Comparison of Tonotopic Maps for Cochlear Implant Fitting: A Study on 149 Patients from MHH Hospital

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Introduction

This study aimed to investigate the relationship between intra-cochlear anatomical variability, electrode placement, and clinical outcomes in cochlear implant (CI) patients. The preservation of neural structures and residual hearing are crucial in CI patients and variations in both intra-cochlear anatomy and electrode placement are thought to contribute to the variability in CI outcomes. However, previous observations in clinical populations have been limited by the lack of automated and accurate techniques to process clinical CT images of the cochlea within the clinical routine. To address this, the study utilized Oticon Medical's Nautilus imaging research software to retrospectively analyze data from 149 CI users implanted with an Oticon Medical device.

Methods

Study design

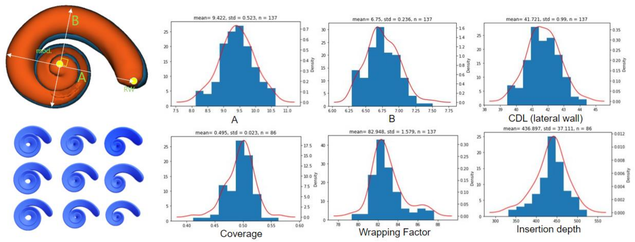
- Retrospective study

Dataset

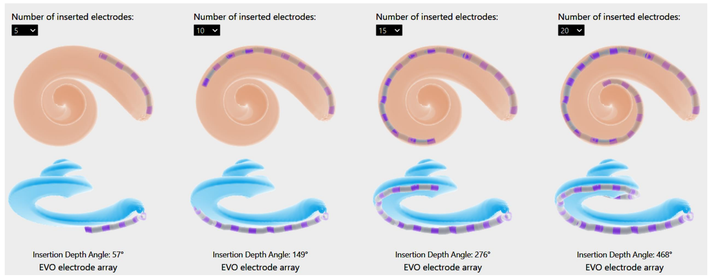
- 149 patients implanted with an Oticon Medical system (EVO electrode)
- 168 ears (91L, 77R)
- Pre-op and post-op clinical CTs
- C/T-levels and frequency allocation tables
- Freiburg monosyllables in quiet and HSM sentences in noise at 6 months and 12 months post implantation

Analysis

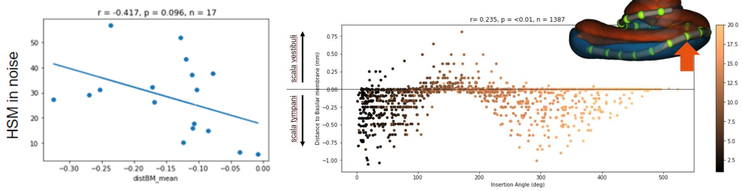
- Pre- and post-operative scans were loaded on the Nautilus research tool
- Image processing was automated – the only manual step: specification of initial landmark: center of the cochlea
- Population statistics
- Automatic computation of natural tonotopic based on Greenwood, Stakhovskaya, Helpard models
- Inter-comparison of different tonotopic maps
- Electrode insertion planning for residual hearing preservation
- Assessment of cochlear coverage w.r.t. predicted coverage for preserving residual hearing
- Statistical analysis carried out on Nautilus metrics and clinical data including C- and T- levels, Freiburger monosyllable scores, and HSM sentence intelligibility at 6 and 12 months after implantation.

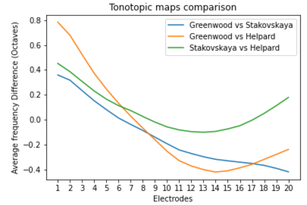


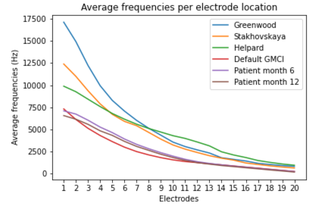
Results

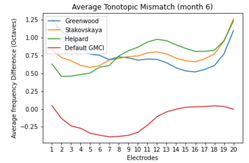


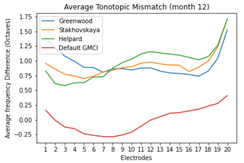
Statistically significant associations were found between metrics of cochlear anatomy and electrode placement including insertion depth. Measures related to electrode placement itself correlated with both C- and T- levels and speech outcomes.

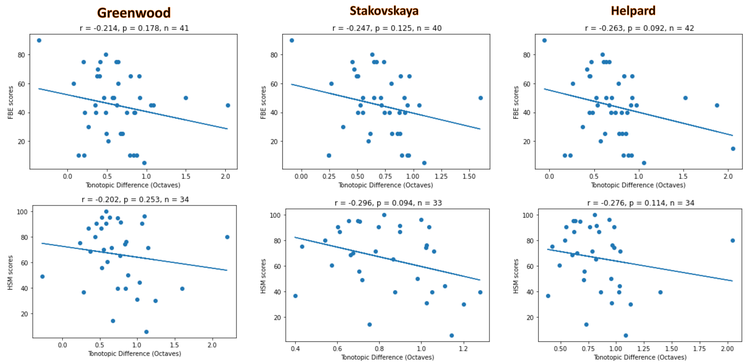












Discussion

Knowledge about intra-cochlear anatomical variability and electrode placement through automated image analysis can play a crucial role in the clinical outcomes of cochlear implant patients and help in reducing trauma and mitigate cochlear damage. The Nautilus System determines relevant measures from the cochlea in pre- and postoperative CT / CBCT images in a fully automatic manner. This makes it possible to individualize cochlear implant provision even within a tense clinical environment. Also for the postoperative fitting procedure, the outputs of Nautilus support an individualized adaptation of parameters like tonotopic frequency allocation to the intracochlear electrode contacts or setting the cross-over frequency in EAS subjects. With an increasing reliability of the system in the near future, relevant cochlear metrics can be reliably determined from each patient helping to explain unexpected performance variability across cochlear implant patients.

References

Hussain R., et al. (2023). Anatomical variations of the human cochlea using an image analysis tool. Journal of Clinical Medicine, 12(2), 509.

Margeta J., et al. (2022). A web-based automated image processing research platform for cochlear implantation-related studies. Journal of Clinical Medicine, 11(22), 6640.

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