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Revision stapes surgery

THOMAS SOMERS, M.D., PAUL GOVAERTS, M.D., M.S., SEBASTIEN JANSSENS DE VAREBEKE, M.D., ERWIN OFFECIERS, M.D., PH.D.

Abstract

This paper reports on the analysis of 332 otosclerosis revision operations. The results have been evaluated with reference to the type of the procedure at primary surgery, the alleged cause of failure and the applied technical solution.

The need for revision surgery was found higher after primary total stapedectomy (3.4 per cent) than after partial stapedectomy (2.2 per cent) or stapedotomy (two per cent). The reason for revision varied according to the originally applied technique eg a migrated piston, a too short piston and a lateralized graft are almost exclusively found after total stapedectomies.

The median hearing gain after revision of stapedotomy and partial stapedectomy was higher (20 dB and 18 dB respectively) than that after revision surgery for total stapedectomy (12 dB), but significantly lower than hearing gain after primary surgery (32 dB).

Revisions yielded better results in the case of primary interventions with the use of a piston or piston-wire than in the case of primary interventions with a wire-type prosthesis.The risk for sensorineural loss (one per cent) was not higher than in primary surgery.

Key words: Otosclerosis, Stapes surgery; Reoperation

Introduction

Primary stapes surgery is one of the most successful otological procedures. In a previous study (Somers *et al.*, 1994) we reviewed the results of 2521 primary stapes operations performed by our predecessor, the late Jean Marquet. Jean Marquet, who died in 1991, was mostly known as a pioneer in homograft tympanoplasty surgery but he also introduced in 1963 the small hole technique, now commonly called stapedotomy (Fisch, 1991). The statistical analysis of his primary stapes operations showed an average gain in air conduction of 32 dB and less than one per cent sensorineural loss (Somers *et al.*, 1994). The next logical step was to evaluate the results of his and our revision operations. Revision stapes surgery offers an entirely different challenge to primary stapes surgery. Surprisingly there is disparity in the results of revision stapes surgery found in the literature. The rate of successful closure of the air-bone gap within 10 dB or less varies between 32.7 per cent and 66 per cent (Crabtree *et al.*, 1980; Sheehy and Nelson, 1981; Pearman and Dawes, 1982; Lippy and Schuring, 1983; Derlacki, 1985; Glasscock *et al.*, 1987; Palva and Ramsay, 1990; Farrior and Sutherland, 1991; Langman and Lindeman, 1993). This is mainly due to differences in the studied populations regarding the primary surgical technique, the cause of failure found at revision surgery, and the technique used to solve the specific problems.

It has been written (Crabtree *et al.*, 1980; Farrior and Sutherland, 1991; Langman and Lindeman, 1993) that the relative frequency of revision operations is increasing. Several authors claim this to be due to a decline of primary cases and to an increase in the number of surgeons with limited experience. Nevertheless, the analysis of all stapes operations performed by J. Marquet (n = 2521) could not confirm this: the annual number of revision cases initially operated by other surgeons, compared with the total number of primary operations did not seem to increase during his career (Figure 1). The factors quoted are probably compensated for by a gradual improvement in techniques, prosthesis materials and training as well as the medico-legal implications compelling less experienced surgeons to refer otosclerosis patients to surgeons with a larger otosurgical practice.

In order to allow us to present a realistic prognosis to future revision stapes surgery candidates, we have retrospectively analysed 332 revision operation files. The present study reports the type of the initial procedure used, the alleged cause of failure, the

From the University Department of Otolaryngology and Head and Neck Surgery, Sint-Augustinus Hospital, University of Antwerp, Oosterveldlaan 24, B-2610 Wilrijk (Antwerp), Belgium.
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TABLE I
TYPE AND INCIDENCE OF PRIMARY INTERVENTIONS NEEDING A REVISION

Type of revised operations	Number	%
Fenestration	5	2
Mobilization	73	22
Polyethylene strut	28	8
Total stapedectomy	69	21
Partial stapedectomy	30	9
Stapedotomy	76	23
Unclear	51	15

Need for revision surgery according to the initial technique

By reviewing all primary cases operated by the late Professor J. Marquet over 30 years, from the early mobilization to the later stapedotomy (Somers *et al.*, 1994), and by the subsequent analysis of his own cases needing revision surgery, we obtained some idea of the probability of a particular technique requiring revision surgery (Table II). The mobilization and the total stapedectomy with polyethylene strut interposition have been abandoned because of the high need for revision surgery (17 per cent and 12 per cent respectively). The reason for failure of the mobilization was invariably a refixation of the footplate. The polyethylene strut has often been found a cause of partial (57 per cent) or total (18 per cent) incus necrosis and in two cases a fistula was also found (one through the lumen of the polyethylene tube and the second around the distal end of the strut).

The chance a stapedotomy would need to be revised was found to be smaller (two per cent) than a partial (2.1 per cent) and total stapedectomy (3.4 per cent).

Reason for revision after present day stapes surgery

The revisions after present day stapes surgery (stapedotomy, partial and total stapedectomy) numbered 226 and the reasons for revisions are listed in Table III. The major cause of failure was a prosthetic problem: a displaced loose prosthesis being found in half of those cases (37/74) often (11/37) associated with a partial erosion of the lenticular process. Migration of the distal end (22/74) from the centre was most often towards the lower margin of the oval window. Misevaluation of the prosthetic length lead in six cases to a too short prosthesis hanging freely over the oval window and in nine cases to a prosthesis reaching too far into the vestibulum (also causing vertigo).

The second most frequent cause of failure was incus necrosis (28 per cent). Incus necrosis is most probably to be ascribed to devascularization of the mucosa over the lenticular process by the wear and tear movements of the prosthesis. In J. Marquet's series we have found four cases of incus necrosis despite conservation of the stapedial tendon during primary surgery. This means that keeping the tendon and its vascular supply to the lenticular process does not necessarily protect the incus against necrosis.

In 29 cases (13 per cent) the presence of adhesions was the only possible cause found at exploratory tympanotomy. Perilymph fistula from the oval window around the prosthesis or along the edge of the oval window was found in 15 cases (seven per cent). Bony reclosure of the oval window under the prosthesis by the otosclerotic focus was found in five per cent.

Among 33 cases listed as 'others', 18 are middle ear explorations performed because of neurosensorial loss to exclude a fistula. In five cases improper elevation of the tympanic flap and excessive bony removal lead to tympanic membrane problems with one cholesteatoma, two retraction pockets and two perforations. A bony ankylosis of the malleus or incus with the attical roof was found in five cases. None of these patients reported to have better hearing after the first intervention (performed elsewhere). This means that the ankylosis at first surgery had been overlooked by not palpating the malleus mobility (Lippy *et al.*, 1980). In five of our own cases the stapes superstructure was removed in a second stage because during initial stapedotomy, after making the calibrated hole and placement of the prosthesis prior to crural fracture according to the Fisch technique (Fisch, 1982), the footplate started to float during each attempt to break a crus. A revision after refixation was necessary to remove the superstructure of the stapes.

Reason for revision surgery according to the initial technique

Table IV shows the reason for revision according to the two most often revised techniques (stapedotomy: n = 76, and total stapedectomy: n = 69), the group of revisions after partial stapedectomy being too small (n = 30) for analysis.

TABLE II
NUMBER OF CASES WHICH NEEDED TO BE REVISED ACCORDING TO THE TYPE OF THE PRIMARY SURGERY

Type of revised operations	Number of revised and primary operations	%
Mobilization	8/48	17
Polyethylene strut	3/25	12
Total stapedectomy	4/117	3.4
Partial stapedectomy	3/140	2.1
Stapedotomy	38/1911	2

TABLE III
REASON AND INCIDENCE FOR REVISION AFTER 'PRESENT DAY' STAPES SURGERY (N = 226)

	n	%
Prosthesis problem	74	33
Loose (37)		
Migration (22)		
Too short (6)		
Too long (9)		
Incus necrosis	64	28
Adhesions	29	13
Fistula	15	7
Reclosure OW	11	5
Others	33	14
SN loss (18)		
Cholesteatoma (1)		
Retr. pocket (2)		
Perforation (2)		
Malleus or incus ankylosis (5)		
Removal stapes superstructure (5)		

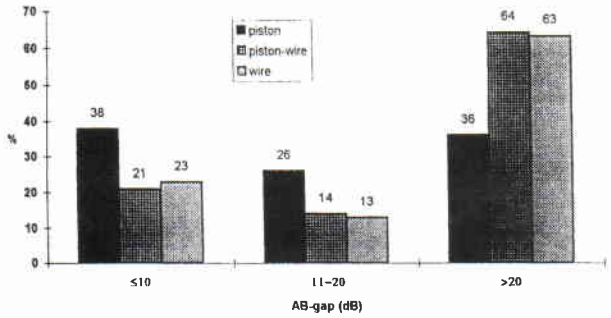

FIG. 2

Air-bone gap closure six months after revision according to the prosthetic material used during primary surgery.

tory long-term results were also found in our analysis of primary stapes surgery (Somers *et al.*, 1994) with total stapedectomy mainly because of hearing deterioration at higher frequencies (4 and 8 kHz).

Hearing results according to the type of prosthesis initially used (Figure 2)

With the present population we were unable to compare the capacity of different prosthetic materials to permanently restore the ossicular sound conduction. There are two reasons for this: first, in our department one type of prosthesis is used almost exclusively (all Teflon piston) whereas for the ears initially operated elsewhere we could not discover with which frequency a material is used by a particular surgeon. What we can compare are the hearing results after revision according to the type of prosthesis initially used catalogued as: all-Teflon piston (n = 135), piston wire (n = 14) and wire prosthesis (n = 31). The results for revision surgery were found more satisfactory when the prosthesis initially used had been of the piston or piston-wire types rather than with wires. A wire end is more difficult to extract from a fibrotic plug in the oval window than a Teflon piston. After the easy removal of a Teflon piston a blue-lined almost transparent vestibular endothelial layer is often found upon which a new piston can be placed.

Hearing results after revision according to the reasons for revision

When the prosthesis was found to be displaced during the revision operation this problem was solved by adapting a new piston with correct diameter and length, and in those cases the best gain in hearing (27 dB) was reached. An oval window reclosure was solved by making a new calibrated hole and by the insertion of a 0.6 mm all-Teflon piston (gain = 22 dB) (Table VII).

Comparatively less satisfactory results were obtained after incus necrosis (gain = 18 dB). This is due to the more profound disruption of the ossicular chain and its more difficult restoration. The length of the remaining lenticular process of the incus as well as the presence or absence of a vestibular opening determined which reconstructive option was chosen. When the length of the remaining lenticular stump was sufficient, and the vestibular hole was still open, a piston (n = 7) or a wire (n = 5) was attached to the remaining incus. In case of a too short lenticular process with an open vestibule, a malleovestibular wire (n = 41) was knotted around the malleolar neck and the medial tip was introduced at the entrance of the vestibule. In case of excessive fenestral fibrosis a sculptured ossicle was placed under the long process if it was not too eroded (n = 1) or most often when the incudal stump was too short under the malleolar neck (n = 9).

In ears where the presence of adhesions was found the only plausible cause of failure, their removal gave only a slight mean improvement (3 dB). In those ears a normal assembly of the prosthesis was always left untouched. Lippy *et al.* (1980) showed that it is better not to change the stapes prosthesis because in 11 out of 13 cases changing of the prosthesis did not improve the hearing and in two cases hearing became even worse.

Thirty-three ears have been revised because of sensorineural loss and suspicion of a fistula. In 15 cases a fenestral fistula was found. All these patients presented some kind of vertigo. Fistulae were closed using a vein graft (8/15) or perichondrium (7/15) kept in place by fibrine glue and a columellar strut like a piston (12/15) or a sculpted ossicle (three out of 15). Closure of a fistula always eliminated the dizziness but average hearing improvement was only minimal (5 dB). Among the 18 other ears where no fistula was disclosed, a reason for the perceptive loss could be traced in only four cases (in three cases the piston was inserted too far into the vestibule, in one case the first surgeon had drilled into the promontory).

We believe no ear should be revised for a stabilized sensorineural loss only, since hearing cannot significantly be improved by surgery. On the other hand when vestibular symptoms with or without fluctuating hearing loss are present a middle ear exploration is mandatory to exclude a fistula.

The risk for sensorineural loss by revision surgery

Revision surgery for otosclerosis led in three cases (one per cent) to sensorineural loss. This one per cent risk is slightly more than after initial stapedotomy (0.67 per cent) and partial stapedectomy (0.71 per cent), but surprisingly less than after the initial total stapedectomy (2.56 per cent) reported in our previous study (Somers *et al.*, 1994). One of the three cases was an uneventful closure of a fistula, the two other cases showed excessive oval window fibrosis

TABLE VII

HEARING RESULTS AFTER REVISION (CLOSURE WITHIN 10 AND 20 DB, AND MEDIAN GAIN IN AC) ACCORDING TO THE REASONS FOR FAILURE FOUND DURING REVISION SURGERY

	<10 dB	<20 dB	Gain AC
Prosthetic problem	55 %	77 %	27 dB
Reclosure oval window	38 %	70 %	22 dB
Incus necrosis	23 %	52 %	18 dB
Adhesions	14 %	37 %	3 dB
Fistula	25 %	33 %	5 dB

mented better long-term results and lower risk for sensorineural loss with this technique.

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Address for correspondence:
Dr Thomas Somers,
University Department of Otolaryngology, and Head and Neck Surgery,
Sint-Augustinus Hospital,
Oosterveldlaan 24,
B-2610 Wilrijk (Antwerp),
Belgium.

Fax: 32-3-443 36 11