Evaluation of vascular activity in otosclerosis by laser-Doppler flowmetry: comparison with CT densitometry

Michihiko Sone, MD, Tadao Yoshida, MD, Kenji Suga, MD, Hironao Otake, MD, Ken Kato, MD, Masaaki Teranishi, MD, Tsutomu Nakashima, MD
Department of Otorhinolaryngology, Nagoya University Graduate School of Medicine, Nagoya, Japan

Abstract

Objective: Evaluate vascular activity in ears with otosclerosis by intraoperative measurement of blood flow using laser-Doppler flowmetry, and compare the data with densitometry on computed tomography (CT).

Methods: Thirty-nine ears from patients who underwent surgery for otosclerosis were assessed in the present study. The subjects were divided into the fenestral (29 ears) and the retrofenestral (10 ears) groups by CT. Ratios of bone density in the area anterior to the oval window (AOW) or the promontory (PT) near the round window niche to that of the basis labyrinthine otic capsule were calculated on CT images. Measurements of blood flow were performed with a laser-Doppler flowmeter at the two corresponding areas evaluated by CT.

Results: In both groups, relatively young subjects with high blood flow values in the AOW or PT had rather low ratios of bone density in the corresponding areas. In contrast, old subjects with low ratios of bone density showed low blood flow values in the same areas. In the retrofenestral group, subjects with high blood flow values in the PT showed low blood flow values in the AOW, but their ratios of bone density were similarly low in both areas.

Conclusion: Blood flow varied and did not correlate with CT densitometry. Measurement of blood flow by laser-Doppler flowmetry could yield useful information to evaluate the progress of vascular activity.

Methods and Materials

Case histories of 39 ears from 33 patients (8 males and 25 females, aged 29-66 years) who underwent surgery for otosclerosis in our hospital were examined in the present study. The surgical findings confirmed the final diagnosis of otosclerosis in all ears.

Evaluation on CT

Based on the CT (Asteion and Aquilion, Toshiba, Tokyo) imaging findings using sequential 0.5-mm-thick slices, the ears were preoperatively classified into the following two types of otosclerosis: i) subjects with hypotenuating lesions limited to areas anterior to the oval window (AOW) (fenestral group); and ii) subjects with hypotenuating lesions extended over labyrinth capsules with or without AOW lesions (retrofenestral group). Circular regions of interest (ROIs), which were areas of AOW on the slice passing through the oval window (OW) or promontory (PT) near the round window niche located three slices (1.5 mm) inferior to the OW, were manually set around the otic capsule in axial CT images. Hounsfield unit (HU) values at each ROI were measured three times, and the mean HU value in each ROI was obtained. To minimize differences in the temporal bone densities among ears, HU values in the inner portion of the lateral semicircular canal (LSC) were also measured at the basis labyrinthine otic capsule. The ratio of the HU value in the AOW or PT compared to that in the LSC was calculated for each ear. An example of ROI setting is shown in Figure 1.

Figure 1

Measurement of blood flow

Measurements of blood flow were performed with a laser-Doppler flowmeter (LDF, model ALF 21, Advance, Tokyo, Japan). The outer diameter of the probe was 0.8 mm. The tip of the probe was attached manually to the anterior portion of the OW directed to the FAO or PT located 1.5 mm inferior to the OW. Data were analyzed statistically using the Mann-Whitney U test and the Spearman rank correlation coefficient. P values < 0.05 were considered significant.

Written, informed consent was obtained preoperatively from each patient. The research protocol was reviewed and approved by the Institutional Review Board at Nagoya University Hospital.

Results

Figure 2 shows the relationship between the ratios of bone density in the AOW and PT of the two groups. Ratios in the PT were not correlated with those in the AOW within the fenestral group; however, a strong correlation was observed between the ratios in the AOW and PT in the retrofenestral group (P = 0.001). Figure 3 shows the values of blood flow in the AOW and PT of the two groups. There was no significant difference of average blood flow values in the AOW between the groups. The average blood flow in the PT was significantly higher in the retrofenestral group than in the fenestral group.

Figure 2

Discussion

High blood flow and low ratios in the AOW observed in ears of relatively young subjects in the fenestral group might indicate an active otospongiotic process in the lesion. In the retrofenestral group, significantly higher blood flow was observed in the PT compared to the fenestral group. High blood flow and low ratios of bone density in the PT observed in relatively young subjects might indicate an active otospongiotic process in the lesion. In contrast, none of the subjects in the group showed high blood flow in the AOW, though their ratios of bone density were similarly low. These findings might suggest high vascular activity in the PT but not in the AOW in the retrofenestral group, which could not be discriminated on CT. Subjects with high blood flow in the AOW of the fenestral or retrofenestral group or those with high values in the PT of the retrofenestral group had low ratios of bone density, but subjects with low ratios of bone density did not necessarily have high blood flow. Vascularity in ears with otosclerosis did not correlate with CT densitometry.

Figure 3

References