



Analysis for Reconstruction of Tympanic Membrane with Various Thickness Cartilage Plate

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Abstract. The purpose of this research is to investigate the appropriate design of the sliced cartilage used for the reconstruction of the tympanic membrane (TM). A great number of people are suffering from TM perforation caused by diseases or accidents. A surgical procedure, called cartilage myringoplasty, can save the people from hearing loss by replacing the damaged part of the membrane with a thin-sliced cartilage. In this research, firstly, we established a three-dimensional finite element model of the human ear for the numerical analysis. The ear model consists of middle ear (TM, ossicular chain, ligaments, muscle), and inner ear cochlea. The joints between earbones were also modeled with softer tissues. The analysis result of the frequency response shows a good correspondence with measurement results reported by other researchers. Then, using the numerical model, we investigated the optimal thickness of the cartilage plate. The TM was cut at bottom position with a size of about 40% of TM, and filled by cartilage plate with the thickness of 0.1mm to 0.7mm. Comparing with the frequency response of healthy ear, we found that the optimal thickness of the plate is different in different frequency range. The reason is considered as the difference of material properties between the membrane and the cartilage. Finally, to evaluate the performance of repaired models in all frequency range, we proposed an equation of matching rate as the evaluation equation. The results show that, 0.5mm cartilage plate model shows a better performance at peak response area (600Hz-1kHz), and 0.3mm cartilage plate model shows better average performance in total frequency range.

Keywords: Middle Ear, Tympanic Membrane, Vibration, Finite Element Analysis