Validity of Predicting Prosthesis Size for Ossiculoplasty from either High Resolution CT or Cone Beam CT Scans

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Abstract

Background: Ossiculoplasty is a technically demanding procedure. One finding vital to the success of the surgery is the intraoperative sizing of the prosthesis to the patient. Improper sizing of a prosthesis places patients at risk for poor wound sound conduction or prosthesis failure. High resolution CT (HRCT) and cone beam CT (CBCT) technologies offer new tools to improve surgical accuracy. However, it is uncertain whether high resolution CT and cone beam CT can be used interchangeably.

Methods: A total of 4 cadaveric temporal bones were used for this study. Each bone was imaged with micro-CT, HRCT, and CBCT scans. Then four computed models were generated using Slicer 4.8. Volumetric landmarks identified in high resolution CT allowed for automatic generation of a cone beam CT model to be confirmed against micro-CT model.

Results: Both high-resolution CT and cone beam CT scans were used to accurately predict prosthesis size for ossiculoplasty.

Conclusions: High resolution CT and cone beam CT technologies offer surgeons foresight into the prosthesis requirements of the patient’s ossicular chain. By utilizing such technology, surgeons may decrease intraoperative times and surgeon-related errors of such procedures.

Discussion

We have demonstrated a novel intra-ossiculoplasty procedure which recreates the normal anatomy of the ossicular chain with hopes of improving surgical outcome. The present project studies the ossicular chain to determine the possibility of designing a new customized prosthesis.

Methods and Materials

4 cadaveric temporal bones were received from the Lewis Katz School of Medicine anatomy lab. All temporal bones were imaged before any surgical manipulation. The bones were imaged with micro-CT, HRCT, and CBCT. The 3D Osso model from the CBCT images was then sliced and analyzed. Using Slicer 4.8 (www.slicer.org), a model was rendered with the CBCT file from the 3D Osso model. The model was then trimmed with the 3D Osso software. With each bone, measurements could be taken with the CBCT module: Articulating surface height (1), short process length (2), Long process length (3), Long process angle (4), and lenticular process length (5). The differences were analyzed with the CBCT module.

After trimming, the bones were imaged with micro-CT, HRCT, and CBCT. The 3D Osso module was used to generate three-dimensional models. Then the 3D Osso models were analyzed with the CBCT module to determine differences. In the future, we would like to continue to collect more data on the accuracy of these imaging modalities. We believe CBCT will have significant utility for this project. With minimal radiation, cost and image acquisition time and potentially higher accuracy than HRCT, CBCT can be an effective method for prosthetic planning. Future studies will analyze the hearing outcomes and reproducibility of implanted prostheses.

Conclusions

Patients with concomitant hearing loss may undergo ossiculoplasty to improve their hearing. FOEPs have unrelated hearing outcomes, especially long term. Our team has developed a novel prosthetic device as a replacement for FOEPs, which may be customized to a patient’s middle ear anatomy. In this study, we looked at the utility of measuring incus anatomy with both HRCT and CBCT. Although the sample data set was small, we are pleased with the accuracy of both imaging modalities, especially CBCT. An exception to this is the lenticular process length, which could not be measured. This may be overcome in future studies with the ability to more accurately render the lenticular process.

Acknowledgements

N01-DC-369008
Temple University’s Biomedical Engineering
LISAM Micro-CT Core

NIDCD, National Institute on Deafness and Other Communication Disorders, National Institutes of Health.