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Close-Up Clinical Imaging of the Inner Ear. Coming To Audiology Soon?

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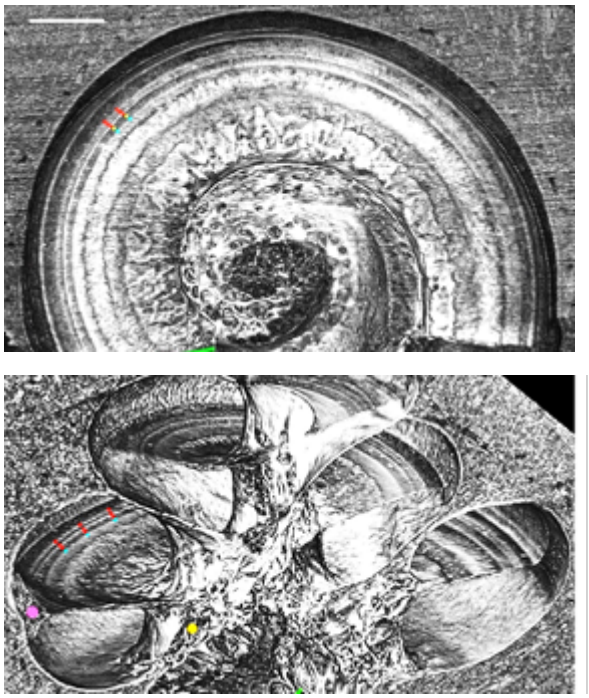


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Do you ever have patients with sensorineural hearing loss and wonder what the cochlea's physical condition is? I'm sure that you do; I hope that you do! Perhaps you have an older person with presbycusis where you would like to see if the pattern of hair cell loss matches the audiogram. Perhaps a candidate for a cochlear implant where you wonder about spiral ganglion cell survival in the basal cochlear turn. Maybe a child with ANSD and a severe hearing loss where you would like to see the presence of outer hair cells responsible for a robust cochlear microphonic. You might even think to check if your patient with Meniere's disease really does have endolymphatic hydrops.

To make these observations, we need a penetrating imaging technique with spatial resolution to

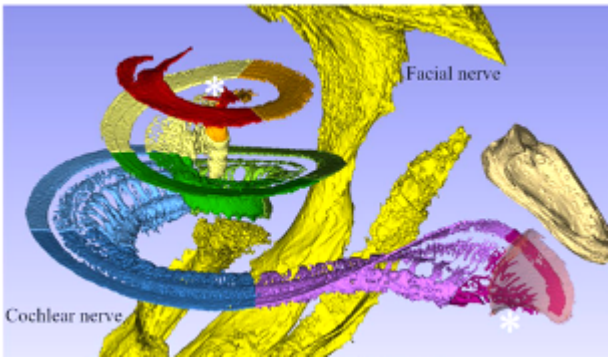
show fine anatomical details. Standard CT or MRI do not come close. However, experimental work with high-energy X-rays generated by a synchrotron shows the potential for inner ear imaging. Such studies are being conducted by Canadian and US research teams that have recently published detailed X-ray images of the human cochlea. These figures reveal some of the fine structure of the cochlea that the new imaging technique can achieve. Structural details of the organ of Corti and the spiral ganglion are very clear. Even individual inner and outer hair cells can be resolved. The research team are based at Western University, Ontario, Harvard University, Boston, and a synchrotron facility in Saskatoon, Saskatchewan. (Janani et al., 2018).

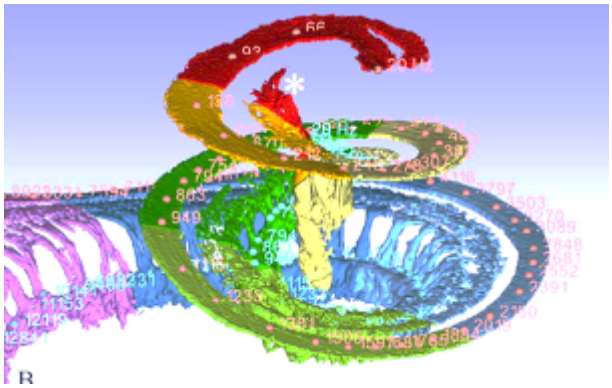


Human cochlear imaging with synchrotron radiation, i.e., coherent, collimated X-rays with high flux. Images adapted from Janani et al., 2018.

Synchrotron X-radiation is produced by charged particles traveling at extremely high speed by being forced to travel along curved paths by applied magnetic fields. To be clear, so far these images have only been obtained in cadaver temporal bone specimens, and not "*in vivo.*" So don't try and order these X-rays quite yet!

Such high-resolution X-ray data can be digitally enhanced and rendered into 3-D images where individual anatomical structures can be identified, highlighted, and quantified. Some examples of such 3-D visualization are shown below. These images are adapted from figures in Li et al., 2021.





Whilst many technical aspects of synchrotron imaging of the inner ear have been explored, we are not at the point of having a clinical imaging tool. However, if this does become a reality, it could provide a very useful diagnostic tool in audiology.

References

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