

Surgical Reconstruction of Ossicular Chain Defect with Custom 3D Printed Ossicular Prosthesis

Friday 10:30-10:40 AM | SST08-01 | Room: E353A

PURPOSE

Conductive hearing loss due to ossicular abnormalities occurs from many causes, including trauma, infection, cholesteatoma, surgery and congenital anomalies. Surgical reconstruction of the ossicular chain is a well-established procedure for repair of ossicular defects, but is still plagued by high failure rates. Underlying disease and proper sizing of prostheses are two challenges that lead to component failure. Three-dimensional (3D) printing has been used successfully to solve a number of medical prosthesis problems. Custom 3D printing an individualized ossicular prosthesis would be a potential solution for the wide range of anatomic variation encountered in the pathological middle ear, and could decrease the rate of post-operative prosthesis displacement by increasing the likelihood of a proper fit, in addition to decreasing surgical time.

METHOD AND MATERIALS

The incus was removed from three formalin-fixed cadaveric human temporal bones with no macro- or microscopic evidence of pathology. Imaging of the cadaveric bone was obtained using a standard temporal bone CT protocol. A custom prosthesis for each cadaveric human temporal bone was designed using the Mimics Innovation Suite software (Materialise, Belgium) and fabricated on a Form2 3D printer (FormLabs, Somerville, Massachusetts). Four surgeons then performed insertion of each prosthesis into each middle ear, blinded to the bone from and for which each was designed. The surgeons were asked to match each prosthesis to its correct parent bone.

RESULTS

Each prosthesis had unique measurements. Each of the four surgeons was able to correctly match the prosthesis model to its intended temporal bone. The chances of this occurring randomly are 1:1296.

CONCLUSION

A custom 3D printed ossicular prosthesis is a viable solution for conductive hearing loss due to ossicular chain defects. Commercially available CT scanners can detect significant anatomic differences in normal human middle ear ossicles. These differences can be accurately represented with current 3D printing technology and, more significantly, surgeons can detect these differences.

CLINICAL RELEVANCE/APPLICATION

This process overcomes a common technical challenge of properly sizing the prosthesis, as each model is custom made for an exact fit which should lead to an improved result and decreased operative time.