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Cochlear Science and Research Seminar Cambridge, March 2023

Optimising Cochlear Implant Outcomes

Cochlear Science and Research Seminar (CSRS) on ‘Optimising Cochlear Implant Outcomes’

The successful on-site CSRS with this title was hosted by Professor Manohar Bance from the University of Cambridge at University Arms Cambridge on 9–10 March 2023. Twenty-four speakers from the EMEA region presented their latest research results and five cochlear implant (CI) users shared their experiences along their hearing journey during a directed discussion.

Pictured above from left to right: Matthijs Killian, Nicole Neben, Manohar Bance, Ulrike Trautmann, Bart Volckaerts, Francine Maget

The CSRS facilitated research networking opportunities amongst the participants and was set up with four sessions looking at cochlear implant (CI) outcomes from different angles:

SESSION 1:
Looking back: What worked in the past and what did we learn?
In this session, speakers discussed and gave science-based insights on the latest developments around CI coding strategies (Dr Bob Carlyon, University of Cambridge), the latest advancements in CI pre-processing (Dr Tobias Goehring, University of Cambridge), the role of multi-modal rehabilitation in paediatric CI recipients (Professor Liat Kishon-Rabin, Tel Aviv University), learnings from cochlear imaging to optimise CI surgery (Dr Nadine Schart-Morén, University Hospital of Uppsala), the role of foreign body reactions in the cochlea in CI outcomes (Professor Tracey Newman, University of Southampton), and the role of the maximal word recognition score in identification of CI candidates (Professor Ulrich Hoppe, University of Erlangen).

SESSION 2:
Living for Today: How are we optimising outcomes using current technologies?
This session was dedicated to findings based on science on the potential performance barriers of CI recipients (Professor Mathieu Marx, University of Toulouse), the role of genetic screening in prediction of CI outcomes (Dr Ronald Pennings, Radboud University Medical Centre), the role of cognition in CI candidacy and outcome (Dr Isabelle Mosnier, Pitié-Salpêtrière University Hospital), the role of perimodiolar electrode position in CI outcomes (Professor Angel Ramos Macías, University of Las Palmas) and the role of remote care in CI outcomes (Professor Helen Cullington, University of Southampton).

SESSION 3

Facing the Future: What is coming down the pipeline?

In this session, speakers discussed and gave scientifically based insights on the advancements of robotics in CI surgery (Dr Hannah Daoudi, Pitié-Salpêtrière University Hospital), the role of the electrode neural interface in CI outcomes (Professor Manohar Bance, University of Cambridge), the advancements in therapeutic delivery in CI treatment (Mr Freddy Dueck,Cochlear Ltd), the recent advancements made in optogenetic stimulation of the cochlea (Dr Lukasz Jablonski, University Medical Center Göttingen), the role of brain plasticity in CI outcomes (Dr Pascal Barone, University of Toulouse), recent advancements in bio-electronics (Professor George Malliaras, University of Cambridge), CI surgery under local anesthesia and early activation of CI (Professor Abdulman Hagr, King Saud University and Dr Ahmed Aldhafeeri, Hafr Albaten Central Hospital) and the future of central auditory prostheses (Professor Andrej Kral, Medical School Hanover).

SESSION 4

CI-Users in Focus: How to optimise the CI-user experience in the real world?

This session was about scientifically and patient-based insights on the barriers for CI uptake (Dr Deborah Vickers, University of Cambridge), the role of Ecological Momentary Assessment in the hearing impaired (Professor Inga Holube, Jade University of Applied Sciences), the recent launch of the Living Guidelines for CI treatment (Dr Leo De Raeve, Independent Information & Research Center on Cochlear Implants), the role of remote care in the CI clinic (Ms Louise Craddock, Midlands Hearing Implant Programme, Birmingham), a CI user journey towards enjoying music (Ms Sarah Smith, Southampton) and a guided discussion with CI users (led by Dr Leo De Raeve).

Some key take-away messages from this CSRS were:

- Connected Care solutions facilitate patient aftercare but are not adopted by all patients and clinicians (Professor Helen Cullington, Ms Louise Craddock)
- The immunological pathways and the implications of a foreign body reaction to a cochlear implant electrode need further investigation (Professor Tracey Newman)
- Better identification of predictors for outcomes needs to be multimodal = genetic/cognitive/electrode-directed (genetic diagnosis does not necessarily affect results)
- Early intervention in hearing-impaired elderly patients leads to improved cognitive outcomes
- Same-day sound processor fitting is feasible in selected cases (Professor Abdulman Hagr, Dr Ahmed Aldhafeeri)
- Music appreciation with a CI is possible but it requires effort and is often an individual journey (Ms Sarah Smith)
- The barriers to uptake of CI are universal and not health care model-specific, despite proof of good outcomes. Examples include lack of awareness of CI as a treatment option, lack of education on referral criterion, fear of surgery, burden of treatment.

The participants of the CSRS provided excellent feedback on the large positive impact of the seminar on their daily clinical routine and asked Cochlear to organise meetings like this more often.

In addition to the summary of the CSRS above, what follows are some notes taken by Louise Allan, Clinical Technical Specialist for Cochlear UK & Ireland on interesting areas of research.

What do you know about synchrotron imaging?

(Dr Nadine Schart-Morén, University Hospital of Uppsala)

The human inner ear is surrounded by the densest bone in the body (Li et al., 2021). This makes studying its anatomy and physiology difficult. Investigations of the cochlea have largely relied on histological analysis, but these techniques have spatial limitations and inherent artefacts; often related to the sectioning, decalcification, and staining of the specimens (Li et al, 2021).

How may synchrotron imaging help further our understanding of the cochlea and cochlear implantation?

Synchrotron imagining has the advantage of 3D bone visualization without the need for sectioning and staining. 3D reproduction of soft tissues is also possible which allows visualisation of structures inside the cochlea such as the basilar membrane, spiral ganglion cells and connective dendrites. This provides the opportunity to review the effects on the cochlea soft tissue post-surgery as well as visualise the precise tonotopic representations of the cochlea (Schart-Morén, 2019).

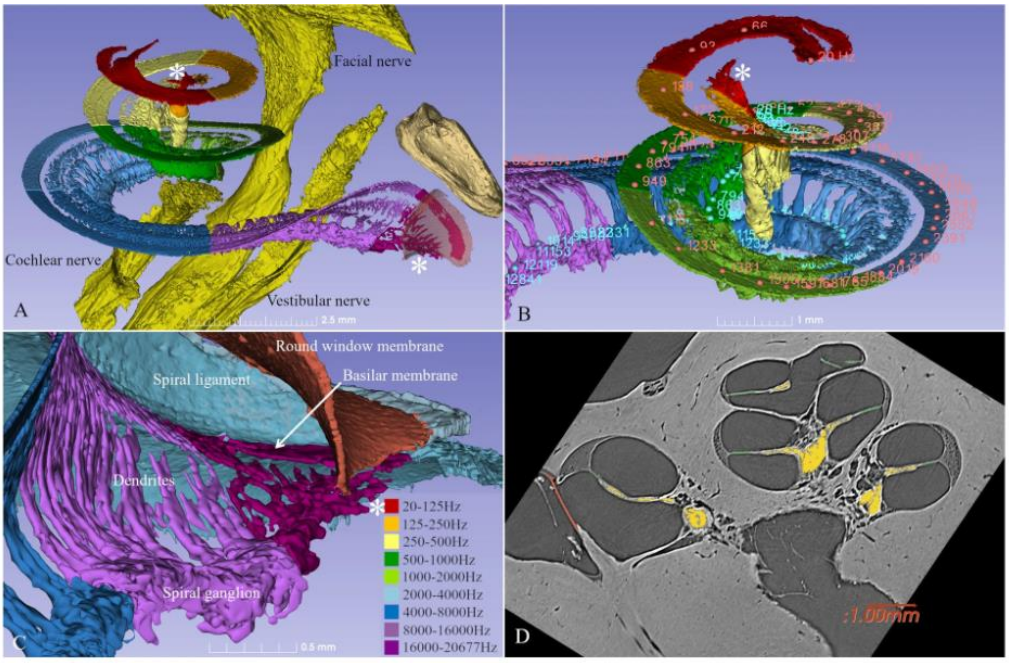

Figure 1 Three-dimensional tonotopic mapping of the human cochlea based on synchrotron radiation phase-contrast imaging. (Li et al, 2021, p.3)

What is optogenetics, and how is it being used in the study of hearing restoration?

(Dr Lukasz Jablonski, University Medical Center, Göttingen)

Optogenetics is a technique that combines optics and genetics to control specific neurons. This technique usually uses viruses that encode photosensitive proteins and shines light on the target nerve region (Chen et al, 2022). Optogenetic approaches are being successfully utilized in cardiovascular research and development (Madrid et al, 2021). There is also hope that optogenetics will help restore neural function in disorders such as epilepsy, Parkinson's disease, and retinal degeneration (Dieter, Keppeler and Moser, 2020) Optogenetics has been investigated for use in the cochlea since 2007 (Izzo et al, 2007).

Is it hoped that optogenetic approaches could one day overcome the drawbacks linked with the current spread associated with electrical hearing. Optically (rather than electrically) stimulating nerves spatially confines the neural stimulation, thus potentially improving the spectral selectivity of artificial sound encoding.

Researchers continue to experiment with optogenetics and have many considerations to address such as tissue heating, safe and efficient viral vectors, phototoxicity, battery life of optical cochlear implants, design requirements of the array and long-term implant stability and reliability (Dieter, Keppeler and Moser, 2020). Therefore, continual development of both the optic cochlear Implant as a

medical device and gene therapy through optogenetic manipulation is required. We can expect that there is still a long way to go before optogenetic cochlear implants might enter clinics (Dieter, Keppeler and Moser, 2020).

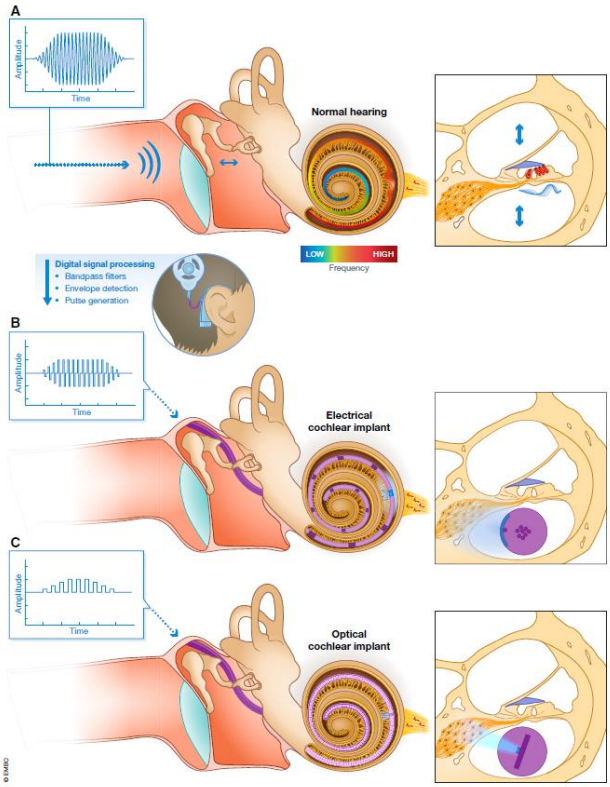

Figure 2: Natural vs. artificial sound encoding in the cochlea. (Dieter, Keppeler and Moser, 2020, p.3)

What is the experience of same day surgery and switch on like for patients?

Dr Ahmed Aldhafeeri, Hafr Albaten Central Hospital and Professor Abdulman Hagr, King Saud University

The study reported that the option of having cochlear implant surgery under conscious sedation may be a valuable option for selected patients. This study found no significant differences between the conscious sedation/general anaesthetic groups both for impedance telemetry and for thresholds/comfort levels. Next day fitting and fine tuning of the sound processor was reportedly preferred by patients. The researchers found a statically significant difference in the same day fitting and next day fitting for mapping of the apical regions.

Most of the 9 patients that underwent conscious sedation experienced a fast recovery and were sent home the same day.
Study Conclusion: The benefits of same day sound processor fitting are still under investigation, however the authors recommended that early next-day fitting of the sound processor should be performed routinely for patients and concluded that early fitting enables stable cochlear implantation maps from as early as 6 weeks postoperatively.

The effect of periomodiolar position on electrode discrimination and listening effort

Dr Angel Ramos Macias et al, Las Palmas University Hospital

This study reported that patients fitted with perimodiolar arrays have lower impedance values and smaller electrode inner wall distances than those fitted with straight arrays (Macias et al., 2017). Following the results of pupillometry tracking, perimodiolar electrodes were reported to provide better electrode discrimination with a lower cognitive workload compared with lateral wall electrodes. The authors concluded that perimodiolar electrodes could be a better solution in terms of pitch discrimination both because they are closer to the modiolus and because their impedance is lower.

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