

CLINICAL STUDY

Revision operations after previous stapes surgery for persisting hearing loss

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Abstract: *Objectives:* The aim of the study was to find out the reasons of the recurrent or persisting hearing loss after previous stapes surgery indicated for otosclerosis.

Background: Revision stapes surgery is a relatively safe surgical method. Recurrent or persisting conductive hearing loss is commonly caused by prosthesis dislocation and adhesions in the oval window. Hearing loss is directly proportional to the number of previous operations.

Method: Retrospective analysis of 48 patients after revision stapes surgery was done over a period of 4 years (2005–2008). Improvement of the hearing and the reasons of a previous surgery failure were studied.

Results: Results were compared to the other studies. The main reason of the failed surgery was adhesions and dislocation of the prosthesis. The mean postoperative air-bone gap was 12.0 dB. A mean postoperative air-bone gap closure within 10 dB occurred in 24 cases (55.8 %), between 11–20 dB occurred in 11 cases (25.6 %) and above 20 dB in 8 cases (18.6 %). The original prosthesis was replaced with a new one in 41 (95.3 %) cases. In 2 cases (4.7 %), previous prostheses were left in place and fixed by a ionomer glass cement to the long process of incus.

Conclusion: Revision stapes surgery is a relatively safe surgical procedure allowing to improve hearing. The number of previous stapes surgery deteriorates hearing ($p < 0.05$) (Tab. 4, Ref. 20). Text in PDF www.elis.sk.
Key words: revision stapes surgery, otosclerosis.

Otosclerosis is the primary disease affecting the otic capsule, which causes a progressive hearing loss (1). Treatment includes hearing aids and surgery. Surgical solution is represented by stapedectomy and stapedotomy. The principle of the surgical procedure is a total or partial removal of stapes and its replacement by a titanium prosthesis (2). Best functional results are reached in a primary surgery. Failure of a primary procedure demands revision surgery in the majority of cases. Hearing results after revision surgical procedures are worse compared to the primary surgeries and are dependent on the cause for a revision surgery and on the number of previous stapes surgeries. Moreover, revision surgery is connected with higher risks, as profound sensorineural hearing loss, dizziness, etc. (3, 4, 5). It is generally known that the rate of successful surgical procedure, evaluated as closure of air-bone gap less than 10 dB ranges between 20–85 % (6, 7). The most common cause of a previous failed procedure is a prosthesis displacement, while other reasons like fibrous adhesion, footplate obliteration, short prosthesis etc., are not so frequent (8, 10).

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Hearing restoration depends especially on a primary surgical technique, technique used during revision procedure and also on the number of previous surgical interventions (9).

Retrospective analysis was realized on 343 patients who underwent a stapes surgery for otosclerosis in the Department of Otorhinolaryngology and Head and Neck Surgery of the 1st Faculty of Medicine Charles University in Prague, Faculty Hospital Motol, in the years 2005–2008. From this group of patients, 48 underwent revision surgery.

Methods

In the study, we have evaluated 43 patients (10 males, 33 females,) who underwent revision stapes surgery in the years 2005–2008. All patients were preoperatively examined and indicated for surgery in the ENT department. No patient suffered from a profound sensorineural hearing loss and vertigo before the revision. All patients were examined by otomicroscopy and pure tone audiometry. The mean age during the first revision surgery was 45.1 years (range 21–74). The indication for revision operation was a conductive hearing loss over 20 dB in main frequencies (500, 1000, 2000, 4000 Hz). The mean preoperative air-bone gap was measured as the difference between preoperative air-conductive threshold and preoperative bone-conductive threshold at frequencies 250, 500, 1000, 2000 and 4000 Hz. Number of previous revisions is summarized in the Table 1.

The revision technique was performed under a local or general anaesthesia. Endaural approach was performed in all cases.

Tab. 1. Number of previous revisions.

1x	31	73%
2x	5	12%
3x	4	9%
4x	1	2%
11x	1	2%
Unknown	1	2%
Total	43	100%

Tab. 2. Mean preoperative air-bone gap (MPABG) and postoperative air bone gap (MPostABG).

	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	Average in all frequencies
MPreABG (dB)	45,9	34,3	30,4	14	22,5	29,4
MPostABG (dB)	23,4	15	11,4	3,14	6,9	11,6

Tab. 3. Frequency of air bone gap closure within 10 dB, 11–20 dB and more than 20 dB.

range (dB)	No.	%
< 10	24	55,8
11-20	11	25,6
> 20	8	18,6
Total	43	100

After exposing of the middle ear, the intra-operative findings were examined to evaluate the reasons of a previous surgery failure.

Postoperative audiological testing was performed and evaluated one year after the surgery. The mean pre and postoperative air-bone gap was calculated as the difference between the mean air-conductive threshold, and mean bone-conductive threshold at frequencies of 250, 500, 1000, 2000 and 4000 Hz. Air-bone gap closure was calculated as the difference between preoperative air-bone gap and postoperative air bone gap (Tab. 2). Number of air-bone gap closure within 10 dB, 20 dB and more than 20 dB was analysed (Tab. 3). The association between number of previous surgeries and postoperative air-bone gaps was statistically analyzed using χ^2 and student's t test. p value was calculated.

Results

During the period 2005 to 2008, 343 patients underwent a stapes surgery indicated for otosclerosis in the ENT department. 48 (14 %) patients underwent revision stapes surgery because of a previous surgery failure. Five patients were excluded from the study because of the lack information in hospital documentation including one patient with a postoperative sensorineural hearing deafness. Revision operations were done on 23 left ears (53.5 %) and 20 right ears (46.5 %). Thirty-one cases (72.1 %) were revised once, five cases (11.6 %) required 2 revisions, four cases (9.3 %) required 3 revisions, one case (2.3 %) was revised four times, one case was revised eleven times and at one case the number of previous revision surgeries was unknown because of the lack of the information from patient and documentation (Tab. 1). The main reasons of repeated previous surgery were especially dislocation of prostheses and adhesions around the oval window.

Tab. 4. Intra-operative findings.

Intra-operative findings	No.	%
Adhesions in the oval window	12	27,9
Prosthesis dislocation	11	25,6
Long process of incus necrosis	7	16,3
Fixation of incus or malleus	3	7
Missed incus and suprastructures	1	2,3
Short prosthesis	1	2,3
Previous mobilisation	8	18,6
TOTAL	43	100

Audiological data are summarized in the Table 2. The table demonstrates mean pre-operative air-bone gap and mean post-operative air-bone gap on frequencies 250, 500, 1000, 2000 and 4000 Hz and average in all frequencies. The results show improvement of hearing gain in all frequencies. The mean postoperative air-bone gap was 11.6 dB. The best hearing results were obtained in the frequencies 500, 1000, 2000 and 4000 Hz. Table 3 demonstrates air-bone gap closure within 10 dB, 20 dB and more than 20 dB after revision surgery. There were twenty-four cases (55.8 %) with air-bone closure within 10 dB, eleven cases (25.6 %) with postoperative air-bone gap closure within 20 dB and eight cases (18.6 %) with postoperative air-bone gap closure more than 20 dB.

In one patient, sensorineural deafness occurred after the fourth revision surgery. This patient was not included into the audiological statistical analysis.

The most common cause of a previous surgical failure were adhesions in the oval window (12 cases, 27.9 %) and prosthesis dislocation (11 cases, 25.6 %), long process of incus necrosis occurred in 7 cases (16.3 %), fixation of incus or malleus occurred in 3 cases (7.0 %), in 1 (2.3 %) patient the incus was missing, in one case (2.3 %) the prosthesis was too short, 8 patients (18.6 %) were after previous mobilisation and 3 of these patient had fracture of dorsal stapes crus (Tab. 4).

During revision surgeries original prosthesis were replaced in 41 cases (95.3 %) mostly by the Piston prosthesis (33 cases, 76.7 %), in 7 cases (16.3 %) by the Schuknecht wire and fat prosthesis. In one patient (2.3 %), the original Schuknecht prosthesis was replaced by TORP prosthesis because the malleus and incus were fixed and prosthesis was dislocated and too short and refixation by original prostheses or piston was impossible. In 2 patients (4.7 %), the Ionomer glass cementum was used to fixation of original Schuknecht prosthesis to bones.

The number of previous stapes surgeries deteriorates hearing ($p < 0.05$).

Discussion

Hearing loss is the main reason of revision surgery after stapes surgery. The incidence of hearing loss after revision surgery ranges from 24 to 80 % (10). The sensorineural hearing loss occurs in 3 to 20 % after this type surgery (11). During the period 2005–2008, 343 patients underwent stapes surgery and 48 (14 %) of them underwent revision stapes surgery because of hearing loss in our study. There was one patient with profound sensorineural

hearing loss in our study. This patient was excluded from audiological analysis.

The success of revision surgery is generally confirmed by closure of the post-operative air-bone gap within 10 dB. Closure of air-bone gap after stapes surgery within 10 dB is described by many authors in the range from 25–80 % (12). In our study, closure of air-bone gap within 10 dB was observed in 24 cases (55.8 %), between 11–20 dB in 11 cases (25.6 %) and closure of post-operative air-bone gap for values above 20 dB was observed in 8 patients (18.6 %).

The most common cause of stapes revision surgery was fibrous adhesions in the oval window, which is contrary to published data from other authors where the most frequent reason of previous failure stapes surgery was displacement of original prosthesis (range 25–80 %) (6, 8, 10, 17).

The presence of fibrous adhesions was found in 12 patients (27.9 %) This result is compared to literature where the incidence of fibrosis is published to range from 2 to 38 % (10, 14).

There are several theories explaining the formation of fibrous tissues. One of them is that fibrous adhesion tissue in the oval window is a result of a mucous irritation from postoperative inflammation or it is a reaction to a foreign-material (10, 15).

The second most common failure of a stapes surgery in our study was a displacement of the prosthesis. Displacement of original prosthesis was present in 11 cases (25.6 %). There were several reasons for displacement of the original prosthesis. The most frequent reason for prosthesis displacement was loosening of the prosthesis hook from the long process of incus.

The third common failure of stapes surgery was necrosis of long incus process which occurred in 7 cases (16.3 %). Avascular erosion from the pressure of prosthesis on mucosa is the most common reason of prosthesis dislocation and the incidence in literature is described from 5 % to 31 % (13, 17, 18, 19, 20). In our series, 41 prostheses were exchanged by a new one and in two cases the ionomer glass cementum was used for a better fixation.

Fixation of malleus, missing incus or suprastapes, short prosthesis and previous failure stapes mobilisation with or without fracture of dorsal stapes crus were not so frequent reason of previous failure stapes surgery. In all these cases, new prosthesis was inserted during the revision stapes surgery.

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