Light exploring life
BMIT

Hanif M. Ladak, PhD, PEng
Western University
Phone: +1-519-661-2111 ext. 86551
hladak@uwo.ca

Optimizing Middle-Ear Prostheses

The middle ear (Figure 1) efficiently transmits vibrations of the eardrum caused by sound entering the ear canal to fluid in the cochlea, the end organ of hearing. Pathologies of the middle-ear bones, the malleus, incus and stapes, can disrupt the transmission of sound energy and lead to so-called *conductive* hearing loss. A common pathology is otosclerosis that is caused by the buildup of bone around the stapes, preventing the stapes from vibrating normally. Surgery can be performed to replace the stapes with a wire prosthesis as shown in Figure 2 to connect the incus to the cochlea directly and restore sound transmission. A common complication of this surgery is erosion of the incus which in turn can lead to discontinuity of this bony chain and disrupt sound transmission once again.

Our multidisciplinary team led by Dr. Hanif Ladak, a biomedical engineer; Dr. Sumit Agrawal, an ear surgeon and scientist; and Dr. Helge Rask-Andersen, an ear surgeon and anatomist, in collaboration with Dr. Ning Zhu of the CLS is using in-line phase contrast micro-computed tomography on the BMIT 05ID-2 beamline to image the middle ear in 3D in healthy and surgically repaired ears. This synchrotron-based imaging approach provides unparalleled contrast and permits simultaneous visualization of bone, soft tissue and metallic implants. These images are being used by our team to understand how prostheses may affect the vasculature of the incus and may lead to incus necrosis. The outcome of our ongoing research will provide insights on the optimal design of middle-ear prostheses.

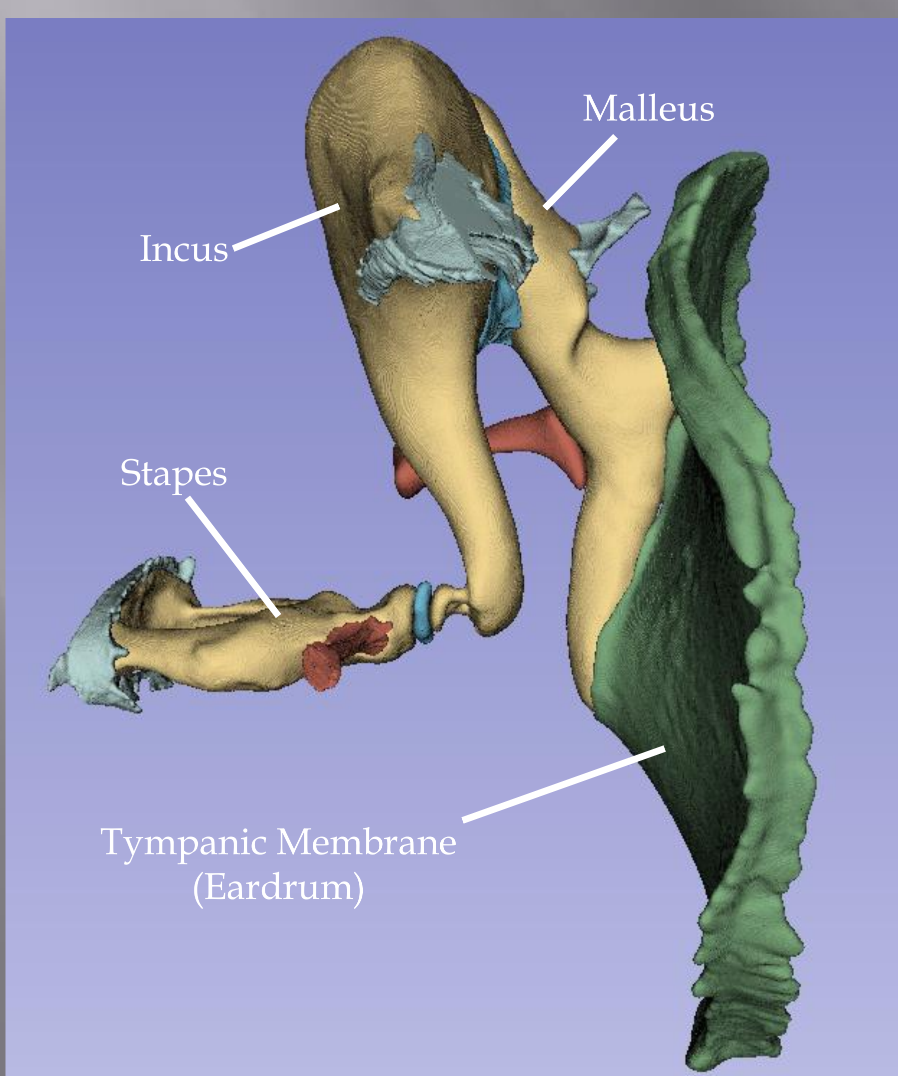

Figure 1: Model of cadaveric human middle ear reconstructed from phase contrast images.

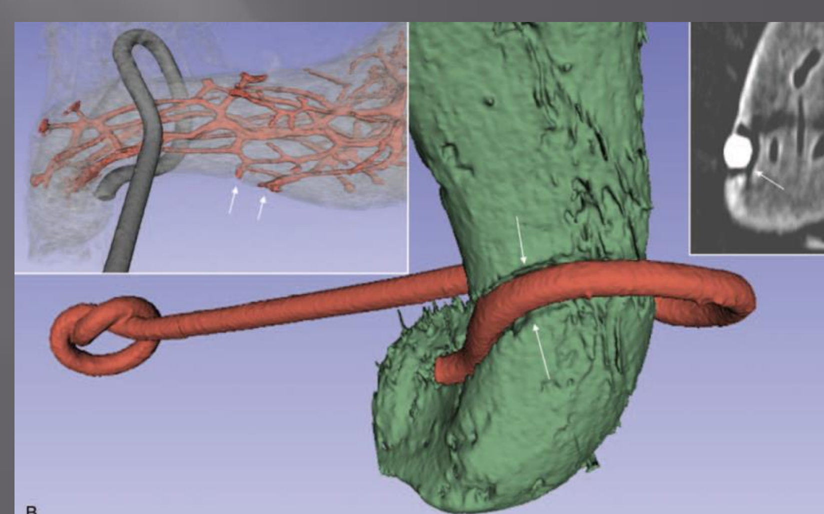

Figure 2: Incus from an individual operated on with stapedectomy using a stainless steel wire prosthesis. The metal loop has eroded the cortex of the incus (arrows). Left inset shows transparent incus with vessels. Two vessels perforate the cortex (arrows). Right inset shows a tomographic section of wire (arrow) with no signs of vascular destruction or inflammation.