

# Development of Prediction Method for Sound Conduction Efficiency of Human Middle Ear – Application to Type IV Operation –

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## ABSTRACT

When the human middle ear is damaged by various ear diseases, the linkage of the auditory ossicles may be reconstructed using the column article called the columella. In a tympanoplasty operation, the sound conduction efficiency changes according to differences in shape, material and the mounting position of the columella.

We have proposed a new method for estimating the hearing restoration effect prior to the operation. In this method, a geometric model of the middle ear is constructed using SolidWorks based on CT scanning data. Frequency response characteristics of the stapes displacement in sound conduction are calculated using harmonic vibration analysis.

The hearing restoration effect can be estimated by a comparison of differences in the stapes displacement between the reconstruction model and a healthy subject. In this research, the harmonic vibration analysis of a healthy subject is performed at first. Then, the case in which the medical device is substituted for the deficient auditory ossicles is analysed. Furthermore, the correlation of hearing restoration effect and the columella volume is examined.

In the case in which the stapes remains in a normal shape, including the horseshoe portion, the type III operation is performed. In the case in which only the basal plane of the stapes is left, the type IV operation is performed. With the type IV operation, it is more difficult to improve hearing ability than with the type III operation. In the type III operation model, various verifications have been carried out on the validity of our prediction method. In this research, the validity of our method is verified for the type IV operation model.

On the other hand, the audiogram is made by precise audiometry in the medical field. The audiogram is the record of the value of hearing level at every frequency in the hearing test. Using our proposed calculation formula, the audiogram for the type IV operation model was made. The degree of hearing amelioration can also be evaluated quantitatively in type IV model. Through this study, the optimization of reconstruction of the middle ear using the columella becomes possible. Finally, the efficacy of predicting the hearing restoration effect prior to an operation was verified.

## REFERENCES

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