome. A larger prospective randomised study is now underway to further evaluate this imaging modality.

P20. Spread of excitation function: what we have learned after more than 100 intraoperative evaluations

MVSGG Goffi-Gomez, ATM Magalhães, RKT Tsuji, RBN Brito Neto

Hospital das Clinicas das FMUSP, SAO PAULO, Brazil

Although the literature has shown no differences in ganglion cell count between good and poor performers with cochlear implants (Khan et al., 2005; Fayad and Linthicum, 2006), the physiologic characteristics of the auditory nerve, i.e. the spread of excitation (SOE) properties might be among the influence factor for the outcomes (Goffi-Gomez et al., 2010).

Objective: To understand the results of SOE function and its correlation with the recovery function, the stimulation levels, etiology of the deafness, hearing deprivation and speech perception outcomes.

Methods: SOE series records the electrical compound action potential (ECAP) at a constant current level as a function of the Masker electrode. Intraoperative SOE function of patients implanted with Nucleus devices was collected on electrode 11, or another adjacent electrode when needed. The SOE width in mm was taken at 50%, 75% and 90% level.

Results: One hundred and thirty-one intraoperative SOE of children and adults were collected. Stimulation levels varied from 161 to 250 current units, representing 4 to 54 units above NRT threshold. SOE width at 50% varied from 0.65 to 9.49mm (mean = 3.41+1.70), at 75% it varied from 0.32 to 8.48mm (mean = 2.01+1.32), at 90% it varied from 0.13 to 5.51mm (mean = 1.09+1.05).

Conclusion: In this presentation the correlation between SOE width to etiology of the hearing loss, residual hearing, and speech perception outcomes will be discussed. It will also highlight the influence of stimulation level and refractory time of the nerve.

P21. ECAP in paediatric MED-EL cochlear implantees: electrode place, age and C-levels

PB Philibert[1], A Bouchair[2], A Saidia[2], S Labassi[3]

[1]MEDEL, LAGNY SUR MARNE, France

[2]CHU Annaba, ANNABA, Algeria

[3]MED-EL France, SOPHIA-ANTIPOLIS, France

Objectives: 1) to validate Evoked Compound Action Potentials (ECAP) recording in children using MED-EL Maestro software; 2) to compare ECAP responses among three tested electrodes (apical, medium and basal); 3) to look for correlation with age at the test, age at the implantation date and cochlear implant (CI) use duration; 4) to see if ECAP thresholds can predict C-levels.

Method: ECAP responses were recorded in 71 children aged between 2 and 14 years old (mean: 5.4 +/- 2.5SD). The duration of CI use varied between 2 months and 4 years (mean: 2.0 +/- 0.9SD). The maximum stimulation level, the ECAP amplitude measured at this maximum stimulation level, the ECAP threshold and the C-level were determined for all 3 electrodes.

Results: ECAP recording was successful in 85% of the children. Comparison among the 3 tested electrodes showed that ECAP amplitudes were larger for at the apex than in the middle or at the base of the cochlea. For all 3 electrodes, statistically significant paired correlations were reported between ECAP amplitudes and age of the children at the test; the older was the child the larger the ECAP amplitude. ECAP thresholds were found to statistically correlate to C-levels for two electrodes out of the three.

Conclusion: ECAP recording in a MED-EL CI paediatric population was successful in most of the subjects. The study showed statistically significant correlations with electrode place, age and C-levels and suggests that ECAP thresholds measurement can give more cues for CI fitting in children.

P23. Statistical comparison of two eCAP measurement masking algorithms

A Benghalem[1], F Saadi[2], F Vanpoucke[3], L Arnold[4], J Bestel[4], C Lhospice[4], A Faillat[4]

[1]Clinique Rachidi, CASABLANCA, Morocco

[2]Rifmed, CASABLANCA, Morocco

[3]European Research Centre Advanced Bionics, HANNOVER, Germany

[4]Advanced Bionics, RIXHEIM, France

Introduction: The primary aim of this study was to statistically analyse the relationship between two artefact masking algorithms for measurement of the eCAP (electrically evoked Compound Action Potential): Masker Probe (MP) and Alternating Polarity (AP). A secondary aim was to conclude on the potential equivalence of these two methods to measure the neural responses in clinical routine.

Methods: 66 experienced Advanced Bionics HiRes 90K recipients were recruited. The eCAPs were measured with the RSPOM software (Research Studies Platform for Objective Measures) on four electrodes: 3, 7, 11 and 15. Measurements were repeated with both AP and MP, on the same day and in the same conditions for each participant. The eCAP thresholds (tNRIs) and the slopes were extracted. The statistical comparison between AP and MP was based on tNRI and slope values.

Results: After statistical pre-processing and exclusion of outliers, a first step analysis showed that the four electrodes were behaving independently for tNRI and slope values, both for AP and MP. Slope and tNRI values were then analysed separately for each electrode. A linear correlation between AP and MP was found for both tNRI and slope. Correlation coefficients were different from one electrode to another and no dependency was found between the tNRI correlations and the slope correlations.

Conclusions: The AP and MP algorithms were linearly correlated for both tNRI and slope for the four considered electrodes. The use of AP and MP in clinical routine may therefore be considered as statistically equivalent.

P24. Assessing spatial channel interactions in cochlear implants

KV Vermeire[1], ED De Vel[1], AI Akhoun[2], ID Dhooge[1]

[1]Ghent University Hospital, GENT, Belgium

[2]Advanced Bionics European Research Center, HANNOVER, Germany

Introduction: The main drawback of modern multi-channel cochlear implants (CI) is that the spatial selectivity of the excitation pattern is severely limited by the widespread nature of electric fields in the extracellular tissue. Modern CIs have the flexibility to electrically stimulate the auditory nerve and to capture various electrical signals inside the cochlear lumen.

Methods: This study examines spatial channel interactions at the electrical and neural level in a group of Advanced Bionics HiRes90K users. All subjects were implanted with the Helix array. The EFI measurements were made with the EFIM research tool. EFI data were obtained for all electrodes. ECAP recordings were done using the RSPOM software. SOEs were obtained from 4 different electrodes (3-7-11-15) using a variable recording location paradigm. SOEs were collected with 3 different loudness levels.

Results: Width, slope and symmetry of spatial excitation patterns derived from these physical (EFI) and physiological (SOE) measures will be compared.

Conclusion: EFI recordings allow a finer interpretation of neural SOEs as it teases out the effects of electrical spread within the cochlea. Taken as a whole, this study serves as a direct comparison and identification of inter- and intra-subject variability in spatial profiles.

P25. ECAP Latency as Function of distance between stimulation and recording electrode

KE Schwarz[1], SB Strahl[2], P Spitzer[2]

[1]INNSBRUCK, Austria

[2]MED-EL Medical Electronics, INNSBRUCK, Austria

In a multi-centre study [1] the electrically evoked compound action potentials (eCAP) of 141 subjects implanted with MED-EL standard and FLEXsoft electrode arrays were investigated. ECAP amplitudes, slopes, thresholds and latencies as well as double peak presence were determined.For three different stimulation electrodes (in the regions apical / middle / basal) 11 amplitude growth functions (AGF) were measured using each of the remaining electrodes as recording site.

In this poster, the focus is on the theory presented by Finley et al. [2] of a second, *ectopic* stimulation. A similar latency shift as reported by Finley et al. was observed in this study. A decrease of latency was determined at ~4-5 µsec / mm for apical stimulation, ~4 µsec / mm for middle stimulation, and ~3 µsec / mm for basal stimulation when moving the recording electrodes towards the base (apical and middle stimulation) resp. towards the apex (for basal stimulation).

In order to get additional indicators for the existence of an ectopic stimulated population, the eCAP amplitudes for different stimulation intensities as well as the thresholds / slopes of the AGFs are analyzed with respect to the recording site and *net summation* of the suggested two different populations stimulated[2]. In this context, the presence of double peaks is discussed.

[1] www.hearring.com; 'Auditory Nerve Response Telemetry (ART) Study of the Hearring Group'; Dataset presented e.g. by P. Senn at the CI conference in Baltimore

[2] Proceedings of CIAP 2011: C. Finley et al., Ectopic Stimulation In Cochlear Implants

P26. Are electrically evoked potential thresholds independent of the speech processor's map parameters?

TKKortmann, **JMD Müller-Deile**

ENT Clinic, Christian-Albrechts-University of Kiel, KIEL, Germany

Introduction: For young children, psycho-acoustic measurements are often difficult. In most cases, the map parameters are estimated according to the TECAP threshold profile. It is essential in this case that the shape and position of the profile are stable and independent e.g. from the everyday map parameters.

Methods: 33 patients in the age range of 7 to 23 years (median 14.5 y.), provided with Nucleus implants, were implanted contralaterally with a long delay to the first implantation. For one third of those patients very bad acceptance had to be observed. To improve acceptance of the second implant it was necessary to lower stimulation levels of the old side, in some cases considerably. For 10 patients the change is more than 20 SU (>10%). TECAP thresholds have been recorded before and after these changes.

Results: Despite stimulation level reductions the speech perception with the first implanted side stayed widely unchanged, as could be documented with the Freiburg Monosyllabic Word Test. With 6 patients we observed a TECAP threshold decrease after a considerable stimulation attenuation (average 13.3±8.6 SU).In 2009 we could confirm the long time stability of the TECAP thresholds. But in this investigation the map parameters stayed mainly unchanged over the time of use.

Conclusion: The TECAP profile can not be assumed as constant but can be influenced by everyday stimulation intensity. If TECAP profiles are used, speech processors therefore have to be programmed especially cautious to avoid over-stimulation and to keep the electrical fields as narrow as possible.

P27. Wireless AutoNRT

S Maruthurkkara, R Banna

Cochlear Ltd, MACQUARIE UNIVERSITY, Australia

Impedance and AutoNRT™ measurements are routinely conducted in clinical practice to aid in programming and troubleshooting. Intraoperative AutoNRT and impedance measurement are also found to be useful to confirm the integrity of the electrodes and provide confidence that the implant will provide hearing. Currently these measurements require the use of a computer and the programming hardware and also a trained clinician to set up the system, run the tests and interpret the results.

Methods: A new device, the CR120 Intraoperative Remote Assistant, and a new feature added to the CR110 Remote Assistant enable wireless measurement of AutoNRT and impedances when paired with only a sound processor. The Remote Assistant records impedance and AutoNRT measurements. The aim of this study was to evaluate the AutoNRT results with the Remote Assistant compared to those obtained with the Custom Sound™ both post-operatively and intraoperatively.

Results: Wireless AutoNRT measurements were conducted post-operatively on Ten (10) adult CI recipients, and intraoperatively on a different group of Ten (10) adult CI recipients. The AutoNRT results with the Remote Assistant were found to be equivalent to those obtained with the Custom Sound software. The measurement time for the wireless measurements with the Remote Assistant was also less compared to the time taken with Custom Sound software.

Conclusion: The reduction in the hardware and the ease of use of the wireless measurements may make it easier for CI clinics to perform intraoperative testing and free the clinician's time by making it possible to delegate testing to theatre staff.

P28. Transtympanic electrically evoked auditory brainstem responses

WPR Gibson[1], H Sanli[2]

[1]University of Sydney, BIRCHGROVE, Australia

[2]SCIC, GLADESVILLE, Australia

Introduction: Transtympanic electrically evoked auditory brainstem responses (TTEABR) provide a useful means of confirming the presence or absence of cochlear nerve fibres when the MRI fails to identify the cochlear nerve.

Methods: The special electrode (a 'golf club' electrode) is inserted through a myringotomy incision so that it accurately fits into the round window niche to provide an electrical stimulus. The stimulus is provided from a 'cochlear implant in a box' with the output of an electrode on the array fed to the golf club electrode. The 'monopolar electrodes' are connected to electrodes placed immediately above and below the pinna to split the return pathway and decrease artefact. A very fast acting recording preamplifier minimises the stimulus artefact and the brainstem recordings are obtained in the usual fashion.

Results: Over 300 ears have been tested and the successful recording rate has risen to over 95%. Poor recordings occur if the golf club electrode is not accurately placed and when there is serous fluid (glue) present. The electrical stimulus must pass down the cochlea and not diffuse within the middle ear.

Conclusion: TTEABR can be obtained reliably using a 'golf club' electrode, the stimulus output from a cochlear implant, a fast recording amplifier and absence of middle ear effusion.

P29. Novel intra-operative device to measure Evoked Compound Action Potentials (ECAPs)

MA Almomani, AR Hagr

King Saud University, RIYADH, Saudi Arabia

Introduction: The measurement of Evoked Compound Action Potentials (ECAPs) intra-operatively during cochlear implant surgery is established practice. Both for confirmation of device operation and the establishment of stimulation thresholds. Nonetheless an audiological expert is required to be present and, furthermore, standard clinical computer equipment is required. This study reports on the use of a novel, automated handheld device to conduct the measurement activity with more convenient equipment thereby reducing the burden for the skilled personnel in the operating theatre.

Methods: A prospective, single-site between subject measurement study was conducted to evaluate whether the novel, automate handheld device could be used to collect ECAPs intra-operatively. The study measures the time taken for these measurements and whether it would be possible for non-audiologically trained staff to conduct the ECAP measurement activity.

Results: The novel device provided for ECAP measurements and thresholds to be measured in a quicker time compared to standard clinical equipment. Furthermore the device was successfully used by non-expert audiological staff.

Conclusion: The use of a novel, automated handheld device to conduct ECAP measurement activities intra-operatively is shown to: i) achieve the same results as a clinical computer set-up; ii) conduct the measurement activities in less time; iii) remove the need for bulky computer equipment in the operating theatre; and iv) potentially allow a non-audiological expert to perform the duty.

P30. Correlation of pulse width on neural response telemetry thresholds

K Berger, BERLIN, Germany

Background: The presentation represents the first step of a study about correlation of pulse width (PW) on neural response telemetry thresholds (NRT) which in a second step should lead do a model of the tissue's electrical properties.which is able to predict thresholds for different PW based on a single measurement line with one PW.

Method: Five series of measurements were carried out over the electrodes 3, 6, 9, 12, 15, 18 and 21 with the Nucleus CI 24RE(CA) (N=15) with fixed interphase gap (IPG=25 µs) and pulse rate (PR=80 pps). PW was increased from PW=25 µs to PW=37 µs, PW=50 µs, PW=75 µs and PW=100 µs. Statistical significance was tested within each subject and within the group results.

Results: Thresholds decrease in regular intervals, statistically significant correlated on increasing pulse widths.

Conclusions: The results are meaningful to evaluate the hypothesis of the second step of our study that the mentioned model of the tissue's electrical properties may provide an explanation for this regularity. If so, the model can be used to predict thresholds without further measurements.This would be not only scientifically interesting but also helpful for clinical practice.

P31. Recovery Function in Auditory Neuropathy Spectrum Disorder in Implanted Children

AK Kontides, NP Pallares, VD Diamante

Instituto Superior de Otorrinolaringología, BUENOS AIRES, Argentina

Introduction: Cochlear implants have been recently considered as a treatment option in Auditory Neuropathy Spectrum Disorder (ANSD)In ANSD the synchrony firing pattern of the auditory nerve is compromised. This provokes abnormal temporal processing with possible consequences in speech discrimination.Abnormal firing response can be measured through Electrically Evoked Compound Action Potential (ECAP).

Aim: To compare refractoriness properties of the auditory nerve within implanted children with ANSD and a control group of implanted children without ANSD, and their outcomes regarding speech perception.

Method: Recovery function was measured at 8 stimulation sites, at loudest acceptable presentation level (LAPL), with 20 varied masked to probe intervals (MPI), in 7 ears of ANSD children and 7 ears of control children. A total of 2.240 measures were obtained. Both groups were matched based on chronological age and age at implantation. Measurements were performed using the modified forward masking technique.To assess refractory characteristics of each group, peak to peak amplitude between N1 and P1 was considered, as well the estimate of the absolute refractory period.Speech perception was evaluated.

Results: Although this study is limited by it`s small sample size, traces could be obtained on both groups however there were some missing responses especially among the ANSD group at basal electrodes. MPI appeared to be shorter in the control group. The slopes of the ECAP recovery function did not differ significantly in both groups. Children with robust ECAPs showed good post-CI performance.

P32. Feasibility and long-term stability of SOE measurements within adult cochlear implant users

BP Philips[1], FVP Vanpoucke[2], ID Dhooge[1]

[1]Ghent University, GENT, Belgium

[2]Cochlear Technology Center, MECHELEN, Belgium

Introduction: Cochlear implants (CI) are designed to take advantage of the tonotopic organization of the cochlea by stimulating various electrodes located along the longitudinal axis of the cochlea. Ideally, each electrode should selectively activate a distinct group of neurons. In reality, the injected current spreads through the cochlear tissue, hereby stimulating overlapping neural populations, causing channel interaction. First, feasibility of spread of excitation (SOE) functions within adult CI users measured with the electrically evoked compound action potential (ECAP) by means of two different SOE measurement techniques: spatial spread (SS) and spatial masking (SM) is tested. Furthermore, long-term stability of spatial masking is tested within repeated trials over a one-year period.

Method: ECAP data were collected from 17 unilaterally implanted post-lingually deaf adults (N=7 AB HiRes90K, N=4 AB CII, N=6 Nucleus 24RE(CA)). Three probe electrode stimulation locations were used: one apical, one mid and one basal for two different spread of excitation measurement techniques: SS and SM.

Results: Experiment 1 revealed significantly broader SS patterns than SM patterns. Experiment 2 showed no significant differences between repeated trials over a one-year period.

Conclusions: SS functions were broader than SM functions. This can be explained by the evidence that SS measures reflect volume conduction of the ECAP response along the length of the cochlea whereas SM functions reflect the relative overlap of neural populations recruited by the masker versus probe. Furthermore, long-term stability of SM patterns showed that SM ECAP measures were highly stable across repeated trials over a one-year time period.

P33. Auditory nerve recovery function in cochlear implant surgery under local anesthesia and sedation

WGRM Wiemes[1], RH Hamerschmidt[1], MVGG Goffi-Gomez[2], MM Mocellin[1]

[1]Federal University of Parana, CURITIBA, Brazil

[2]Hopital das Clinicas da FMUSP, SÃO PAULO, Brazil

Introduction: The Custom Sound EP software connected to the Nucleus ® Freedom Cochlear Implant Contour Advanced allows the measurement of Neural Recovery Function. There are studies showing changes in neural function recovery in intraoperative and postoperative of CI surgery (GoffiGomez, et al., 2010). The cochlear implant surgery performed under local anesthesia and sedation has alterady been described by our group (Hamerschmidt et al., 2011).Objective: To evaluate whether changes in values of To, A and Tau in Neural Recovery Function are faster in cochlear implant (CI) surgeries under local anesthesia and sedation.

Methods: A prospective study in two groups 'A' and 'B', 'A' in which 5 patients who underwent CI surgery under local anesthesia and sedation and group 'B' in which 5 patients underwent CI surgery under general anesthesia. The measurement of the recovery function was made accessing Advanced NRT the software on three electrodes representing the base, medial turn and the apex. Statistical analysis compared the absolute Refractory Period (T0), the curviness parameter for the model function (tau) and the amplitude of the saturation level (A) in both studied groups.

Results: No significant difference was observed in the values of To, and Tau and the recovery function in the group undergoing surgery with local anesthesia and sedation, when compared to general anesthesia.

Conclusion: The values of recovery function were not affected by the type of sedation or local anesthesia.

P34. In Vitro EFI Assessment of the Effect of Current Focusing Inside and Outside the Scala Tympani

CK Berenstein[1], FJ Vanpoucke[2], LHM Mens[1], AFM Snik[1]

[1]UMC St.Radboud University, Donders Institute, NIJMEGEN, Netherlands

[2]Advanced Bionics European Research Center, ANTWERP, Belgium

Introduction: Only limited benefits of tripolar stimulation and similar attempts at current focusing have been found in eCAP and psychophysical experiments in humans, possibly because focused fields require higher stimulation levels to recruit a sufficient extent of the spiral ganglion. However, Electrical field imaging (EFI) suggested a strong effect of focusing. One possible factor explaining these discrepancies is the effect of the cochlear bone on the width of the electrical field outside the scala.

Methods: The goal of this study is to assess how current level and cochlear bone structures affect the field geometry. We collected cochlear potentials from mono- and tripolar configurations using an electrode array inserted in a bone specimen: Intra-scalar using EFI telemetry and using a scanning probe next to the electrode array, and Extra-scalar using a scanning probe in a parallel canal (similar to the setup of Ifukube et al. (IEEE Trans. Biomed. Eng. 1987).

Results: Intra-scalar potential measurements in our specimen showed considerable current focusing at the electrode array, and less so close to the electrode array. However, the extra-scalar potential showed no distinguishable effect of focusing, even without approximated loudness normalization.

Conclusion: The diffuser effect of the cochlear bone reduced the benefit of current focusing (similar to Ifukube 1987) much more than loudness normalization did. This strong effect of the bone supports the idea that individual EFI recordings refined by knowledge of these experiments, holds promise for a better understanding of different electrode configurations in individual patients.

P35. Estimation of abnormalities of cochlear implant electrode placement using SoE measurement

AW Walkowiak, AW Walkowiak, AL Lorens, BK Kostek, AO Obrycka, AW Wasowski, HS Skarzynski

Institute of Physiology and Pathology of Hearing, WARSAW, Poland

Objectives: To evaluate possible dependence between Spread of Excitation profile and electrode placement assessed by CT scans in Advanced Bionics HiRes90K implant users.

Method: Postoperative Spread of Excitation profiles recordings were made using RSPOM software for electrode 4, 8 and 12. CT scans according to cochlear view technique was performed for 1 selected patient with discovered disturbed shape of SoE profile.

Results: Abnormalities in implant electrode placement in the cochlea was found, accompanied by disturbed spread of excitation profiles.

Conclusions: A dependence between disturbance of Spread of Excitation profile and abnormalities in implant electrode placement for selected patient was found. Further investigation in bigger group of implant users is planned to check if it is a general correlation. A possible confirmation of mentioned correlation would provide an useful, objective tool to assess implant electrode position and placement and would supply clinicians with important information, crucial for speech processor fitting.

P36. Time course of neural response telemetry thresholds in 200 cochlear implants: Preliminary results

FM Digeser, DJ Jäger, TL Liebscher, AH Hast, UH Hoppe

Universitäts-HNO Klinik Erlangen, ERLANGEN, Germany

Background: Electrically evoked compound action potential (ECAP) thresholds are commonly used for rehabilitation, especially for the fitting of children. However, there is a variation in threshold values over time. The aim of this study was to investigate the time course of ECAP thresholds during the first years after implantation.

Method: ECAP thresholds (via AutoNRT) were measured from 137 adult Nucleus Freedom™ and 69 Nucleus CI512 implantees for nine electrodes (1,3,6,8,11,13,16,19 and 22). For all Subjects, AutoNRT measurements were performed during surgery and first fitting period. Subsets of subjects were also tested during routine checkups after 6-12 months, 1-2 years and 2-4 years. Average threshold profiles and profiles of relative change of thresholds were calculated. Additionally, the mean relative change of NRT thresholds over time was determined.

Results: From intra-operatively to first fit, both implant types exhibit a typical drop in average NRT threshold profiles of about 10-15 current levels (CL). The shape of the profile changed for the low and the high frequencies. The mean relative change in NRT thresholds from intra- to post-operative measurements was ‘8 CL. From first fit to routine checkups up to 2-4 years after implantation, profiles shifted to higher CL again and the mean relative change in NRT thresholds increased almost linearly with ‘1.5 CL per year.

Conclusions: Besides a typical drop from intraoperative to postoperative measurements, there seems to be a linear increase in average NRT thresholds for measurements in the periods of 6 months to 4 years after implantation.

P37. Relationship between medel auditory nerve response telemetry (ART) and behavioral programming levels

RKN Kaplan Neeman[1], CM Muchnik[2], ZY Yakir[1], FB Bloch[1], YS Shapira[1], LM Migirov[1], MH Hildesheimer[1], YH Henkin[1]

[1]Sheba Medical Center, RAMAT GAN, Israel

[2]3Department of Communication Disorders, Tel Aviv University, RAMAT GAN, Israel

Electrically evoked compound action potential (ECAP) thresholds are commonly used to ascertain the integrity of the neural/electrode interface as well as to facilitate the programming process. Numerous studies have determined the associations between ECAPs and thresholds (T levels) as well as comfortable levels (C/M levels) obtained from Cochlear and Advanced Bionics recipients. Data concerning ECAP measurements in the MedEl device, and their relationship with programming levels, is scarce. The objective of the present study was, therefore, to explore the association between Auditory Nerve Response Telemetry (ART) measurements and programming levels of the MedEl device. For this purpose we studied post-operative ART thresholds and behaviorally obtained most comfortable levels (M) in a group of adults that were using their implants for at least three months. ART thresholds and M levels were compared at basal, medial, and apical electrodes. While data collection is still in progress, preliminary analysis showed that: (1) ART thresholds and behavioral M levels shared a similar profile across the electrode array; (2) ART thresholds were found to be higher than behavioral M levels. These initial results coincide with previous findings obtained from Cochlear and Advanced Bionics recipients.

P38. ECAP recovery function in a pediatric population of AB HR 90K implant users: normative data

Saidia[1], IA Akhoun[2], **DG Gazibegovic**[2], AF Faillat[2]

[1]CHU Annaba, ANNABA, Algeria

[2]Advanced Bionics European Research Centre, HANOVER, Germany

Introduction: Objective measurements of auditory nerve (AN) function inform about the status of cochlear implant (CI) peripheral sound encoding, which is a main aspect influencing CI outcome. Recovery functions measure the ECAP amplitude in refractory state. They typically have an exponential shape: $ECAP(IPI)=A.(1-\exp(-(IPI-t_0)/t))$. The parameters t_0 and t have been used as a measurement of AN absolute and relative refractoriness. This poster describes a normative range of recovery function data, including their fit parameters.

Methods: 68 Advanced Bionics HiRes 90K pediatric users were included in the study. Recovery functions were obtained at four electrodes locations (3, 7, 11 and 15) using the Research Software Platform for Objective Measurement (RSPOM). CI fitting parameters including NRI thresholds (T-NRIs) were obtained with the CI fitting software SoundWave.

Results: Large ECAPs over 100 µV were obtained in 94% of the subject/electrode conditions. 247 (93%) recovery functions, obtained in 1 min 27 (±6s), were strongly correlated ($R^2>0.8$) to the exponential fit. Distributions and confidence-interval of A, t_0 and t are presented. They are compared to more straightforward measurements: respectively ECAP amplitude over the plateau, first-ECAP and IPI producing 75% of the plateau amplitude. Effect of electrode position and correlation of these parameters to CI fitting data and etiology is sought.

Discussion: The relevance of the recovery-function parameters depends on the fit accuracy and measurement noise. Optimal practice is discussed.

P39. Hearing preservation and neural health: Analysis of hearing thresholds and ECAPs in CI users

AB Kleine Punte[1], SS Strahl[2], FS Schwarze[2], PVDH Van de Heyning[1]

[1]Antwerp University Hospital, EDEGEM, Belgium

[2]Med-EL GmbH, INNSBRUCK, Austria

Background: It has been shown in the animal model that the electrically evoked compound action potential (eCAP) can give information on the neural status of the auditory nerve (Pfingst et al. 2011, Ramekers et al. 2012. The now regularly achieved hearing preservation during cochlear implantation allows the comparison of pre- and post-operative audiograms with eCAP parameters that correlate with the status of the auditory nerve.

Methods: During a multi-centre study, eCAP responses were recorded from subjects implanted with MED-EL standard and FLEXsoft electrode arrays. Using the auditory nerve response telemetry (ART) task of MAESTRO fittingsoftware, amplitude growth functions and recovery functions were obtained from the apical, midddle and basal region of the cochlea. The audiogram was recorded pre- and post-operative. Correlations between eCAP parameters eCAP amplitude, slope, thresholds, absolute refractory period and the recovery time constant with hearing loss and the hearing preservation are calculated.

Results: A preliminary analysis of 120 ears shows that hearing preservation was achieved after CI in the majority of cases. On average 15 dB hearing loss occurred postoperatively. It seems as if the eCAP slope is higher for lower hearing thresholds.

Conclusion: eCAP may give useful information on the status of the auditory nerve. The possible implications of these findings will be further discussed.

Pfingst et al. 'Cochlear infrastructure for electrical hearing' Hear Res, 281:65-73 (2011)Ramekers et al. 'Temporal Response Properties of the Electrically Stimulated Auditory Nerve in the Deafened Guinea Pig' 35th ARO MWM, San Diego (2012)

P40. Neural response telemetry during cochlear implantation in dysplastic inner ears

GP Psillas[1], DR Rachovitsas[2], GK Kyriafinis[2], GT Tsiropoulos[2], MT Tsaligopoulos[2], VV Vital[2]

[1]THESSALONIKI, Greece

[2]1st Academic ENT Department, Aristotle University of Thessaloniki, AHEPA Hospita, THESSALONIKI, Greece

Objective: The aim of this study was to perioperatively measure the neural response telemetry (NRT) in children with dysplastic inner ears and to compare it to that of children with normal inner ears.

Methods: The dysplastic group consisted of 4 deaf children and the control group of 6 children matched for age of implantation. In the dysplastic group, two children, aged 2 and 4 years old, respectively, were implanted with Cochlear electrode and the other 2 children, both aged 5 years old, were implanted with Medel electrode. In the control group, 4 children were implanted with Cochlear electrode and two with Medel one. The NRT threshold and NRT amplitude at threshold probe current level were measured across the electrode array in all children.

Results: There was no difference between the NRT threshold and amplitude data of dysplastic compared to control group from the basal to apical electrodes. The values of NRT threshold varied from 150 to 250 CU for Cochlear dysplastic group and from 300 to 1000 CU for Medel dysplastic group. The NRT amplitude values ranged from 8 to 32 μV for Cochlear dysplastic group and from 34 to 83 μV for Medel dysplastic group.

Conclusion: Earlier studies showed that in malformed cochleas the spiral ganglion cell populations were substantially diminished. However, although the NRT is closely related to neural responsiveness to electrical stimulation, in our study the NRT parameters in the dysplastic group did not seem to be influenced of the reduced ganglion cells.

P41. Analysis of eCAP growth function and insertion depth in hearing preservation patients

SM Prentiss[1], JF Ferraro[2], HS Staecker[1]

[1]Unviersity of Kansas Medical Center, Department of Otolaryngology Head & Neck Su, KANSAS CITY, United States of America

[2]University of Kansas Medical Center, Hearing and Speech Department, KANSAS CITY, United States of America

Introduction: Hearing preservation with cochlear implantation has added a new dimension to cochlear implant candidates and aural rehabilitation. Several studies have shown that combining electric stimulation with acoustic stimulation, a condition referred to as EAS, results in better word understanding as compared to listening with electric stimulation only. This is particularly apparent in background noise; however, outcomes for each individual can vary significantly. The purpose of this study is to compare the neural transmission of sound throughout the brain of good performers to poor performers. This can be accomplished through the use of electric compound potentials (eCAPS). Analyzing the recovery function and refractory period of the eCAP may correlate with individual outcomes and provide us with some insight on predicting outcomes.

Methods: This study will look at eCAP growth and 6 month CNC scores for both EAS patients and traditional implant users. All participants were implanted with the Med-El device. Auditory Response Telemetry (ART) was run on at least 6 electrodes. The slope of the recovery was measured and compared to CNC scores at 6 months.

Results: ECAP growth functions could be recorded on all hearing preservation patients. There appears to be a correlation between eCAP slope and speech discrimination scores.

Conclusion: Objective measures are a fairly new way of analyzing the cochlear implant and how it functions. Studies thus far have shown somewhat contradictory results. Some studies conducted have shown that slower eCAP recovery is correlated to larger neural population, whereas, the opposite is shown in other studies.

P42. Speech processor programming in case of non-auditory effects

JG Kiss, F Tóth, AL. Nagy, J Jarabin, A Szamosközi, J Jóri, L Rovó

University of Szeged, SZEGED, Hungary

During the fitting process it is the most important to determine the exact electrical threshold and comfort levels, which assumes a series of psychophysical measurements to be taken. The intensity at which just a hearing sensation is evoked (threshold level) and the intensity that causes a bearable loudness (the comfort level) must carefully be determined on each electrode. The speech processor will then transform the external sound stimuli – with the use of the appropriate speech coding strategy – to this dynamical range.In several special cases the determination of the electrical comfort levels is impossible. Frequently the maximum level of the electric stimulation is not sufficient to couse a normal hearing level. In other cases the stimulation of facial nerve or other non-auditory effects impede obtaining the appropriate hearing sensation. Using behind the ear speech processor the optimal power consumption and avoiding out of compleance values are very important. But we can solve theese problem with the optimalisation of the different stimulation parameters. The autors show theese procedures in their patients. Having the above in mind we must say that the regular programming of the device is very important.

P43. A peripheral neural correlate of temporal processing by cochlear implant listeners

JM Deeks, RP Carlyon

Medical Research Council, CAMBRIDGE, United Kingdom

Temporal processing of fine temporal information by cochlear implant (CI) users is modest, and usually very poor at rates above 300 pps. It also differs substantially across CI listeners. The neural basis of the poor performance remains unclear.In experiment 1, rate discrimination on a single mid-electrode was measured in nine Freedom users. Standard rates of 100 to 500 pps were compared to signal rates 30% higher using a 2I-2AFC task. ECAPs to every pulse in these pulse trains were also measured, using identical stimuli to the behavioral experiment. Rate discrimination by most listeners was best at low rates, although this pattern varied across listeners. ECAPs to the pulse trains were usually amplitude-modulated, showing larger responses to odd-numbered than to even-numbered pulses. The depth of this modulation increased with increasing pulse rate. There was a statistically significant trend whereby listeners who showed more ECAP modulation showed better performance. This may provide a useful index of neural survival; another possible index comes from the reliable within-listener across-electrode differences in ECAP modulation that we observed.To test whether ECAP modulation had a *causal* influence on rate discrimination and pitch perception, in experiment 2 we modulated a 200-pps pulse train by attenuating every other pulse, and measured both ECAP modulation and perceived pitch as a function of the depth of this physical modulation. The results showed that the ECAP modulation observed in experiment 1, to unmodulated pulse trains, was too small to account for the deterioration in rate discrimination with increasing pulse rate.

P44. Negative Correlation of post-operative impedances with stimulation levels

G Paasche, K Wuttke, A Zapf, T Lenarz, A Lesinski-Schiedat

Hannover Medical School, HANNOVER, Germany

During the first two to three weeks after cochlear implantation electrode impedances increase before they slightly decrease again after starting electrical stimulation. Earlier results showed that a single intraoperative deposition of glucocorticoids (triamcinolone) is able to reduce electrode impedances for several years. The objective of this study now was to investigate any influence of these reduced impedances on the T- and C-level of the patients.Data evaluation was performed in four groups of adult patients: a) standard Nucleus 24 Contour (control), b) standard Nucleus 24 Contour with intra-operative application of steroids, c) Iridium-coated Nucleus 24 Contour, and d) Iridium-coated Nucleus 24 Contour with intra-operative application of steroids. Impedance values were evaluated and compared to the respected T- and C-level by statistical methods before and after electrical stimulation during first rehabilitation period and after 3 years of electrical stimulation.Besides very large variations in the impedance profiles along the electrode arrays between different patients, significantly higher stimulation levels were observed with lower impedances in both, common ground and monopolar (MP1+2) modes. This correlation was stable also when the influence of single electrode contacts, treatment groups and different time points were taken into consideration. As the increase in impedance is typically explained by the growth of fibrous tissue around the electrode array, these results could be explained by altered current paths inside the cochlea during electrical stimulation.

P45. Fluctuation of objective measurements data in normally functioning cochlear implants

MM Litvak, AV Starokha

Siberian State Medical University, TOMSK, Russian Federation

Introduction: Cochlear implantation has become a method of choice for profound hearing loss treatment. However, outcomes vary significantly, which could be explained also by specific condition of implant and surrounding tissue environment. Electrode array impedances and neural response telemetry (NRT) are believed to be the most informative parameters for assessment implant interaction with tissues and provide essential information for implant fiting.

Material: Ten patients of age between 2 and 20 years (mean age - 3,9 years) implanted using traditional method through cochleostomy by Nucleus (Cochlear, Australia) implant system were under observation. We measured impedances four times running with one minute gaps; then repeated this sequence after one and four hours. NRT was measured twice and repeated as well after one and four hours.

Results: Means for objective data obtained were: 12.1 kOm for electric impedances and 162 CL for NRT threshold. We managed to register minor real-time changes of data which was 0.14±0.04 kOm for impedances and 7.1±1.2 for NRT thresholds. However, impedance and NRT fluctuations were always higher than expected measuring inaccuracy. The most significant changes were obtained in patients during first fitting and after long period of implant disuse. For instance, it was 2.4(18%) kOm after one hour and 4.2(29%) kOm after four hours of observation. Thresholds of NRT changed for 4.6 CL and 14.2 CL respectively. It suggests that ionic environment around electrode is not stable and react to stimulation. Such phenomenon could be explained by polarization of tissues and electrophoresis caused by electric stimulus.

P46. Delayed isolated pain after cochlear implantation

YS Shapira[1], LM Migirov[1], JK Kronenberg[2]

[1]Sheba Medical Center, TEL HASHOMER, Israel

[2]Assaf Harofeh Medical center, ZERIFIN, Israel

Introduction: Pain over the receiver-stimulator months and years after cochlear implantation may be related to device malfunction or to local infection. Many times the pain leads to explantation of the device. We report an uncommon complaint of pin-point-pain at specific sites over the receiver-stimulator, unrelated to whether the implant is on or off. Integrity tests performed in some of these cases showed no malfunction, and physical exam was normal.

Materials and Methods: A review of all patients who in the years 2009-2012 complained of pain related to their cochlear implant (CI).

Results: Twenty patients complained so far of pain related to their CI. Three of these were excluded from this study as it was found that their pain was related to other factors. The remaining 17 were implanted from 3 months to 9 years before presentation of pain. The pattern of pain in all 17 subjects was typical, and was located to specific pin-point sites surrounding the receiver-stimulator. The pain was present even with the processor off. Nine patients were treated with antibiotics, five were treated with anti-inflammatories and 3 needed no treatment. The response rate to either treatment was variable.

Conclusion:
Pin-point pain is an uncommon, yet serious consequence of CI. Reports in the literature are scarce.

P47. Successful partial cochlear implantation on a patient with relapsing polychondritis

B Aldosari[1], R Meller[2], J Magnan[3], T Lenarz[4]

[1]MARSEILLE, France

[2]Department of ORL & Head and Neck surgery, CHU Nord, Hôpitaux de Marseille, MARSEILLE, France

[3]Department of ORL & Head and Neck surgery, CHU Nord, Hôpitaux de Marseille, Univ, MARSEILLE, France

[4]Department of Otorhinolaryngology, Hannover Medical School, Carl-Neuberg-Str. 1, HANNOVER, Germany

Relapsing polychondritis is a rare disease of unknown etiology causing systemic inflammation of the whole cartilaginous tissues. We report a patient of relapsing chondritis with a history of progressive bilateral profound sensorineural hearing loss. She had been treated many times with steroids, immunosuppressant. Because of cochlear obliteration, we performed a cochlear implant surgery on the right ear of this patient with partial insertion. Results were very good and stable. This raises the risk of cochlear obliteration and the indication of cochlear implant in this pathology.

P48. Relation between position and impedance of the extracochlear reference electrode MP1 in Nucleus CI

T Wesarg[1], R Beck[1], H Hessel[2], R Laszig[1], S Arndt[1], A Aschendorff[1]

[1]University Medical Centre Freiburg, FREIBURG, Germany

[2]Cochlear Deutschland GmbH & Co. KG, HANNOVER, Germany

Introduction: All 24-channel Nucleus cochlear implants include two extracochlear reference or ground electrodes, a Monopolar 1 (MP1) ball electrode in Nucleus 3 and 4 implants or a cylinder electrode in Nucleus 5 implants, and a Monopolar 2 (MP2) electrode located on the casing of the receiver stimulator. According to Cochlear surgeon's guides for 24-channel Nucleus cochlear implants the MP1 electrode should be placed against the bone under the temporalis muscle to avoid mechanical stress. However, some surgeons prefer the placement of the MP1 electrode in the mastoid cavity instead of the temporalis muscle, as this placement allows for a much simpler removal of this electrode in case of necessary reimplantations. But this electrode position might elicit an unusually large impedance of MP1 at least in the long-term.

Methods: By now, in 100 Nucleus 24-channel cochlear implant surgeries the MP1 electrode was placed under the temporalis muscle and in another 100 surgeries in the mastoid cavity. MP1 electrode impedance was assessed intraoperatively, during processor switch-on and 12 months after switch-on.

Results: Twelf months after switch-on the impedance of electrode MP1 is significantly and much larger for Nucleus 24-channel implants with mastoid cavity placement of MP1 than implants with temporal bone placement. In case of mastoid cavity placement there are several cases with MP1 impedance larger than 30 kOhm, and thus an open circuit status of MP1.

Conclusion: Due to presumably occuring MP1 electrode impedance increase over time the placement of the MP1 electrode in the mastoid cavity should be critically reconsidered.

P49. Music and quality of life in post-lingually deafened cochlear implant users

CD Fuller, RH Free, A Maat, D Baskent

University of Groningen, University Medical Center Groningen, Department of Otor, GRONINGEN, Nederland

Introduction: We hypothesized that better enjoyment, quality, and perception of music in post-lingually deafened cochlear implant (CI) users may be associated with higher health related quality of life (HRQoL) and self reported hearing related performance, as well as objective speech perception scores.

Methods: Ninety-eight post lingual, adult CI users filled questionnaires on music perception (Dutch Musical Background Questionnaire; DMBQ), health related quality of life (Nijmegen Cochlear Implant Questionnaire; NCIQ) and hearing related performance (Speech Spatial and Qualities; SSQ). Speech perception in quiet was measured with a phoneme recognition test during regular outpatient visits. Associations between the outcomes of the questionnaires and speech scores were assessed.

Results: The DMBQ results showed that the musical listening habits declined after implantation and the quality of music perception was low. The ability to differentiate the elements of music was associated with the speech perception scores. The HRQoL was associated with all DMBQ measures and speech perception scores. The hearing related performance was only associated with the differentiation of music elements and the speech perception scores.

Conclusion: This study showed all measures of DMBQ: the music enjoyment, the perceived quality of music and the ability to perceive the basic elements of music as well as the speech perception scores to be associated with HRQoL. The hearing related performance was only associated with the ability to perceive the basic elements of music and the speech perception scores. These findings could imply that improving the perception of music and speech may enhance the HRQoL.

P50. Assesment of speech production development in cochlear-implanted children

KK Kosta[1], RL Laboissière[1], DO Ostry[2], MP Porot[3], MM Mazzuca[4], ET Truy[3], HTV Thai-Van[4]

[1]INSERM U1028 - CNRS UMR5292 Lyon Neuroscience Research Center DYCOG Team, LYON, France

[2]Department of Psychology, McGill University, MONTREAL, Canada

[3]Dpt ORL, Chirurgie Cervico-Maxillo-Faciale et Audiophonologie, Hôp. E. Herriot, LYON, France

[4]Service d'Audiologie & d'Explorations Orofaciales, Hôp. E. Herriot, LYON, France

Rehabilitation of cochlear implanted (CI) patients may depend on both the duration of auditory deprivation (DAD), and the duration of cochlear implant use (DCIU). Indeed, the audio-phonological loop may be more functional if DAD is short and/or DCIU is long. In order to test this hypothesis, twenty CI children aged from 3y1m to 12y2m were included in a cross sectional study aimed at evaluating the effects of DAD and DCIU on oral language development. The productions of isolated phonemes were recorded with the implant in states ON and OFF. There were four recording blocks: ON1, OFF1, OFF2 and ON2, with a ten-minutes pause between OFF1 and OFF2. The amount of production change between the reference condition (ON1) and each of the three other conditions, was computed by calculating distances in the acoustic space. We found that in children with more than 1300 days of CI use, the amount of shift decreases when the implant is turned ON (block ON2). In contrast, in children with less than 1300 days of CI experience the amount of shift increases. The amount of shift is also predicted by the amount of auditory deprivation. In children with auditory deprivation less than 600 days the amount of shift decreases when the CI is turned ON, while it increases if auditory deprivation is more than 600 days. This demonstrates independent effects of both factors, auditory deprivation and cochlear implant use, on oral language development.

P51. Loudness and speech recognition in noise of cochlear implant users

C Mace[1], AV Vieu[2], JPP Piron[3], JLP Puel[4], FA Artieres[5], FV Venail[3]

[1]MONTPELLIER, France

[2]Institut Saint Pierre, PALAVAS, France

[3]ENT department, University Hospital of Montpellier, MONTPELLIER, France

[4]Audiology Platform I-PaudioM INSERM U1051-Montpellier, MONTPELLIER, France

[5]Cochlear implant center in Montpellier, Institut Saint Pierre, PALAVAS, France

Introduction: This study aimed at demonstrating the role of loudness and pitch discrimination during speech perception in noise of cochlear implantees.

Methods: 35 congenitally deafened subjects, with a minimum of 5 years of unilateral cochlear implantation, and significant speech comprehension in quiet environment (PBK> 60%) were enrolled in this study. Speech intelligibility was evaluated using monosyllabic words test (PBK), delivered free-field at 65 dB, in quiet and noisy conditions (ICRA-4 noise, SNR +10, +5 and 0 dB). Multivariate logistic regression was performed on PBK scores and residues of PBK scores in noise adjusted on PBK in quiet according to several variables as regression curves of loudness at 250, 1000 and 4000 Hz (ASSE software), pitch discrimination (ASSE software), pure tone audiometry (low - average 250+500+750, middle 1000+2000, and high 4000+6000 Hz), and communication mode (total versus oral).

Results: PBKSNR0 correlated with good pitch discrimination ($p=0.033$) and loudness at 4000 Hz ($p=0.039$) only. PBKSNR5 correlated to middle and high frequencies auditory thresholds ($p= 0.02$ and $p<0.001$ respectively in addition to pitch and loudness at 4000 Hz ($p<0.001$ and $p=0.005$). Finally PBKSNR10 was associated with auditory thresholds ($p=0.005$, 0.021 and 0.038 for low, middle and high frequencies), and loudness at 250 Hz ($p=0.043$). Pitch was nearly significant ($p=0.056$)

Conclusion: Pitch discrimination and loudness are important parameters for speech perception in noise in implanted patients. Auditory thresholds are also involved when SNR is elevated. Psychophysicals measures could be used in cochlear implant fitting to improve speech in noise perception after cochlear implantation.

P51. Cortical activation in late implanted prelingually deaf implanted patients

LV Straatman[1], MM Van Wanrooij[2], LF. De Geus-Oei[3], EP Visser[3], AFM Snik[4], JJS Mulder[4]

[1]NIJMEGEN, Netherlands

[2]Department of Biophysics, Donders Institute for Brain, Cognition and Behavior, NIJMEGEN, Nederland

[3]Department of Nuclear Medicine, Radboud University Nijmegen Medical Centre, NIJMEGEN, Netherlands

[4]1Department of Otorhinolaryngology, Donders Institute for Brain, Cognition and B, NIJMEGEN, Netherlands

There is still a wide range in performance after cochlear implantation in late implanted prelingually deaf adults. Previous studies showed that probably preoperative cortical activation can be used to predict the outcome after implantation. The first objective of this study was to investigate if preoperative brain metabolism, measured with FDG-PET, can be used in order to predict the postoperative outcome in prelingually deaf late implanted adults. To that end the cortical metabolism of the preoperative FDG-PET scan of 6 prelingually deaf adults is correlated with the postoperative speech perception scores with the cochlear implant. The second objective was to investigate differences in cortical metabolism between good and poor performers after implantation. To that end the cortical metabolism of 4 good performers is compared to that of 4 poor performers. In this study the preliminary results are shown.

P52. Changes of psychophysical parameters in cochlear implant users

F Tóth

University of Szeged, SZEGED, Hungary

It is the most important to determine the exact electrical threshold and comfort levels during the fitting process. Our aim was to study the alterations of T- and C-levels in the early and late postoperative periods.Our investigation were performed in 85 cochlear implant users. The electric T-, C-levels and dynamic ranges were examined in all device fittings. Psychophysical parameters show a temporal change which can be traced back to numerous reasons. During an adaptation period, the central nervous system gets used to the louder sounds (especially in case of prelingual hearing loss). The comfort level rises, the hearing threshold drops, the dynamical range widens. As the result of continuous stimulation some regeneration processes occur at the periphery of the hearing nerve. This causes the (sometimes drastically) change of thresholds.Having the above in mind we can conclude that the regular programming of the devices is very important.

P53. Brain-speech alignment enhances auditory cortical responses and speech perception.

HS Saoud[1], ET Truy[2], EB Bertasi[3], MC Chait[4], GJ Josse[5], ALG Giraud[5]

[1]INSERM U1028 - CNRS UMR5292 Lyon Neuroscience Research Center DYCOG Team, LYON, France

[2]Dpt ORL, Chirurgie Cervico-Maxillo-Faciale et Audiophonologie, Hôp. E. Herriot, LYON, France

[3]Centre de NeuroImagerie de Recherche (CENIR), PARIS, France

[4]UCL Ear Institute, LONDON, United Kingdom

[5]Inserm U960, Department of Cognitive Studies, PARIS, France

Asymmetry in auditory cortical oscillations could play a role in speech perception by fostering hemispheric triage of information across the two hemispheres. Due to this asymmetry, fast speech temporal modulations, could be best perceived by the left auditory cortex, while slower modulations would be better captured by the right one. Sixty-three French native speakers took part in two experiments. 41 subjects were included in the first (psychophysical study) and 22 in the second (fMRI study). The test material consisted of disyllabic words. We extracted and filtered the temporal envelope with two band-pass filters. The stimuli were presented in five listening conditions. In the psychophysical study subjects were instructed to listen to the stimuli and to repeat immediately what they heard. During the fMRI experiment, subjects reported the word by choosing between three written items. When we provide different parts of the speech envelope to each ear, word recognition is facilitated when the temporal properties of speech match the rhythmic properties of auditory cortices. We further show that the interaction between speech envelope and auditory cortices rhythms translates in their level of neural activity (as measured with fMRI). In the left auditory cortex, the neural activity level related to stimulus/brain rhythm interaction predicts speech perception facilitation. These data demonstrate that speech interacts with auditory cortical rhythms differently in right and left auditory cortex. This interaction impacts speech perception performance. We propose that this lateralization effect could have practical implications in the framework of bilateral cochlear implants.

P54. The perception of stimulus intensity – the comparison of AutoNRT measurement and behavioral methods

Z Lukaszewicz[1], K Niemczyk[1], M Lachowska[1], M Kida[2]

[1]Medical University of Warsaw, WARSAW, Poland

[2]Medicus, WROCLAW, Poland

Objective: AutoNRT is one of thesupplementary objective measurements used during the adjustmentof stimulation parametersof sound processor. Among specialists in speech processorfitting the usefulness of this tool in the evaluation of the thresholdshas been discussed. The aim of this study was to determine the correlation of the level of the recording and the behavioral thresholds.

Material and Methods: 48 cochlear implant userstook partin the study. A prerequisite was the width of the applied electrical pulse, identical to that used in AutoNRT (PW = 25). The measurement was performed on five electrodes. 5 termsof volume were used (from ‘no’ to ‘too loud’).

Results: In 10 patients received sound level was similar in AutoNRT and MAP, in the remaining patientsdifferences were observed in the loudness levels of perceived sound. It wasnot always managed to get a record in AutoNRT.

Conclusions: Measurement of AutoNRT can be used as a tool to assist in the process of adjusting parameters of the speech processor.The’Shape’of the MAPbased on AutoNRTresult, in most cases is not consistent withthese based on the behavioral measurements.

P55. Assessment of directionality performance for CP 810 and freedom sound processors

EC Cristofari, SR Razza, GA Albanese, LE Ermoli

Ospedale di Circolo, VARESE, Italy

In 2009 Cochlear made available the Nucleus® CP810 sound processor, claiming for a new remarkable evolution, with respect to the previous device Freedom, in approaching the challenge of noise management for CI recipients. Both the systems can be programmed with a range of input processing options including Beam™, which exploits a beamforming technology aimed to attenuate sounds based on their spatial distribution, in order to improve speech understanding in noise.The Freedom processor, employs a rear omni-directional microphone, which is equally sensitive to sounds from all directions, as well as an extra directional microphone pointing forward.The CP810 Processor is equipped with two sensitivity and phase-matched, low noise, omni-directional microphones which can be combined into selectable directional responses via DSP.The purpose of this research is to compare the directional effectiveness of the two different devices evaluating the hearing performance of a group of ci recipients.Each participant underwent speech-in-noise tests, using the different sound processors, with same map and Beam option on, in randomised order across two test sessions. Hearing performances were evaluated, through the presentation of lists of italian bysillabic words in a spatially separated noise set-up using fixed speech levels of 65 dBSPL and multiple signal to noise ratios, in order to measure the SNR at which the participant recognized 50% of words in babble noise (SRT50). In the poster are displayed the scores of the hearing performances obtained by the patients with the two different processors.

P56. Impact on hearing level on language skill of hearing-aided and cochclear implanted deaf children

RN Nagata[1], TN Nakagawa[1], TM Murakami[1], HH Higuchi[1], SN Nishio[2], KF Fukushima[3], NK Kasai[3]

[1]Fukuoka University School of Medicine, FUKUOKA, Japan

[2]Department of Otorhinolaryngology, Shinshu University School of Medicine, MATSUMOTO, Japan

[3]Department of Otorhinolaryngology, Head and Neck Surgery, Okayama University Pos, OKAYAMA, Japan

Introduction: The Research on Sensory and Communicative Disorders (RSCD) project was performed in Japan to investigate the skills of severe and profound hearing loss children test battery depending on a concept of languages domain. The date were analyzed from the standpoint of hearing level.

Methods: 638 participants were recruited for the RSCD project in Japan. Criteria for inclusion were as follows; (1) age from 48 months to 6th grade of elementary school; and (2) congenital hearing impairment, with a hearing level >70 dB (on an average) appearing no later than 4 years of age. ALADJIN battery was conducted by trained audiologists, speech pathologists, or deaf school teachers in a noise-minimized area (Kasai 2012). Background information, including hearing level, age at identification, diagnosis of hearing impairment, modalities of communication, hearing devices, and age at commencement of hearing intervention, was collected by parental questionnaire. Among them, hearing level was measured from 480 children. 266 children were hearing-aided and 214 were cochlear implanted.

Results and Conclusion: Aided hearing level was the most affected factor for language skill in hearing-aided children. In order to aim at better language skill, aided hearing level should be equal or less than 45dB. Early intervention is an important factor to lower aided hearing level. Factors such as good communication with parents lowered the aided hearing level in cochlear-implanted children. Lower aided hearing level significantly improved the ability of syntax and verbal communication in cochlear-implanted children.

P57. Analysis of intracochlear electrical stimulation patterns

TL Liebscher[1], FD Digeser[1], HH Hessel[2], UH Hoppe[1]

[1]ENT-clinic, University of Erlangen-Nuremberg, ERLANGEN, Germany

[2]Cochlear GmbH, HANNOVER, Germany

Introduction: Evaluation of coding strategies is usually performed with speech tests including speech in noise and speech in quiet. Evidently, the electrode activation pattern differs significantly between different strategies. However, it has to be assumed that different speech material also may result in different electrode activation. Therefore, looking at the activation pattern may be of interest. This study takes characteristic noise and speech signals and shows which electrodes will be activated. The influence of various map parameters in ACE and MP3000 coded signals will also be illustrated.

Methods: The levels of various noise signals and German speech tests were adjusted and processed with the Nucleus MATLAB Toolbox. A maxima selection based on the MP3000 algorithm was implemented. The default map parameters of Nucleus Custom Sound for a simulated CI listener were used. The computed impulse sequences were analyzed and compared.

Results: Increasing the stimulation rate leads to a bigger temporal resolution, but has no (relatively) spectral influence. By increasing the maxima, more medial electrodes will be stimulated. A flat slope leads to a bigger masking effect; hence more frequency bands with lower energy levels are selected. In comparison to ACE, this enhances the average distance between the maxima.

Conclusion: The analyzed speech and noise signals stimulate primary apical electrodes. A maxima selection treating spectral masking effects can increase the spectral resolution. The analysis of electrode stimulation patterns allows comparing coding strategies on an objective level. To simulate the signal processing more accurately, the (missing) preprocessing algorithms should be included.

P58. Speech measurements after cochlear implantation in dysplastic inner ears

DR Rachovitsas[1], GP Psillas[1], KM Markou[1], ST Triaridis[1], JC Constantinidis[2], VV Vital[1]

[1]1st Academic ENT Department, Aristotle University of Thessaloniki, AHEPA Hospita, THESSALONIKI, Greece

[2]2nd Academic ENT Department, Aristotle University of Thessaloniki, Papageorgiou, THESSALONIKI, Greece

Objective: The aim of this study was to assess the speech perception and speech intelligibility outcome after cochlear implantation in children with anomalous cochleovestibular anatomy.

Methods: The dysplastic group consisted of six deaf children (5 boys and 1 girl) which were matched with a control group of 6 children with normal inner ear. All subjects were tested with a battery of tests including the LiP, CAP and SIR test. A closed and open set word perception test adapted to the Modern Greek language was also used. In the dysplastic group, two children suffered from CHARGE syndrome, another two from mental retardation, and two children grew up in bilingual homes.

Results: At least two years after switch-on, the dysplastic group scored mean LiP 62%, CAP 3.8, SIR 2.1, closed-set 61%, and open-set 49%. The control group achieved significantly better scores, except for CAP which this difference was marginally statistically significant.

Conclusion: The dysplastic group showed benefit of speech measurements; however, they performed less well compared with the control group. This was possibly due to the high proportion of disabilities detected in the dysplastic group, such as CHARGE syndrome and mental retardation. Bilingualism could also be considered as a factor which possibly affects the outcome of implanted children. Therefore, children with malformed inner ear should be preoperatively evaluated for cognitive and developmental delay. In this case, counseling for the parents is mandatory in order to explain the possible impact of the diagnosed disabilities on performance and habilitation.

P59. Perception of voicing of stop consonants in children with cochlear implant

Y Avilala[1], S Raja[2], K Prasad[1]

[1]MedEL India Pvt Ltd, NEW DELHI, India

[2]MAA ENT Hospital, HYDERABAD, India

Introduction: It has been hypothesized that improvement in the voicing parameters, could be determine at up to 6 months after surgery (Campisi et al, 2005). In this study, we determined the perception of voicing of stop consonants in young children using cochlear implants.

Methods: All children using cochlear implant who had undergone a minimum six months of structural auditory training were participated in this study. Thirty children (18 males and 12 females) aged 3 to 10 years were enrolled. Consonant vowel combinations of voiced and voiceless stop consonants were presented randomly to all the participants through sound field testing in a closed set condition. All the correct responses were recorded and analyzed.

Results: The results of the present study show that, even after formal training, there was no significant difference in perception of voicing of stop consonants in children using cochlear implants.

Conclusion: Additional training should be given to children using cochlear implants to improve the perception of voicing.

P60. Electromagnetically driven Microactuator for an implantable hearing aid

M Steffens[1], U Bilbal[2], T Creutzburg[3], M Wurz[3], L Rissing[3], T Lenarz[1], G Reuter[1]

[1]Hannover Medical School, HANNOVER, Germany

[2]Medical Schhool, Department of Otorhinolaryngology, Head and Neck Surge, HANNOVER, Germany

[3]Leibniz University Hannover, Institute of Micro Production Technology, HANNOVER, Germany

Introduction: To treat conductive and sensorineural hearing loss is to implant a full implantable active middle ear device. All middle ear devices were developed to activate the ossicular chain. Now, these devices also were adapted and used to stimulate the round-window-membrane (RWM) and the perilymph of the cochlea directly. The objective of this study was the development of an electromagnetically driven microsystem, specially designed for stimulation of the RWM.

Methods: The laser-Doppler-vibrometer-system was used to investigate the efficiency of the microactuator and mechanical stimulation of the RWM in temporal bones. For the well-defined stimulation of the RWM-measurements a mini-shaker was used. The actuator movement properties were analysed with and without membrane coupling. For the membrane measurements the microactuator was fixed to a model-membrane under different conditions (plunger length, attachment at / in the membrane). The plunger movement and the membrane drive performance were measured during application of frequencies up to 17 kHz.

Results: Mechanical Stimulation of the RWM and model-membranes with a mini-shaker showed a possible constant frequency-independent energy input into the cochlea. The displacement amplitudes during the stimulation with the actuator indicated a reproducible membrane drive performance, whereas the system temperature under load conditions was higher as expected based on a 3D-thermal simulations of system heating effects during operation.

Conclusion: The stimulation of RWM can be very effective demonstrated with a shaker-system in temporal bones and our membrane model. The obtained displacement amplitudes with the new designed electromagnetically driven microactuator have to be optimized for the amplitude frequency response.

P61. Performance of elderly cochlear implant recipients

M Alhajry, J Chénier, J Whittingham, **C Séguin**, D Schramm

Ottawa Univrsity, GLOUCESTER, Canada

Objective: To analyze the benefits and risks of cochlear implantation in recipients aged = 65 years at the time of implantation compared to younger adults.

Design: Retrospective analysis of cochlear implant outcomes database.

Setting: Tertiary referral center.

Population: 203 individuals > 45 years of age with adult onset profound hearing loss underwent implantation between 1993 and 2011 at our institution: 110 were age = 65 years, 93 were ages 45–64 years. Recipients (111 females, 92 males) had a mean age of 65.2±10.9 years (range 45–89 years) at the time of implantation and median duration of deafness of 5.3 years (range 0–56 years).

Main Outcome Measure: Speech perception at 12 months post-implantation: CNC word recognition and HINT sentence recognition tests.Change in speech perception over time was evaluated as a secondary outcome measure to determine if elderly recipients plateau earlier and/or lose functional benefit from implantation due to cognitive decline.HRQoL was assessed with PIPSL (Performance Inventory for Profound and Severe Loss).Adverse events and co-morbidities were documented.

Results: 12 months post-implantation, 52% of individuals scored > 75% on HINT sentences. There was no significant difference between elderly (median 69.8%, IQR; 54.7, 90.8) and younger adults (median 64.9%; IQR; 40.5, 94.6). Linear regression analysis was utilized to evaluate the effect of age on speech perception outcomes with duration of deafness and preoperative functioning as covariates.

Conclusion: Cochlear implantation in the elderly provides improvements in speech understanding and quality of life similar to those for younger adults.

P62. A preliminary study of C levels and electrode impedance in MED-EL CI adult users

ML Lien[1], GC Chen[2]

[1]TAIPEI, Taiwan

[2]Auditory Medical Center at Cheng-Hsin Hospital, TAIPEI, Taiwan

The goal of the present study was to assess the correlation between electrode impedance values and C levels. The assumption was made that the higher impedance values would cause higher C levels to reach 'loud but ok' perception across electrodes. However, the results of the present study indicated that electrode impedance values had no correlation with behaviorally measured C levels.

P63. Growth-function of electrically evoked brainstem responses in cochlear implant patients

JS Steinhoff[1], C Lackner[2], A Giebel[3], W Hemmert[2]

[1]Klinikum rechts der Isar, MÜNCHEN, Germany

[2]Technische Universität München, Bio-Inspired Information Processing, IMETUM, MUNICH, Germany

[3]University of Applied Science, MUNICH, Germany

This investigation develops a system for the objective measurement of auditory brain stem responses in awake cochlear implant patients. Electrical stimuli were delivered with MED-EL implants under computer control (RIB II) and responses were amplified with a biosignal amplifier and sampled synchronously with an A/D data acquisition board using custom software. Data analysis was conducted both on-line (to follow the measurement progress) and off-line to implement more complex stimulation- and muscle artifact rejection algorithms. In addition to the eBERA measurements (N=6), our patients also evaluated the perceived loudness of the pulse-trains used in these measurements.Electrical stimulation artifacts were two orders of magnitude larger than wave V of the evoked potentials. We were still able to extract reliable responses using alternating stimulation pulses and fitting and subtracting the remaining artifact with an exponentially decaying function. Wave V was easily identified at high stimulation levels and tracked by eye down to low levels. An objective threshold criterion was established based on the binomial average. For low to medium stimulation amplitudes the amplitude of wave V amplitude grew linearly with the perceived loudness, individual correlation coefficients were between 0.81 and 1. Notably, our measurements were very sensitive, the objective detection threshold was between the loudness categories ‘soft’ and ‘very soft’.In summary our results indicate that carefully measured and analyzed eBERA data provides interesting insights into loudness growth in CIs. If a systematic relation between single-pulse thresholds and burst stimulation can be established, it can be even used for objective threshold estimations.

P64. Impact of pulse width on electrically evoked auditory brainstem responses

NXB Bonne, IR Ruzza, JD Desruelles, GH Hosana, PF Fayoux, FMV Vaneecloo, CV Vincent

CHRU Lille, LILLE, France

Objective: DIGISONIC SP® cochlear implants (CI) uses variable time-pulse for sound coding between comfort and threshold levels. We aimed to investigate the effect of increasing pulse width on electrically Evoked Auditory Brainstem Responses (eABR) recorded at the time of cochlear implantation.

Design: eABR recorded during 188 surgeries for cochlear implantation from 1999 to 2006 in a single centre were retrospectively reviewed by to independent observers. All patients were fitted with a NEURELEC CI device, initially DIGISONIC® then DIGISONIC SP® (2004-2006). We used a biphasic pulse train and unique setting of stimulation parameters and filter characteristic, and tested two values of pulse width (T-pulse) for paired comparison.

Result: Immediately following cochlear implantation, stimulation by the CI resulted in reliable wave III and V eABR waveforms (wave V 4.28+/-0.42 ms and 2.23 +/- 0.38 ms for wave III (Mean +/- SD)). As previously reported, latencies followed an apical to basal gradient (0.32 ms increase in mean eV latency and 0.12 ms for eIII latency). Secondary to increasing pulse width, Wave III and wave V latencies significantly decrease in association with a shortening of the eIII-eV interwave gap, while amplitudes of both waves increase. These observations are consistent for the three stimulating electrodes tested along the array.

Conclusion: We report the result of eABR registered during cochlear implantation of a Neurelec CI and we detail the stimulating parameters used. We demonstrate herein the impact of varying pulse width on latency and amplitude of brainstem responses in a large set of patients.

P65. Evaluation of Baha implant stability in children

PR Laz[1], PR Laz[2], JR Mierzwinski[1], M Drela[1]

[1]Children Hospital in Bydgoszcz, BYDGOSZCZ, Poland

[2]Children Hospital, BYDGOSZCZ, Poland

Introduction: To measure the stability, as determined by Implant Stability Quotient (ISQ) values, of Baha implants placed according to the protocol for FAST (one-stage) surgery in children. [1]

Methods: In an open, prospective study 10 children up to 14 years of age with Baha implant were included. Implant stability quotient (ISQ) values were recorded using resonance frequency analysis at the time of implantation and at 10 days, at 8 and 12 weeks, and at 6 months after surgery. Skin reactions were evaluated according to the Holgers classification. [2] Sound processor fitting was performed from 8 weeks after implantation.

Results: Mean ISQ values, measured in children with Baha BIA300 Implant 4 mm between 0 and 6 months – 59/61 were compared to the published results of obtained ISQ values with the same type of implant in adults[3]. These results combined with the observation of skin reactions according to Holgers classification allowed for early sound processor fitting significantly shorter than originally recommended in children.

Conclusion: The level of osseointegration reached with the implants in children similar values as in adults at 8-10 weeks after implantation. This was sufficient to support the sound processor

P66. Electrode impedances in patients reimplanted due to Nucleus 5 failure

MK Karlik, OMS Stieler, RG Gibasiewicz

Poznan University of Medical Sciences, POZNAN, Poland

Introduction: Cochlear implant program in Poznan started in 1994. Till the end of 2009 we did not observed in our group of 670 patients any spontaneous device failure. After introducing Nucleus 5 we had to gain a new experience with reimplantations due to implant problem. In the group of 125 Nucleus 5 devices implanted 7 reimplantations were done.

Material: 7 patients with Nucleus 5 and reimplanted with Nucleus Freedom due to device failure.Methods. Measurements of electrode impedances done using Custom Sound 3.2 during first surgery and during reimplantation were analyzed. Also measurements performed during speech processor switch-on were analyzed.Results. An increased impedance was observed during 2nd surgery. The mean difference between two surgeries (reimplantation-implantation) was 3.7 kOhm. The higher difference was noted in basal turn (electrodes 1-7, 4.13 kOhm) than apical turn (electrodes 16-22, 3.01 kOhm). During speech processor switch-on a little bit higher average difference (1st-2nd) of electrode impedances was noted (0.55 kOhm), also higher in the basal turn of the cochlea.

P67. Evaluation of hearing impairment due to exposure to noise or Meniere's disease by DPOAE

S Abdi

Azad University, TEHRAN, Iran

Background: Different pathologies may lead to different levels of hearing impairment in certain durations.Evaluation of the nature and extent of the hearing impairment is a crucial step in treatment of patients which is accomplished via different tests.

Methods: In this study we have tried to compare the results of pure tone audiometry with results of distrotion product otoacoustic emission (DPOAE) and auditory brainstem response (ABR) in normal subjects, patients with meniere's and patients with noise induced hearing loss.

Results: Hearing thresholds of the Menier's group were significantly worse (higher) than the normal group at all frequencies ($p<0.01$ at all frequencies). Hearing thresholds of the NIHL group were significantly worse (higher) than the normal group at 1000 and higher frequencies ($p<0.03$ at all frequencies). Menier's group had significantly worse (higher) hearing thresholds than NIHL group at 2000 Hz and lower frequencies ($p<0.03$ at all frequencies). Menier's group subjects had significantly higher SRTs as compared to NIHL and normal groups ($p < 0.001$ for both comparisons). Speech discrimination scores were not different between the groups. Signficantly higher wave V absolute latency for NIHL group was revealed as compared to Menier's and normal groups ($p=0.01$ and $p=0.002$, respectively).

Conclusion: No correlations could be proven between duration of disease (in Menier's group) or duration of exposure to noise (in NIHL group) and any of the hearing thresholds, DP, NF or DP-NF. Detailed discussion of results is provided in the article.

P68. The amplitude growth function of V peak eABR in cochlear implant fitting

VE Gaufman

KRASNODAR, Russian Federation Medical Center'MasterSluh', Krasnodar, Russia

Introduction: Postoperative eABR can be used to objectively visualize and verify the stimulation of auditory brainstem pathways for CI users. Data on auditory pathway function can help fit CIs if the patient 1) is non-responsive, 2) has concomitant neurological diseases, and/or 3) has auditory neuropathy and inner ear malformations.

Methods: Post-cochlear implant eABR was performed on 15 CI users aged 2 to 37 years (mean 11.2) with MED-EL cochlear implants. eABR was conducted using ABR registration system and synchronized with the MED-EL DIB II. Weused the standard parameters for ABR registration and electrode installation. Stimulation consisted of a single run of 2000 two-phase incentives with a negative initial phase of alternating polarity and a length of 30mks at a 43Hz stimulation frequency.We also recorded eSRT, eCAP, subjective (TH) thresholds, and MCL for all the cochlear implants' active channels.

Results: III and V peaks were recorded in all patients with stimulation of all the selected channels. eABR threshold was recorded at stimulation levels exceeding 20% to 30% dynamic range from the threshold of subjective perception. Stepwise rising the stimulation level up to levels close to the MCL and eSRT resulted in a cessation of amplitude growth in peaks III and V.

Conclusion: Finding the saturation point at amplitude growth function can be used as a predictor for setting MCL in speech processors during fitting. This technique is especially useful when eSRT cannot detect or determine subjective MCL thresholds.

P69. Clinical picture and classification of auditory neuropathy

S Abdi

Azad University, TEHRAN, Iran

Objectives: To describe the clinical picture of the patients with the key clinical feature of hearing loss for pure tones and reduction in speech discrimination out of proportion to the pure tone loss, having some of the criteria of auditory neuropathy (i.e. normal OAE, abnormal ABR) and lacking others (e.g. present auditory reflexes).

Methods: During 1997–2011, in a retrospective study, patients' records were reviewed and the results of OAE and ABR and pure tone audiometry (PTA) were tabulated as well as speech discrimination scores (SDS), measured in all patients using a standardized list of 25 monosyllabic Farsi words at MCL in quiet.

Results: Both ears of 45 patients (25 males and 20 females) comprised the study population. Mean age at the onset was 15.2±3.5. SDS had a mean±SD of 29.2±30.7. A strong significant correlation was noted between SDS and hearing threshold. Six samples (33%) had auditory reflexes. All of the patients were suffering from different degrees of tinnitus. 20 patients were able to hear music, without understanding the words of the singer, although the SDS in all of them was no more than 10.

Conclusions:
Reviewing the medical records revealed deterioration of hearing and speech discrimination over time. Although in most of the cases the hearing loss had been more apparent in the lower frequencies, a stronger correlation was found between SDS and hearing threshold at higher frequencies. These patients may not benefit from hearing aids, though, it was tried for all.

P71. Influence of cochlear electrical stimulation on peripheral vestibular receptor function

ND Deggouj, VW Wiener

Cliniques UCL Saint-Luc, BRUSSELS, Belgium

Background: Cochlear implanted subjects often complain of postoperative symptoms of dizziness. The cochlear implant's impact on the vestibular function may be caused by surgery trauma and by spread of the electrical stimulation. This impact is generally presented as negative.

Objective: to assess the influence of cochlear implant(CI) functioning on peripheral vestibular receptors responses of the implanted and non-implanted ears.

1. to verify if all the selected outcomes are concerned.
2. to confirm that the impact is always negative.

Method: Prospective study on 39 cochlear implanted adults in 2 conditions (CI switched on and off), using Subjective Visual vertical measures (SVV), caloric horizontal semicircular canal tests, vestibular evoked myogenic potentials (VEMP). The responses of the 2 ears on the 2 conditions were compared.

Results: The switched on condition modifies more the VVS and the VEMP measures than the caloric responses.
The VVS measures are more instable and more deviated in the switched off than the on condition: deviations are higher than 3° in 61% of the subjects in the off and in 33% of the subjects in the on condition. The VEMP are more frequently recorded in the on condition in the implanted and non-implanted ears. The caloric tests are normal in ½ of the subjects. They tend to be more frequently normal in the on condition for the implanted ear.

Conclusion: The electrical cochlear stimulation influences the vestibular responses of the implanted but also of the non-implanted ears. The impacts may be also positive.

P72. Cochlear implantation in patient with ANSD, vision neuropathy and peripheral neuropathy

LM Mikolajewska, PA Pastuszka, RJ Rozycka, ZL Lukaszewicz, KM Morawski, KN Niemczyk

Medical University of Warsaw, WARSAW, Poland

Introduction: The results of the implantation and rehabilitation in patient with auditory neuropathy spectrum disorders (ANSD) depends on precise localisation of the pathological process. If the localization of pathological process is post-synaptic, it is the poor prognosis for the development of open-set speech perception. Patient described in the study suffered of neuropaty with the site of impairment localised in the nerve. Because of strong vision problem he was not able to use lip-reeding in everyday life.

Method and Results: Retrospective study of young patient with ANSD, visual neuropathy and peripheral neuro-pathy, who received CI some years ago. He underwent electrophysiologic and medical assessment, genetic evaluation, behavioral audiometric thresholds tests with and without HA. Degree of hearing loss before implantation was mild to severe in both ears, but he had no speech perception abilities with HA at all. Because of dificulties in communication, he finished secondory school for deaf and blind children and stopped his education. After implantation he achived speech perception abilities good enaugh to finish Warsaw University. In this study authors present follow-up based on results of speech tests, before and afer implantation,made during regullar visits at the hospital

Conclusions: This report shows that patient with ANSD and the site of pathology localisated in the nerve, can benefit from implantation. Result of implantation in this case was successful and changed patient life complitely. It seems that even when we have cochlear nerve deficiency, we can think about implantation individually.

P73. Vestibular deterioration after implantation measured with bithermal calorics: the risky age

AJ Beynon, H Kieft, EAM Mylanus

University Medical Centre Nijmegen, NIJMEGEN, Netherlands

Background: CI can induce vestibular deterioration or even complete vestibular loss. Due to the broadening selection criteria, number of candidates with preop residual hearing increases. As a result, an increase of postoperative dizziness has been reported. Preop predictors are of utmost importance for adequate counseling and long term evaluation.

Aim: State-of-the-art of literature and investigate risk of vestibular deterioration after implantation

Methods: In addition to audiological- and MRI findings, electronystagmography (ENG) was performed in CI candidates and patients. Pre- and postoperative caloric dysfunction of horizontal semicircular canal is compared and rotational testing evaluated. Besides vestibular variables (Slow Phase Velocity, Gain, and 'Gesamtamplitude') also 'Cause of deafness', 'Age at implantation', 'Surgical procedure', 'Type of electrode', 'Surgeon', 'Time between surgery and ENG' and 'Postoperative deterioration in pure tone threshold' are taken into account.

Results: Bithermal caloric testing show that 26% of CI subjects lost their vestibular function after cochlear implantation, while 9% completely lost their vestibular function. Regression analyses reveal that 'Age at implantation' plays a significant role in predicting postop vestibular deterioration: candidates older than 49 years are more susceptible to deterioration. Other variables do not play a (significant) role.Rotational chair data reveal postoperative central adaptation which is in agreement with behavioral DHI results. Present data show no relationship between objective caloric test results and subjective handicap.

Conclusion: With an increasing number of CI candidates with residual hearing, candidates older than 49 years are significantly more at risk for postop vestibular loss and should be informed preoperatively.

P74. Neural correlates of conversion deafness in a cochlear implant patient: A H215O-PET study

JJ Song[1], S Staelens[2], S Deleye[2], S Ceyssens[2], A Gilles[3], G Mertens[3], M De Bodt[3], S Vanneste[1], D De Ridder[4], P Van de Heyning[3]

[1]University Hospital Antwerp, EDEGEM, Belgium

[2]Molecular Imaging Center, University of Antwerp, EDEGEM, Belgium

[3]Brai²n, TRI & ENT, University Hospital Antwerp, EDEGEM, Belgium

[4]Brai²n, TRI & Department of Neurosurgery, University Hospital Antwerp, EDEGEM, Belgium

Introduction: To report a case of presumed cochlear implant (CI) device failure that was evaluated by $H_2{}^{15}O$-PET and ultimately diagnosed with conversion disorder.

Methods: A 4-year left CI user complained of sudden device failure symptom. Given a succession of stressful life events in the patient's recent history, normal device integrity test results, and reliable spiral ganglion evoked potentials measured by auditory response telemetry, we planned a $H_2{}^{15}O$-PET scan with auditory stimuli under the impression of conversion deafness.

Results: The $H_2{}^{15}O$-PET scan revealed several suspicious foci of conversion as well as normal auditory cortex activation which verified normal integrity of the ascending auditory pathway as well as of the device itself. Under speech stimuli, the patient demonstrated decreased regional cerebral blood flow (rCBF) in the left o-inferior prefrontal cortex (piPFC) and dorsal premotor cortex (dPMC), which were areas of increased rCBF in average efficient CI users in our previous meta-analysis. In addition, while our meta-analysis indicated rCBF increase in the salience network areas by non-lexical stimuli, the current case did not activate those regions by noise stimuli. After several sessions of counseling with respect to stressful life events and a sham transcranial direct current stimulation, the patient eventually recovered 3 months after onset of the symptom.

Conclusion: The current study suggests molecular imaging methods as diagnostic tools for a CI patient with possible conversion deafness. Deactivation of the piPFC and dPMC as well as relatively less active salience network components may be related to the pathogenesis of conversion deafness.

P76. An automatic method for locating intracochlear electrodes with clinical CT scanning

SJ O'Leary[1,2], J Husseman[1,2], M Maiorca[1,2]

[1]Hearing CRC and [2]University of Melbourne,[1,2] MELBOURNE EAST, Australia

Aim: To image cochlear electrodes without artefacts obscuring tissues in the immediate vicinity of the electrode.

Methods: Using a conventional clinical CT scanner, pre- and post-implantation helical scans were taken of 6 human cadaveric temporal bones. Contour Advance electrodes were implanted via a cochleostomy. The images were co-registered, and the position of the implant electrode on post-operative scan, was superimposed upon the pre-operative image in 3D. The implanted bones were submitted for histology; after embedding in resin, the block face was ground down and sequentially imaged with the electrode in situ. The electrode position was then compared between the histological sections and the CT-derived images.

Results: This method provided an artefact-free image of the electrode position and the surrounding cochlear structures. The electrode position was accurate to within 1 pixel resolution on the CT images in 75% of the measurements; 96% of the measurements were within 1.5 pixels and 100% within 2 pixels.

Conclusions: We present a method for eliminating the artefacts surrounding a cochlear implant electrode, that are normally complicate the interpretation of conventional CT scans. This was achieved through the automated co-registration of pre- and post-operative images. The method was accurate to within the resolution of the CT scanner in the majority of cases, providing high quality images that enable visualisation of an electrode's position with respect to the cochlear walls, or the cochlear partition.

P77. A clinical study of cortical auditory evoked potentials in cochlear implantees

S Raghunandhan, Kameswaran, Ranjith

Madras ENT Research Foundation, CHENNAI, India

Introduction: In congenitally deaf children, cochlear implantation increases auditory sensitivity by direct electrical activation of auditory nerve fibers, enabling phonemic awareness and yielding speech understanding. Early implantation stimulates a brain that has not been re-organized making it receptive to auditory input. Cortical potentials have enabled us to objectively study this phenomenon.

Objective: To assess the outcomes of cochlear implants on the auditory cortex by analyzing cortical auditory evoked potentials (CAEP) in the habilitation period. Methods: 30 pre-lingual implantees underwent CAEP testing at 6 months and 1 year post-implantation. Study group had 2 cohorts (Group-1: 0-8 yrs & Group-2: 8-15 yrs). Comparison of CAEP wave parameters (P1 amplitude, P1 latency & P1 morphology) were done between the two cohorts.

Results: In children Implanted early there was an early onset rapid increase in P1 amplitude along with a decrease in P1 latency during the follow-up period. Significant change in CAEP wave morphology was notable in group-1, unlike in group-2. Candidates with less than 3 years of auditory deprivation before implantation showed P1 latencies, which fell into the range of normal children, within 6 months of habilitation. Children with more than 6 years of auditory deprivation did not develop normal P1 latencies or morphology even after 1 year of habilitation.

Conclusion: CAEP has objectively proved that there is a critical age for stimulating the auditory brain via cochlear implantation. If auditory input is not restored until after the developmental period, then cross-modal reorganized pathways exhibit abnormal characteristics as observed in the CAEPs.

P78. Objective determination of frequency specific hearing thresholds following Baha stimulation

TR Rahne, TE Ehelebe

University Hospital Halle (Saale), HALLE (SAALE), Germany

Purpose: Patients suffering from conductive or mixed hearing loss and single-sided deafness may benefit from implantable hearing devices relying on bone conducted auditory stimulation. However, with only passively cooperative subjects and young children, objective methods are needed to estimate the aided and unaided pure-tone audiogram. After the feasibility of this method has been shown by the authors before, this study focuses on the electrophysiological determination of the hearing thresholds with bone anchored hearing aid (Baha) stimulation.

Methods & Materials: Therefore, 10 hearing-impaired subjects were provided with a Baha Intenso (Cochlear Ltd.) which was temporarily connected to the Baha Softband (Cochlear Ltd.). Pure tone thresholds were determined by a clinical audiometry and the Bone Conduction Direct measure as well. Frequency specific auditory evoked cortical potentials were measured by an auditory stimulation paradigm as used in clinical routine. The thresholds of the resulting auditory evoked responses were correlated with the respective behavioral thresholds.

Results: The behavioral pure tone thresholds were comparable between the clinical audiometry and the bone conduction direct measure. The electrophysiological determined thresholds were comparable to the subjective pure tone audiometry. Residual deviations can be explained by the Baha softband coupling of the sound processor.

Conclusion: The frequency specific pure tone thresholds of Baha users can be measured objectively using the direct input of the Baha processor. This electrophysiological determination is applicable in both, normal hearing and hearing impaired listeners and thus appears as a frequency specific objective method to approve the fitting of bone anchored hearing aids.

P79. The ASSR Air-Bone Gap estimates in children with normal hearing and conductive losses

MC María del Carmen Hernández, MCP Pérez Abalo, ER Rodríguez Dávila

Cuban Neurociences Center, HAVANA, Cuba

Introduction: This study investigates the accuracy of the multiple ~ 80Hz auditory steady-state responses (M-ASSR) to estimate the audiometric air-bone gaps (ABGs).

Methods: The M-ASSR to both air- (AC) and bone- conducted (BC) stimuli were recorded in two groups of children (7-14 years old). Four carrier tones (0.5-4 kHz) modulated in amplitude (77-115 Hz) were mixed together and simultaneously presented at variable intensities (AC 80-10 dB HL; BC 40-10 dB HL). For this investigation we evaluated 16 children with normal hearing (G1=22 ears) and 20 patients with conductive hearing losses (G2=28 ears).

Results: In all children tested the M-ASSR ABGs estimates were within 0 to 6 dB from the behavioural measures. The AC and BC response (RTH) and audiometric thresholds (BTH) showing similar differences (RTH-BTH) across groups and stimulation modes (G1: AC=15-18 dB; BC=11-15 dB and G2: AC=9-15 dB; BC=14-16 dB). The physiological ABGs were significantly correlated to the behavioural estimates (G1=0.51 and G2 r=0.81) and could differentiate in a discriminate analysis (88% efficiency) between groups.

Conclusions: The M-ASSR can provide highly accurate ABG estimates, differentiating between children with normal hearing and actual conductive pathology.

P80. The value of direct bone conduction measurements in fitting a bone conduction device

JD Desmet, MDB De Bodt, PV Van de Heyning

Antwerp University Hospital, EDEGEM, Belgium

Introduction: BCDirect is a technology developed by Cochlear™ to provide a more accurate measurement of bone conduction thresholds and to consequently improve Baha® fitting outcomes. Using BCDirect, bone conduction thresholds are measured through the Baha® sound processor. The effectiveness of transmission of sound from the sound processor to the cochlea is directly measured and the prescribed gain and output can be based on the patient's actual direct bone conduction thresholds.

Methods: Data of 40 Baha® users were analyzed. 18 patients had a mixed hearing loss (MIX), 22 patients had a severe unilateral hearing loss (SSD). Unmasked bone conduction thresholds between 0.25 and 4kHz were measured ipsilaterally using a type B-71 bone vibrator. BCDirect thresholds were measured through the Baha device (MIX, Baha BP110; SSD, BP100). Consequently, the difference between both measurements could be analyzed.

Results: Differences between measured thresholds were statistically significant at 0.25, 2 and 4kHz. Significantly higher thresholds were measured with BCDirect at 0.25kHz (B-71 10dBHL (SD 12.52); BCDirect 21.05dBHL (SD 11.69); $p<0.0001$)) and at 4kHz (B-71 27.11dBHL (SD 20.02); BCDirect 31.20 dBHL (SD 17.54); $p=0.006$). At 2kHz, measured thresholds are significantly lower with BCDirect (B-71 26.7 (SD 15.91); BCDirect 23.25 (SD 12.59); $p=0.037$).

Conclusion: The differences between both measurements are statistically significant which implies a difference in fitting of new digital devices, especially concerning low frequencies (0.25kHz). Less fitting sessions might be necessary using this tool which is available in the most recent Baha® devices.

P81. Measuring sound localization abilities of auditory implant users under open-loop conditions

MJH Agterberg, **MJH Agterberg**, MKS Hol, MM van Wanrooij, AJ van Opstal, AFM Snik

Donders Institute for Brain, Cognition and Behaviour, NIJMEGEN, Netherlands

Introduction: Sound localization in the horizontal plane requires neural processing of binaural difference cues in timing (ITD) and sound level (ILD). Spectral pinna cues are used for localization in the vertical plane. There is limited objective data about localization abilities in listeners who are fitted with auditory implants (cochlear implant, vibrant-sound bridge or temporal bone implant). Many clinical-studies indicate improved directional hearing with an auditory implant. Because these studies apply low variation in sound location, spectrum and level, they actually demonstrate that ambiguous cues like sound level can be used.

Methods: Listeners point a head-fixed laser in the perceived sound direction in a dark, sound-attenuated room. Head-movements are recorded with the magnetic search coil induced technique. Stimuli consist of broadband (0.5-20 kHz), high-pass (3-20 kHz), low-pass (0.5-1.5 kHz) and narrow-band (0.5 or 3 kHz) noises roved over a large range (45-65 dB SPL).

Results: Listeners who lack binaural cues are using sound level for localization. In our setup it is possible to demonstrate that sound level is not an adequate cue. Listeners with congenital single sided deafness were able to use spectral cues for the localization of sounds in azimuth. Listeners with unilateral conductive hearing loss who were fitted with a vibrant-sound bridge or temporal bone implant demonstrated improved directional hearing in the aided condition.

Conclusions: The bone-anchored hearing implant provides successful use of ITDs and ILDs for listeners with acquired conductive hearing loss. As expected the temporal bone implant did not affect localization in single sided deaf listeners.

P82. Stability and osseointegration of Baha implant systems in children: A pilot study

PM Marsella, **AS Scorpecci**, CP Pacifico, FP Presuttari, SB Bottero

Bambino Gesù Pediatric Hospital, ROME, Italy

Introduction: Auditory rehabilitation of children with Baha implant systems presents important limitations due to poor skull thickness: surgery is not recommended under age 3 (Snik, 2005) and is frequently performed as a two-stage procedure, and the processor is loaded 6 months post-operatively. The last-generation BI300 Baha implant has been designed to be more stable and to osseointegrate faster than the previous generation model, thanks to its macroscopic (wider diameter) and microscopic (TiOblast coating) features. Aim of the present longitudinal, prospective study is to compare for the first time in children the stability and osseointegration of BI300 to those of the previous generation implant.

Methods: Ten children were implanted “single stage” and with 3-mm fixtures: 5 received the previous generation and 5 the BI300 implant. In both groups, processors were loaded 6 months post-operatively. Implant stability was measured at abutment level by means of Resonance Frequency Analysis intraoperatively, at 1 week, 2 weeks, 1 month and every month till 9 months post-operatively.

Results: The BI300 implant had a significantly greater stability than the previous generation one, both intra- and post-operatively. Over the 9 months’ follow-up, a non-significant stability increase consistent with osseointegration was observed with both models.

Conclusion: The BI300 implant has a greater stability than the previous generation model, but its faster osseointegration could not be definitely verified. Our results suggest that the BI300 implant will probably make single-stage surgery safer, even with 3-mm fixtures, and that it will allow to shorten the interval between surgery and processor loading.

P83. Transcutaneous bone conduction hearing sensitivity in normal hearing subjects – BAHA vs BCI position

TAS Reinfeldt[1], HR Taghavi[1], MT Eeg-Olofsson[2], BEV Håkansson[1]

[1]Chalmers University of Technology, GÖTEBORG, Sweden

[2]ENT Dept, Sahlgrenska University Hospital, GOTHENBURG, Sweden

Objectives: The aim was to investigate if the increased vibration velocity of the cochlear promontory implies that the hearing sensitivity is improved at the position for a Bone Conduction Implant (BCI) system over the Bone-Anchored Hearing Aid (BAHA) position. Another aim was to study similarities between hearing sensitivity and ear-canal sound pressure (ECSP) differences between these positions.

Study Design: The difference in hearing thresholds from transcutaneous stimulation at the BAHA and BCI positions in the frequency range of 125 Hz to 8 kHz was determined. The ECSP was measured by a small probe tube inserted close to the tympanic membrane in the frequency range of 100 Hz to 10 kHz. All measurements were done at 20 normal hearing subjects both ipsilateral and contralateral, to calculate the sensitivity differences and the transcranial attenuation for both positions. The results were compared with previous laser Doppler vibrometry (LDV) measurements.

Results: Ipsilaterally, the BCI position gave 2-17 dB (8 dB in average) higher hearing sensitivity for all frequencies. There were non-significant differences between threshold and ECSP differences for most frequencies. The transcranial attenuation was in average 6 dB higher for stimulation at the BCI position, which implies bilateral BCI's to give improved binaural hearing.

Conclusions: Present results confirm previous LDV measurements. However, also at low frequencies the BC sensitivity improved and this has not been shown using LDV. The threshold and ECSP measurements were significantly alike, which means that subjective threshold difference could be replaced by objective ECSP difference.