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Stabilization of total ossicular replacement prosthesis using cartilage "shoe" graft☆,☆☆

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ABSTRACT

Purpose: We aimed to determine the effect of a cartilage shoe graft placed between the foot of the TORP and the stapes footplate on hearing improvement and long-term displacement rates.
Materials and methods: Patients who underwent TORP ossiculoplasty were divided into two groups. The TORP-alone group consisted of 32 patients who underwent TORP placement without cartilage shoe graft and served as the control group. The study group consisted of 56 patients who underwent placement of cartilage shoe graft together with TORP. Pure-tone audiometry was administered to all patients before and 3, 6 and 12 months after surgery. Indications for surgery, surgical technique used, postoperative complications, and air and bone conduction thresholds at 500, 1000, 2000 and 4000 Hz were recorded for all patients.
Results: No significant difference in postoperative air–bone gaps was observed between the groups. The number of patients with air–bone gaps less than 20 dB was 14 (25%) in the study group and 8 (25%) in the control group. There was no significant difference in changes in air–bone gaps between the groups. Dislocation of the prosthesis was observed in 3 patients in the study group (5.3%) and 4 in the control group (12.5%). There was less dislocation of the prosthesis in the study group, but the difference was not statistically significant.
Conclusion: Placement of a cartilage graft between the footplate of the stapes and the foot of the prosthesis may have positive effects on long-term hearing improvement and rates of prosthesis displacement. Further research with larger patient numbers is needed to identify the advantages of shoe graft.

1. Introduction

The human ossicular chain acts as a cantilever mechanism to permit reliable conduction of sound energy from the tympanic membrane to the oval window. An intact ossicular chain is required for successful hearing together with an intact, vibrating tympanic membrane and a ventilated middle ear. Defect in the ossicular chain is reconstructed using ossicular

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reconstruction prosthesis. There are two main types of prosthesis, partial ossicular reconstruction prosthesis (PORP) and total ossicular reconstruction prosthesis (TORP). The stapes superstructure is important in reconstruction choices. PORP is used in the presence of an appropriately oriented stapes superstructure. The superstructure provides a stable attachment point for the prosthesis. When the stapes superstructure is inappropriately oriented or damaged, TORP must be used. The ideal TORP must have similar acoustic characteristics and long-term stabilization to the human ossicular chain. In order to achieve successful hearing outcomes after ossiculoplasty, the prosthesis must be attached in a firm and stable manner. A loose connection results in inefficient energy transfer and a high risk of displacement.

Prosthesis displacement is the second most important cause of ossiculoplasty failure, after persistence of middle ear disease [1]. A TORP consists of three main parts: a head in contact with the tympanic membrane, a thin shaft and a wider base of the shaft, the foot, which lies over the footplate. Either of these two connections may be the cause of displacement after surgery, resulting in a persistent postoperative air–bone gap.

Several methods, intended to minimize the rate of ossicular displacement after reconstruction have been described. One consists of two-point fixations with cartilage grafting. Two-point fixation refers to fixation of the head of the prosthesis to the tympanoplasty graft and of the foot of the prosthesis to the footplate [2]. Establishing a stable TORP-footplate coupling is mandatory for successful reconstruction [3]. The purpose of this study was to determine the effect of a cartilage shoe graft on hearing improvement and long-term displacement rates. We prepared a cartilage shoe graft in order to achieve stable coupling between the foot of the TORP and the stapes footplate.

2. Materials and methods

2.1. Subjects

The study was performed at the Ataturk University Department of Otorhinolaryngology, Erzurum, between October 2013 and February 2015. All patients undergoing TORP ossiculoplasty were included. Patients with previous stapedectomy or stapedotomy or a history of aural atresia were excluded. Eighty-eight patients were included in the study. Age and gender, indications for surgery, surgical technique used, and postoperative complications were recorded for all patients. Patients were divided into two groups. The TORP-alone group consisted of 32 patients who underwent TORP placement without cartilage shoe graft and served as the control group. The study group consisted of 56 patients who underwent placement of cartilage shoe graft together with TORP.

Pure-tone audiometry was administered to all patients before and 3, 6 and 12 months after surgery. Air and bone conduction thresholds were recorded at 500, 1000, 2000 and 4000 Hz. Pure-tone averages were calculated by averaging the thresholds for 500, 1000, 2000 and 4000 Hz for air and bone conduction. The air–bone gap was calculated for each patient as the difference between average air conduction and average bone conduction.

2.2. Surgical technique

Under general anesthesia, all patients underwent type 3 tympanoplasty using a postauricular approach. Depending on the surgeon's preference at the time of surgery, canal wall up or canal wall down procedures were employed. In the control group, a cartilage graft was formed from tragal cartilage and placed between the tympanoplasty graft and the head of the TORP as a "hat graft" and attached with bone cement. In the study group, as well as the hat graft, another piece of the cartilage was reshaped and placed between the foot of the TORP and the footplate as a "shoe graft" and attached with bone cement. In both groups, after preparation, the TORP was placed between the oval window and tympanic graft. The fascia of the temporal muscle was used for reconstruction of the tympanic membrane. All surgeries were performed by the same senior surgeon (E. A., with 20 years of experience).

2.3. Statistical analysis

Statistical analyses were performed on SPSS 15.0 for Windows. The χ^2 test was used to compare categorical variables, the t test for interval levels and analysis of variance when more than one independent variable was involved. Success of surgery is based on a postoperative air–bone gap of less than 20 dB. The rates of successful outcomes were compared between the groups using the χ^2 test. $P < 0.05$ was considered statistically significant for all tests.

3. Results

Eighty-eight patients were included in the study. The TORP-alone group consisted of 32 patients (20 female, 12 male) and the study group of 56 (22 female, 34 male). Patients' ages ranged from 12 to 68 with a median age of 34. There was no statistically significant difference in terms of age or gender between the groups. Patients' demographic properties are summarized in Table 1.

The main pathology was cholesteatoma, present in 28 patients in the study group (50%) and 18 in the control group (56.3%). Canal wall down procedures were performed in 24 patients from the study group (42.9%) and 14 from the control group (43.8%). There was no statistically significant difference in primary disease or surgical procedure between the groups (Table 1).

According to the preoperative audiograms, there was no significant difference in preoperative air conduction, bone conduction or air–bone gap between the groups (Table 2). In

Table 1 – Comparison of the demographic properties of patients in study and control groups.

	Control (n = 32)	Study (n = 56)	
Average age	35.7	33.1	p > 0.05
Range of age	18–60	12–68	
Male/female	12/20	34/22	p > 0.05
Choleasteatoma	18	28	p > 0.05
CWD/CWU	14/18	24/32	p > 0.05