

## TOTAL STAPEDECTOMY

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This article discusses the indications, contraindications, preoperative and anesthetic preparations, and results of total stapedectomy for the treatment of otosclerosis.

### INDICATIONS FOR STAPEDECTOMY

The history is critical in the diagnosis of otosclerosis. The typical symptoms of otosclerotic deafness are a gradually increasing unilateral or bilateral hearing loss, most frequently occurring between the end of the second and fifth decades; the presence of paracusis of Willis, and tinnitus. In two thirds of the patients, there is a family history of deafness with autosomal dominant pattern of transmission with 40% of penetrance. It occurs two times more frequently in women than in men and also is more common in whites than in other races. The progression of otosclerosis seems to be more rapid in younger patients. The hearing loss is also often rapidly progressive during pregnancy and in women on estrogen therapy.

Careful otomicroscopic examination can rule out other diagnoses that present with a conductive hearing loss such as the presence of a middle ear effusion, tympanosclerosis within the tympanic membrane, cholesteatoma, and tympanic membrane perforation. After obtaining a careful history and physical examination of the ear, complete audiologic and tuning fork examinations are used to diagnose otosclerosis. In every case, to confirm the presence and size of a genuine air-bone gap, the clinician should use the 256, 512, and 1,024 tuning fork Rinne's tests, with narrow-band masking of the opposite ear to ensure an accurate assessment of the ear under examination. Although the preoperative hearing tests indicate the degree of fixation, they do not predict the pattern and extent of oval window involvement by otosclerosis, which can be only determined at the time of surgical exploration.

Stapedectomy is indicated when the stapes is fixed, as shown by an air-bone gap of 20 dB for the speech frequencies and a negative Rinne test result for the 512 tuning forks.

It is also important to remember that in a certain subset of patients, profound bilateral sensorineural hearing loss may be caused by far advanced otosclerosis.<sup>1-4</sup> It is important that these patients are identified, because often their hearing can be improved through surgical correction so that serviceable aided hearing is possible. The diagnosis of far-advanced otosclerosis is made from the history and can

be confirmed by the presence of cochlear otosclerosis on the CT scan. A positive family history with gradual progressive hearing loss starting in early adult life, paracusis noted in an earlier stage of hearing loss, present or previous use of a hearing aid, and measurable air-bone gap on previous audiogram are highly suggestive of far-advanced otosclerosis.<sup>4</sup>

If a patient is believed to have far-advanced otosclerosis, a stapedectomy should be offered. Based on the data obtained recently by the senior author (Glasscock), stapedectomy performed for far-advanced otosclerosis was able to provide aidable hearing to 82% of such patients.<sup>1</sup> If a patient has profound sensorineural loss for other reasons, cochlear implantation may be the procedure of choice.

In obliterative otosclerosis, the oval-window niche is totally or almost totally filled with otosclerotic bone that obscures the definition of the margins. It is the final stage of the bony remodeling process. In other cases, the footplate is only partly obliterated, and portions of the margins can be identified. Young patients are particularly at risk for such development at puberty when active otospongiotic lesions are highly vascularized. Obliterative otosclerosis cannot be identified preoperatively through clinical and audiometric investigations. The condition is usually an operative discovery; however, CT scan can diagnose obliterative otosclerosis before surgery. Certain signs of presumption can attract the clinician's attention: (1) an early onset of hearing impairment; (2) a Schwarze sign; (3) rapid bilateral progression of hearing loss in childhood or adolescence; (4) rapid progression of the air-bone gap in both ears in young patients; and (5) a low compliance in tympanometry.

Contraindications to stapes surgery include poor speech discrimination or a history of vertigo in recent months, because either can indicate the probability of endolymphatic hydrops, with the risk of further cochlear loss should the labyrinth be opened. Otomicroscopic evidence of outer or middle ear infection requires postponement of surgery until the infection is successfully treated. Operation on a patient's only useful hearing ear should be avoided because of the small but definite and unpredictable risk of a permanent cochlear loss.

Bilateral otosclerosis in children mandates a preoperative CT scan of the temporal bone to rule out any congenital inner ear malformation, because this could result in perilymphatic gusher.

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## PREOPERATIVE PREPARATION

Because the ideal candidate for stapes surgery is also an ideal candidate for a hearing aid, he or she should be fully informed of this and of the uncertainties and risks of surgery. Because verbal explanations of surgery are often misinterpreted by patients, a printed sheet and videotape describing the information are provided to the patients preoperatively. Patients need to be well-informed of the potential risks of stapedectomy including dizziness, alteration of taste, tympanic membrane perforation, facial nerve paralysis, and total sensorineural hearing loss.

## ANESTHESIA

General anesthesia is as safe as local anesthesia today and is often preferred by the patient. Long circuits are used on the anesthesia machine to enable the anesthesiologist to be seated at the foot of the table, opposite the surgeon.

## SURGICAL PREPARATION

For surgical preparation, the patient's hair is not shaved, and skin degreaser is applied around the ear, followed by the application of Mastisol (Ferndale Laboratory, Ferndale, MI). Nonsterile 3M (no. 1010) plastic towel drapes (3M, St. Paul, MN) are then used to cover the hair. Electrode insertion for intraoperative facial nerve monitoring occurs before the surgical preparation. An iodine soap solution is used to wash the auricle and the skin around it, which is blotted dry with a sterile towel, and the ear itself is bathed in an iodine prep solution for 3 minutes. The solution is allowed to enter the external auditory canal. Finally, the area about the ear is prepared with an alcohol-based solution (DuraPrep, 3M, St. Paul, MN).

The circulating nurse next injects the tragus with a 2% lidocaine (xylocaine) and 1:100,000 epinephrine solution.

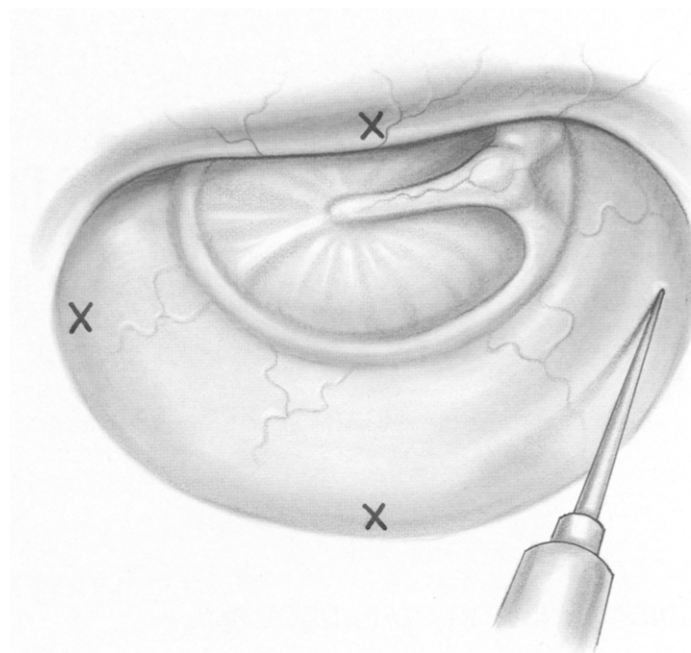
After injection of tragus, the scrub nurse drapes the auricle. Irrigation and suction tubing and cautery lines are secured to the field using Velcro adhesive pads. The surgeon then checks the integrity of the tympanic membrane with binocular microscope, and the ear canal is irrigated with Betadine followed by copious amount of saline using a 5-gauge suction. Preoperative antibiotics are not necessary. Approximately 1 mL of 2% lidocaine (xylocaine) with 1:50,000 epinephrine is injected into the ear canal, producing a rapid constriction of blood vessels (Fig 1).

## HARVESTING PERICHONDRIUM

A Bard-Parker no. 15 blade is used to make an incision on the inner surface of the tragus, leaving the dome intact. The surgeon pulls the tragus posteriorly with an Adson forceps, and a scrub nurse gently retracts the tragus anteriorly with a single hook. A House no. 2 lancet knife is used to elevate the posterior perichondrium off the tragal cartilage. Using a sharp iris scissors, the perichondrium is carefully dissected from the surrounding soft tissue and excised. The scrub nurse uses a 20-gauge needle suction to control any small amount of bleeding from the tragal incision. The perichondrium is compressed in a fascia press to thin and dry the tissue. The tragal incision is then closed with 6-0 fast absorbing chromic suture.

## INCISIONS

The largest speculum that can be inserted is secured using a speculum holder to allow the use of both hands. An

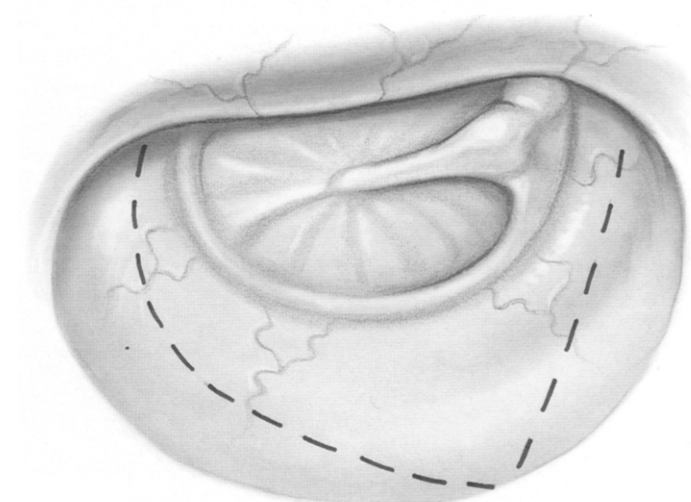


**FIGURE 1.** Injection of the ear canal with 1 mL of 2% lidocaine (Xylocaine) with 1:50,000 adrenaline.

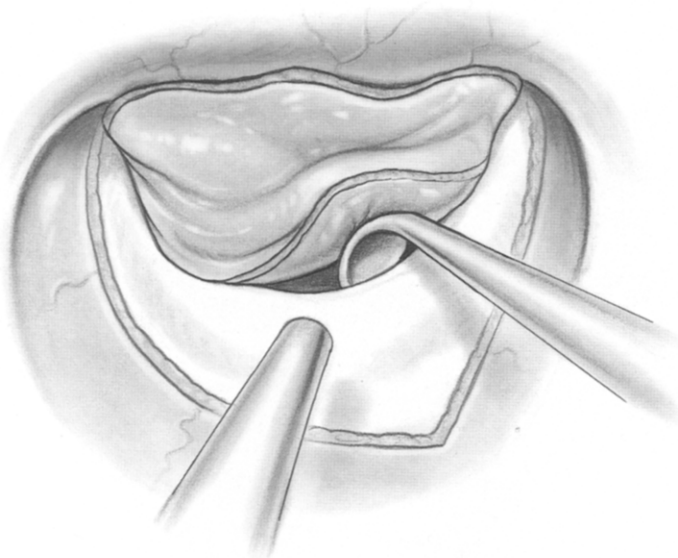
endomeatal incision is made over the skin of the posterior osseous meatal wall with a no. 72 Beaver knife. A v-shaped flap is made beginning at 6 o'clock in the floor of the meatus just lateral to the annulus, sloping backward and upward to 6 mm from the annulus at 10 o'clock for the right ear and 2 o'clock for the left ear, and then curving forward to above the pars flaccida at 12 o'clock (Fig 2).

With a 20-gauge needle suction in the left hand and a House no. 2 lancet knife in the right, the endomeatal flap is elevated down to the level of the fibrous annulus (Fig 3). Next, a House no. 1 sickle knife is used to elevate the chorda tympani from the annulus and the tympanic membrane is reflected anteriorly.

A House curette is used to remove the bone over the scutum carefully so as not to injure the chorda tympani or to disarticulate the incus. Bone must be thoroughly removed from the scutum so both the facial nerve and the pyramidal eminence are clearly visible (Fig 4). The chorda tympani often needs to be mobilized upward or downward to fully visualize the footplate. Mobility of the ossicular chain is then ascertained by carefully elevating the malleus.



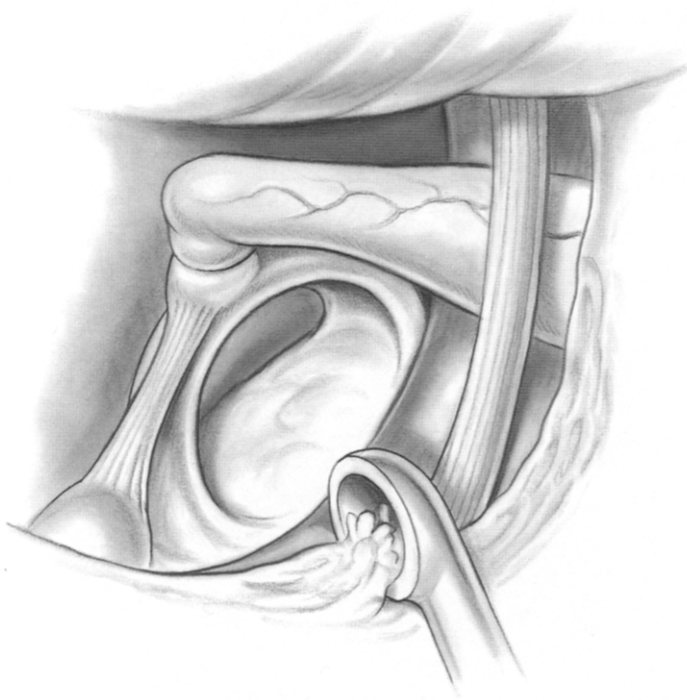
**FIGURE 2.** V-shaped posterior tympanomeatal flap.



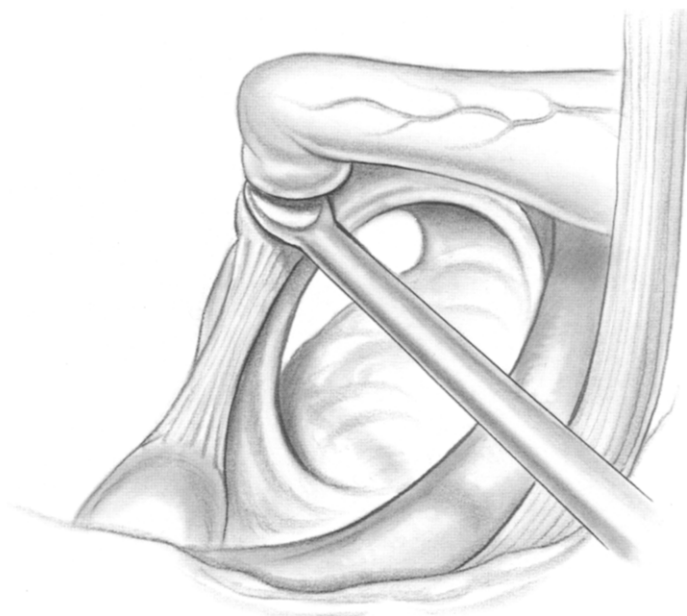
**FIGURE 3.** Tympanomeatal flap is elevated with no. 2 knife.

The incudostapedial joint is disarticulated using an angled joint knife (Fig 5). It is important to do this in a direction opposite the stapedial tendon, so that the tendon supports the stapes against this force. Next the stapedial tendon is cut using middle ear scissors (Fig 6). The stapedial tendon is not reconstructed. At this point, the scrub nurse changes the suction to a 24-gauge needle.

A Rosen needle is used to remove the mucosa from the stapedial footplate, then a Barbara needle is used to create a control hole in the center of the footplate (Fig 7). A control hole is placed in the footplate for two reasons. First, it allows the surgeon to determine if there is increased perilymph pressure that might lead to a fistula. Second, if the whole footplate is mobilized and extracted in one piece, the control hole prevents undue suction in the vestibule, which could cause injury to the saccule and



**FIGURE 4.** A curette is used to remove scutal bone until the facial nerve is seen above and the pyramidal eminence is seen posteriorly.

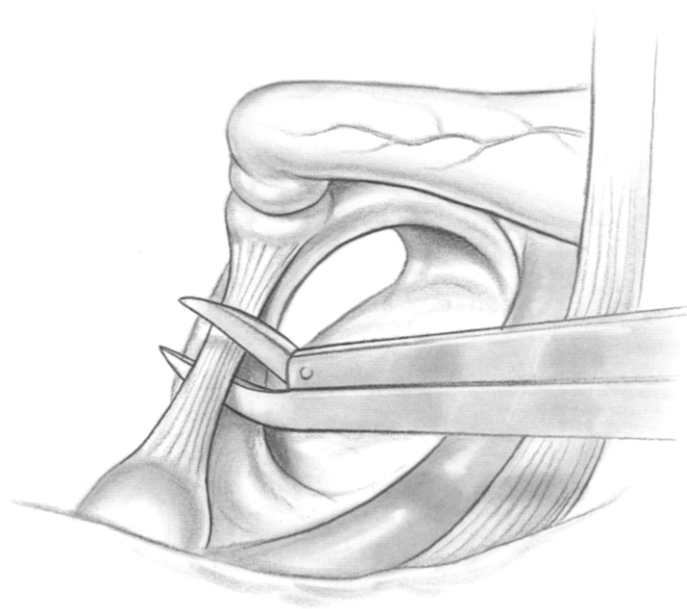


**FIGURE 5.** The incudostapedial joint is disarticulated with a joint knife.

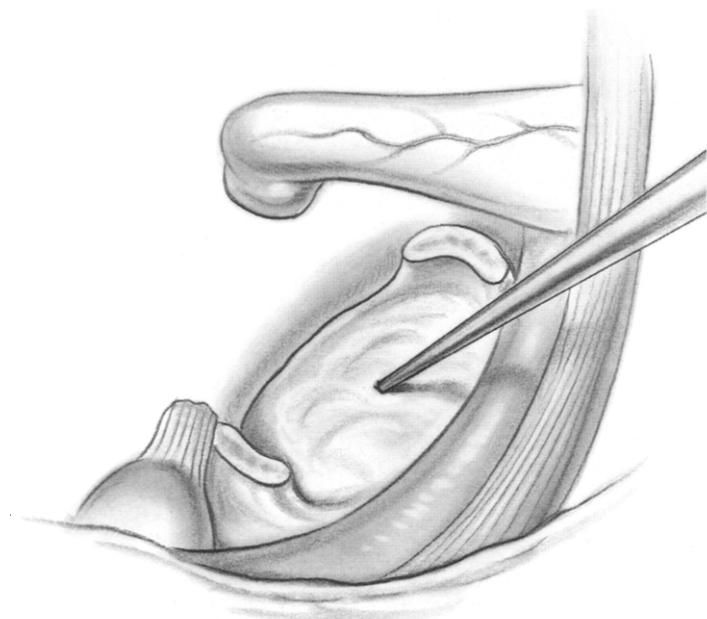
utricle. After placing a control hole in the footplate, the stapedial suprastructure can be fractured downward, using a Rosen needle. The fractured stapedial suprastructure is kept aside and is given to the patient at the time of discharge from the hospital.

Total footplate removal is performed using an anterior and a posterior Hough Hoe (Fig 8). Great care is taken so as not to suction the perilymph directly out of the oval window. The previously harvested tragal perichondrium is placed over the oval window to prevent perilymph leak (Fig 9).

The Robinson prosthesis is placed under the lenticular process of the incus and on top of the perichondrium (Fig 10). This prosthesis does not require crimping and also tends to self-center. The surgeon holds a small right angle pick in the right hand with a 24-gauge needle suction in the left hand. A photograph demonstrating good placement of a prosthesis is obtained at this point for documentation and is given to the patient postoperatively. Once the



**FIGURE 6.** The stapedial tendon is cut with middle ear scissors.

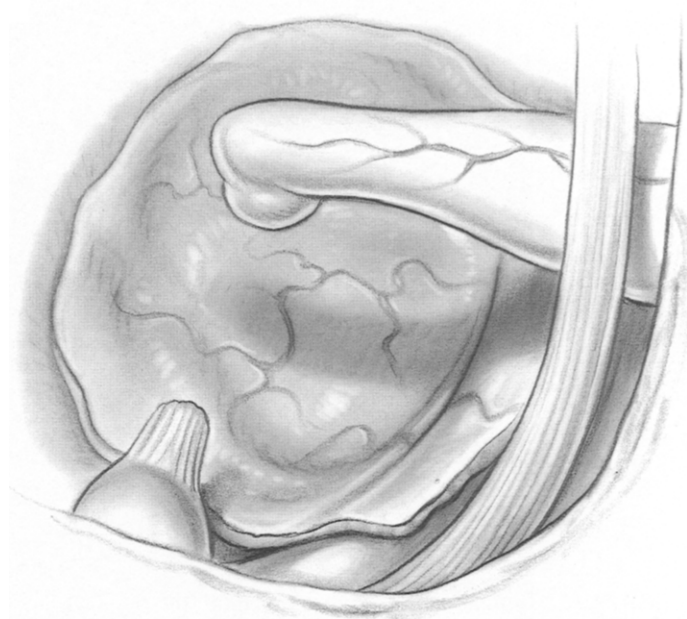


**FIGURE 7.** A Barbara needle is used to create a control hole in the center of the stapes footplate.

prosthesis has been placed, the scrub nurse changes the suction to a 20-gauge suction.

The endomeatal flap is then returned to its anatomic position, and sulfacetamide ointment is used to fill the external auditory canal. A cottonball is placed in the meatus and a sterile prepackaged plastic bubble dressing (Glasscock ear dressing) is applied. Postoperatively, the patient is given adequate analgesics and instructed to avoid straining or blowing the nose. The patient is instructed to keep the ear dressing on overnight.

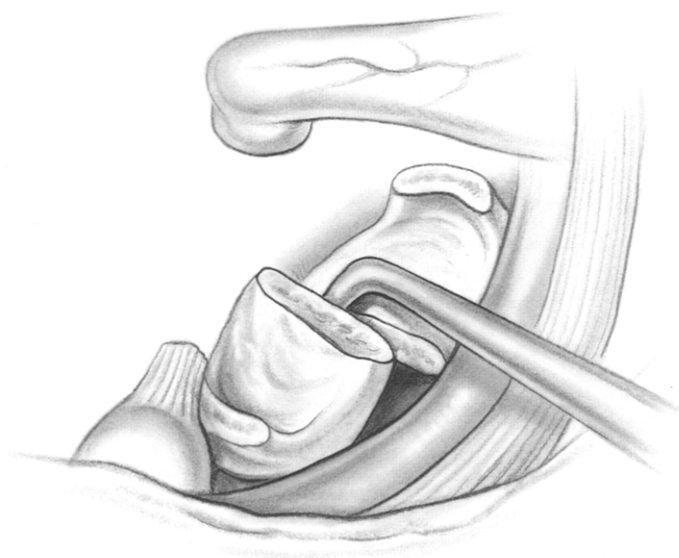
Antibiotics are not routinely prescribed. Unless the patient has postoperative dizziness, the majority of the patients are discharged to home the same day with a 3-week follow-up appointment. On the first postoperative day, the bubble ear dressing is removed by the patient, and a fresh cottonball is inserted in the meatus of the ear canal to absorb the ointment as it liquidifies. Patients are instructed to change the cottonballs at least three times daily or whenever it becomes soiled. There is no restriction regarding air travel or riding in an automobile. An audio-



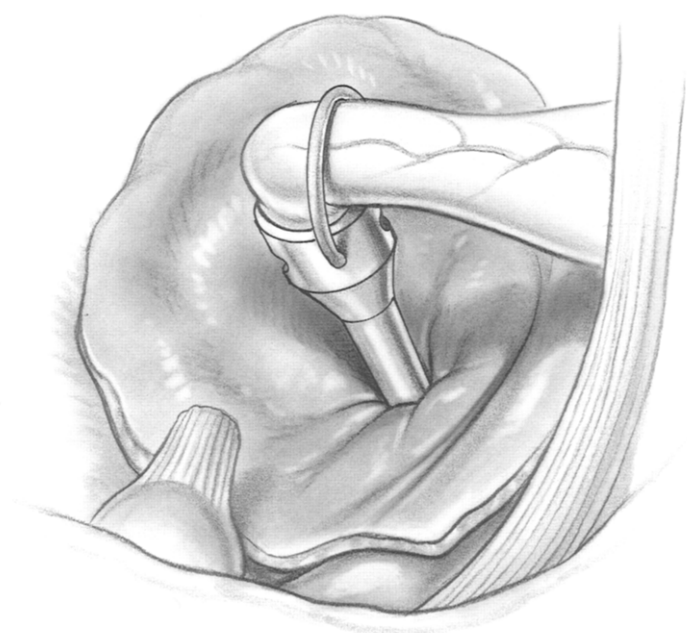
**FIGURE 9.** Tragal perichondrium is used to seal the oval window.

gram is obtained at 3 weeks and 3 months postoperatively. In cases in which a patient has bilateral otosclerosis and stapedectomy resulted in good closure of air-bone gap, the contralateral ear can undergo operation 1 year later.

The loss of an initial gain in hearing after stapedectomy can be due to gradual adherence of the prosthesis to the edge of the oval window; osseous closure of the oval window, fixation of the prosthesis; aseptic necrosis of the long process of the incus; slippage of the prosthesis from the long process; ankylosis of the malleus; and, rarely, ankylosis of the incus to the attic wall. Hearing tests, with special attention to the discrimination score, as well as air and bone testing, always confirmed by tuning forks, are used to establish whether there is recurrence of a large air-bone gap without sensorineural loss or whether the loss of hearing is sensorineural. Revision is indicated for confirmed pure conductive loss, occurring early or late



**FIGURE 8.** The stapes footplate is removed with anterior and posterior Hough hoes.



**FIGURE 10.** A Robinson prosthesis is placed onto the perichondrium and under the lenticular prosthesis.

after stapedectomy, because the probability of useful hearing improvement is high. However, the prognosis for maintaining satisfactory hearing after a revision is less favorable than after operation on a virgin ear.<sup>5</sup>

The technique of revision of a stapes operation is exactly the same as for the original operation, except that the chorda tympani nerve is likely to be embedded in adhesions to the meatal skin flap, so that it is likely to be damaged when gaining exposure to the oval window niche.

## RESULTS

Recent retrospective analysis conducted on patients who underwent stapedectomy by the senior author (glasscock) totaling 828 operations from 1970 to 1994, showed air-bone gap closure in 94.0% of primary surgeries.<sup>6</sup> This result compares favorably to the previously published air-bone gap closure from stapedotomy.<sup>7-9</sup> Studies that analyzed the degree of air-bone gap closure after stapedectomy and stapedotomy showed that stapedectomy resulted in slightly improved air-bone gap closure, but stapedotomy resulted in improved high-frequency gap closure.<sup>8,9</sup> Today stapedectomy can be performed as successfully as stapedotomy,

with comparable results of air-bone gap closure, and it remains as an option for the surgeon performing operations for otosclerosis.<sup>6</sup>

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