Effects of Absence of Malleus on Ossiculoplasty in Human Cadaveric Temporal Bones

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Abstract

Pathology in the middle ear can affect the hearing outcome in ossiculoplasty, as well as the selection of the ossiculoplasty technique and the choice of prostheses. De Vos et al. (1) reported that the presence of the malleus was the most important factor related to middle ear ossicles to predict hearing results following reconstruction of the osseous chain. Dornhoffer et al. (2) also described the malleus manubrium as significant in determining hearing results after reconstructive middle ear surgery. The malleus handle allows for proper adaptation of a fascia graft and improves the stability of a reconstructed ossicular chain (3). Furthermore, the malleus is thought to contribute to the function of the middle ear via its action as a lever (4). However, some studies have found that the presence of the malleus is not an important contributor to the post-surgical hearing outcome (5, 6).

These experiments were performed to evaluate the acoustic role of the malleus on middle ear reconstruction using human cadaveric temporal bones.

Methods

- Fresh human temporal bones were extracted from human cadaveric within 48 hours of death using a Schucoke bone saw at the time of autopsy.
- Manoeuvres and postoperative hypotony maneuvers were performed and the horizontal segment of the facial nerve was removed to allow a good view of the epitympanic through the facial recess. A plastic tube was fixed around the bone canal using thin spaghetti that the size of the incus placed perpendicular to the TM. Sound was presented at the side of the lateral end of the plastic tube using a 2500s Hearing aid receiver.
- Reflective microbead targets were placed on the center of the stapes footplate. The stapes footplate velocity was measured using a high-resolution vibrometer (Heine-1000, Heine). Measurements were taken using the same method for both ears, and an analysis system (Fig. 5). The velocity of the stapes footplate was divided by the sound pressure level at 1 kHz to correct the mean velocity of the angle for measurement.

Effect of the malleus

Eight temporal bones were studied. The incus was removed and replaced with a sculpted incus between the malleus and handle and head (Fig. 2, left side). This was compared with the other ear where the incus was removed and another sculpted incus placed between the TM and stapes head (right side). The sculpted incus was placed in perpendicular or parallel to the stapes head.

Influence of cartilage insertion

The cartilage was trimmed to a thickness of 0.5 to 0.7 mm and three different diameters of cartilage (2.5, 2.4, and 2.3 mm) were used to evaluate the influence of interposed cartilage in reconstruction without a malleus (Fig. 6). After the incus had been replaced, one of the three cartilage discs was inserted in random order between the TM and stapedius incus. The stapes footplate displacement was measured after placing each cartilage in the eight temporal bones and compared to the baseline intact middle ear measurement.

Results

Effect of the malleus

Figure 4 shows the mean displacement of the center of the stapes footplate for the eight specimens relative to the ear canal pressure. The mean curves of the baseline stapes footplate displacement were in agreement with previous studies (6). The mean change in dB of stapes footplate displacement after reconstruction with and without the malleus compared to the intact middle ear is shown in Figure 5. Below 0.6 kHz, the gain after reconstruction with and without the malleus was nearly identical. The gain for reconstruction with the malleus in place was slightly better than that without. However, this range was not statistically significant. The malleus present condition results tended to be worse above 4.5 kHz compared to reconstruction without the malleus. Table 1 shows the results of a Student’s t-test of stapes footplate displacement at eight representative frequencies. There were no significant differences at any test frequency.

Conclusions

- Absence of the malleus impaired middle ear sound transmission slightly in the mid-frequencies and improved it at higher frequencies compared to reconstruction with the intact middle ear.
- Based on human temporal bone experiments, absence of the malleus impaired middle ear sound transmission slightly in the mid-frequencies and improved it at higher frequencies compared to reconstruction with the intact middle ear.

References