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The surgical results of stapes fixation in children

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ABSTRACT

Objectives: The aims of this study were to review the causes of stapes fixation in children undergoing stapes surgery and to analyze the results of stapes surgery in children in the short term, at 1 year, and over the long term.
Methods: The medical records of 18 children (28 ears) who had undergone stapes surgery between January 1999 and December 2012 were retrospectively reviewed. The medical history, computed tomography results, intraoperative findings, video clips, and hearing outcomes of all patients were reported.
Results: The mean age of patients was 11.1 years (range, 5.9–15.3 years). Congenital stapes fixation (22/28 ears, 79%) and juvenile otosclerosis (6/28 ears, 21%) were responsible for all cases of stapes fixation. Intraoperatively, abnormal facial nerves that were downwardly displaced over the stapes footplate were noted in four ears. Incudostapedotomy was performed in 24 ears, malleostapedotomy in three, and partial stapedectomy in one. The early postoperative audiometric outcome was favorable in 21 ears (87.5%). There was no significant difference between early postoperative (87.5%), 1 year postoperative (91%), and long term (92.3%) favorable audiometric results. There was no significant difference in the postoperative hearing results between patients with congenital stapes fixation and juvenile otosclerosis.
Conclusion: Congenital stapes fixation was diagnosed in 22 (79%) ears and juvenile otosclerosis in six (21%) ears from a series of 28 ears that were operated on for stapes fixation. Facial nerve anomalies were found in four of 22 ears (18%) that had congenital stapes fixation. There was no difference in the postoperative hearing results between patients with congenital stapes fixation and juvenile otosclerosis. Regardless of the cause of stapes fixation, stapedotomy is a safe and effective procedure for managing the condition.

1. Introduction

Stapes surgery for correction of conductive hearing loss is a well-established procedure in adults. However, stapes surgery in children is less commonly reported, primarily because of the risk of postoperative sensorineural hearing loss (SNHL). Due to this risk, most otologists operate on children who are old enough to participate in the decision-making process. Also, hearing aids are a viable alternative to stapes surgery and offer good prospects for rehabilitation following conductive or mixed hearing loss due to stapes fixation. Thus, stapes surgery in the pediatric population remains controversial despite improvements in surgical technique.

Since the first case series was published by House et al. [1] in 1980, there have been few reports on stapes surgery in children under the age of 18. In these reports, the major causes of stapes fixation were congenital stapes fixation and otosclerosis, which had a similar prevalence. However, in our experience with Korean patients, juvenile otosclerosis was rare compared with congenital stapes fixation. The aims of this study were to determine the incidence of congenital stapes fixation and otosclerosis in children who had undergone surgery for stapes fixation and to analyze the postoperative audiologic results in the short term, at 1 year, and over the long term.

2. Materials and methods

The medical records of 18 pediatric patients (28 ears) who underwent stapes surgery for conductive hearing loss between January 1999 and December 2012 were retrospectively reviewed. All patients were younger than 15 years and underwent stapes surgery by one surgeon at the Asan Medical Center (Seoul, South Korea).

This retrospective study was approved by the Institutional Review Board of Asan Medical Center and for data collection and analysis, and informed consent was waived. There were nine males (13 ears) and nine females (15 ears). The mean age at the time of

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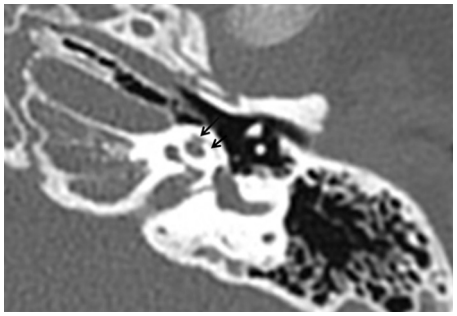

Fig. 1. Axial CT scan demonstrating osteolytic foci (arrow) of juvenile otosclerosis.

surgery was 11.1 years (SD, 3.2; age range, 5.9–15.3 years). There were 16 right-sided ears and 12 left-sided; 10 from 18 children underwent bilateral surgery.

All patients had undergone a preoperative workup comprising of a clinical examination, audiometric data collection, and high-resolution temporal bone computed tomography (HR TBCT). Age at surgery, age at onset, bilaterality, sex, and intraoperative finding were analyzed using operation records and video clips. Postoperative complications and hearing results were compared for various clinical parameters. Revision surgeries were excluded from this study.

The diagnosis of juvenile otosclerosis was made based on the presence of progressive deafness associated with a typical otosclerosis focus in the HR TBCT (Fig. 1). A positive family history, and/or exclusion of other causes of progressive conductive hearing loss were considered. The presence of malformed ossicles was determined on the basis of surgical findings and HR TBCT.

Surgical methods. All patients underwent general anesthesia. An endo-meatal approach with ear canal speculum was used in all cases. After elevation of the tympanomeatal flap, the chorda tympani nerve was slightly detached from the bony annulus anteriorly, and bone over the incudostapedial joint (ISJ) was removed with a small osteotome with mallet. After exposure of the ISJ, the shape and mobility of the ossicular chain was observed. When stapes fixation was identified, the stapes tendon was cut followed by separation of the ISJ. The posterior crura were cut with cururotome scissors, the anterior crus with capitulum of stapes was down fractured with a fine pick, and then the stapes superstructure was removed. An approximately 0.6 mm fenestrum was made in the stapes footplate using a 0.5 mm Skeeter drill. Routinely, a Fish type polytetrafluoroethylene (Teflon®) piston-wire prosthesis was attached in the long process of the incus. When an anomalous incus long process or incus fixation was found, the prosthesis was attached to the handle of malleus (malleostapedotomy).

Audiometric evaluation. Preoperative audiometric data were compared to early postoperative (less than 4 months), approximate 1 year postoperative, and last follow-up (more than 18 months) data. Preoperative and postoperative air conduction (AC) and bone conduction (BC) tests at 0.5, 1, 2, and 3 kHz were included in the analysis. When a frequency of 3 kHz was not used, the mean value of the 2 and 4 kHz results was substituted.

The air-bone gap (ABG) was calculated only for those patients who had BC and AC values collected at the same time. The patient's hearing level in the postoperative period was classified into four groups: (1) very good, ABG less than 10 dB; (2) good, ABG between 10 and 20 dB; (3) acceptable, ABG between 20 and 30 dB; and (4) bad, ABG over 30 dB.

The mean preoperative AC was 51.8 dB (SD, 9.4; range, 30–65 dB), and the mean preoperative ABG was 35.3 dB (SD, 10.3; range 9.5–55 dB; Table 1).

Statistical data analysis. Categorical data were expressed as percentages and continuous variables were expressed as means with standard deviations (SDs). The Fisher exact test was used to compare categorical data. Paired *t*-tests were used for changes in hearing within a group, and independent *t*-tests for the comparison of hearing between groups. A *p* value of less than 0.05 was the criterion for statistical significance. Statistical analyses were performed using SPSS software (version 21).

3. Results

3.1. Surgical findings

Congenital stapes fixation was found in 15 patients (22 ears) and juvenile osclerosis in 3 patients (6 ears). Two girls (four ears) and one boy (two ears) had juvenile bilateral otosclerosis. Interestingly, two girls with juvenile otosclerosis were identical twins.

Congenital stapes fixation with an anomaly of the ossicular chain was found in 10 of 22 ears. Among them, stapes suprastructure anomalies were found in five ears, a fibrous band of ISJ (Fig. 2) in three ears, ISJ fusion in one ear, and a stapes suprastructure anomaly with incus fixation in one ear. Four patients had an anomalous facial nerve course with the tympanic segment located inferior to the oval window niche (Fig. 3).

Incudostapedotomy was performed in 24 ears, malleostapedotomy in three, and partial stapedectomy in one due to incidental footplate fracture.

3.2. Postoperative audiometric results: early, 1 year, and last follow-up

Early postoperative (2.1 ± 1.2 months) audiometric data were available for 24 ears. The mean early postoperative AC was 23.5 dB (SD, 7.7; range 13.7–38.8 dB) and the mean residual ABG was 11.6 dB (SD, 7.4; range 0–27.5 dB).

The early postoperative audiometric outcome was classified as very good in 13 ears (54.2%), good in eight (33.3%), and acceptable in three (12.5%). There were no cases of bad outcomes.

At 1 year after surgery (22 ears), the mean AC was 23.1 dB (SD, 5.3; range 12.5–32.5 dB) and the mean residual ABG was 11.3 dB (SD, 6.5; range 0.50–29.3 dB). The mean AC was 24.6 dB (SD, 11.9; range 10.0–76.3 dB) and the mean residual ABG was 11.5 dB (SD, 8.5; range 0.5–45.0 dB). The audiometric outcome at 1 year was classified as very good or good in 20 ears (91%), which was not

Table 1
Preoperative and postoperative audiometric outcomes for 18 children (28 ears) who underwent stapes surgery.

Period	No. of ears	Mean (SD) [range]		
		AC (dB)	BC (dB)	ABG (dB)
Preoperative	28	51.8 (9.4) [30–65]	16.5 (7.8) [3–31]	35.3 (10.3) [9.5–55.0]
Early postop	24	23.5 (7.7) [13.7–38.8]	11.9 (4.0) [5.0–21.3]	11.6 (7.4) [0–27.5]
1 year	22	23.1 (5.3) [12.5–32.5]	11.8 (4.3) [3–22]	11.3 (6.5) [0.5–29.3]
Last	13	24.9 (16.4) [10.0–76.3]	13.4 (6.3) [7.5–31.3]	11.5 (11.1) [2–45.0]

ABG, air-bone gap; BC, bone conduction; AC, air conduction; early postop, postoperative results less than 4 months; 1 year, postoperative results 1 year ± 3 months; last, postoperative results more than 18 months.