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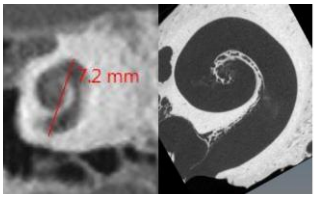
Title of Project
Mapping the variability in the microanatomy of the cochlea and its impact on cochlear function and on cochlear implant electrical stimulation spread to the auditory nerve

Summary
Cochlear implants (CI) are life-transformative technologies for profoundly deaf patients. Despite this achievement, the variation in user experience is vast and suggests that the process of converting sounds into an electrical signal, via the auditory nerve, is not fully explained by current theory. Anatomical variations in cochlea size and shape are important when considering current spread. Stimulation voltage levels inside the modiolus of the cochlea have not been measured, and are likely to be dependent on cochlear anatomy. Cross-stimulation of the facial nerve can also be distressing for recipients of cochlear implants. It is essential to understand why this occurs and to determine potential sites of dehiscence that predispose to it.

This project aims to determine how the microanatomy of the cochlea impacts CI function in relation to current spread to the modiolus and cross-stimulation of the facial nerve. Our objectives are 3-fold:

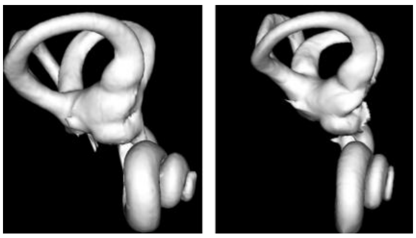
1. To create population-based models of a range of size and shapes of human cochleas, focusing on the modiolus, by using microCT scanning of cadaveric temporal bones and 3D reconstruction.

Fig. 1 Comparison of conventional CT and microCT



Left = CT scan, voxel side length = 0.60mm
Right = microCT scan, voxel side length = 0.02mm

Fig. 2 Two 3D reconstructions of the inner ear



These are orientated so that the difference in cochlear height can be clearly seen. One cochlea has a large basal turn, with the second turn embedded in the first turn; whereas the other cochlear has a smoother transition between turns.

(Figs.1 & 2 courtesy of Prabhvir Marway and Dr Matthew Mason, University of Cambridge)

2. To measure electrical current distribution in the modiolus in cochleas of different shapes, using CIs of differing lengths, electrode contact designs (full- vs. half-banded), coding strategies (monopolar, bipolar, tripolar) and implant position (perimodiolar, lateral wall).

3. To measure current spread to the facial nerve canal and correlate it with microCT measurements of the cochlear-geniculate ganglion interface.