A critique of stapedectomy

By Jack Van Doren Hough (Oklahoma, U.S.A.)

Stapedial surgery has been the best news the vast population with hearing impairment has received in the history of mankind. There is, however, still another side to the coin that cannot be ignored. The undesirable surgical complications from these operations are sobering and sometimes devastating, and the long term regressions are disappointing. Nevertheless, when I look back over the few short years from the time in 1953 when Samuel Rosen accidentally, or providentially, mobilized the stapes, I am still awed by its repercussions and its marvellous fall-out. Historically, 1956 was an important year. Rosen was talking about even entering the labyrinth with a pickhole fenestra, and Shea actually took the stapes entirely out and replaced it with an acrylic model thus introducing stapedectomy. My own experiences during this year began leading me along another pathway. One day in 1956, while doing a Fowler anterior crurotomy bypass mobilization, I decided to reduce possible refixation by breaking out the anterior crus. Inadvertently, I pulled out not only the anterior crural stump but the entire anterior one half of the footplate. This left only the posterior crus and posterior footplate dangling free in the oval window. Frustration and fear were soon overcome when the ear healed well and recovered excellent and lasting hearing. This (Fig. 1) was the birth of stapedectomy with preservation of the posterior crus

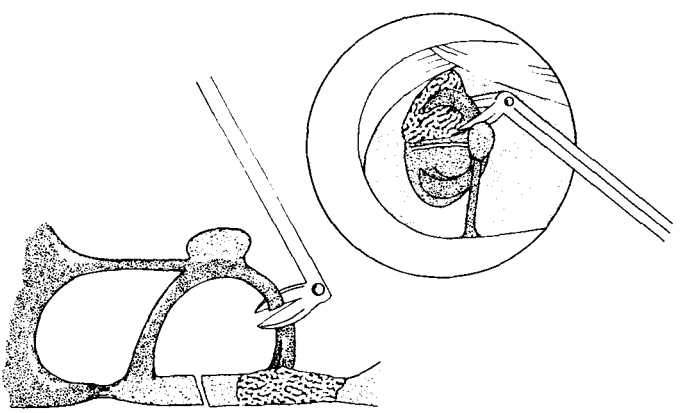


Fig. 1.
Partial Stapedectomy—Anterior Crurotomy.

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(Hough, 1959 a, 1959 b, Partial stapedectomy). Later, I found, by another providential slip, that the posterior crus and arch could be lifted completely out of the oval window and laid on the promontory while still being attached to the incus (Fig. 2). This allowed perfect visualization of the footplate for complete removal (Hough, 1960). Since the crus could be replaced in the oval window as a natural sound conductor, this manoeuvre eliminated the need for the use of an artificial prosthetic stapes. The oval window was covered with Gelfoam anteriorly and posteriorly to the crus. I soon found that I was able to consistently perform this procedure in 80 to 90 per cent of ears.

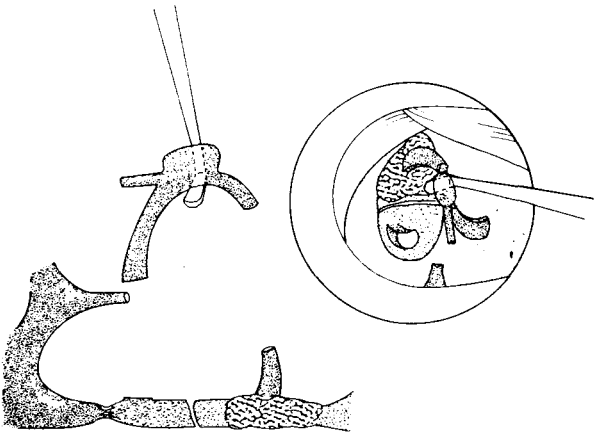


FIG. 2.
Stapes arch temporarily removed to improve access to footplate.

Almost simultaneously, Portmann began doing the procedure he called the Interposition. His original idea was different. It was to remove the entire stapes with footplate, and re-insert most of it over a vein graft oval window covering. The venous tissue would then form a new annular ligament and prevent refixation. He severed the incudo-stapedial joint, lifted the stapes out, laid it aside still attached to the tendon, placed a vein over the oval window, and replaced the stapes in the oval window (Portmann and Claverie, 1958). At present, I believe Portmann no longer separates the incudostapedial joint, but, as I do, preserves the joint, cuts the tendon, and then lifts the posterior crus out of the window. We differ only in the material used to seal the oval window.

In the late 1950s, many total stapedectomy techniques were being developed by such prominent otologists as Shea, Schuknecht (1960), House (1962) and others. All kinds of prostheses and oval window coverings were used successfully. It must be remembered, however, that the only reason for removing the stapedial arch and using a prosthesis was for

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the surgeon's mechanical convenience and visualization. Both Portmann and I deny this necessity.

For sixteen years, the technique I described above was done with a few investigative interruptions on many thousands of ears. The results have been very gratifying from the standpoint of excellent hearing acuity and lack of postoperative complications. The air bone gap closure to within 10 db. of the preoperative bone conduction in the three speech frequencies occurred permanently in 90 per cent. Total closure or over-closure of the air bone gap occurred in 70 per cent and 0·27 per cent experienced significant cochlear loss. When I could not preserve the posterior crus, I was happy to apply the total stapedectomy procedures using prostheses recommended by my colleagues.

Fortunately, for complacent, stubborn otologists, such as myself, the 'Gelfoam scare' suddenly spread across America two or three years ago. Apparently American Gelfoam has been entirely different from European Gelfoam. The latter, in my experience, is too flimsy and porous for use as an oval window covering; and, furthermore, it may have been more toxic to the labyrinth. In America, more and more of us used Gelfoam in the years from 1956 to the early 1970s. Schuknecht and Armstrong even designed a prefabricated wire Gelfoam prosthesis that became popular overnight. In the late '60s and early '70s, however, an alarming number of ears with postoperative fistulas, granulomas and serous labyrinthitis were being reported. The relationship of these complications to Gelfoam could not be positively determined, but many otologists, including myself, discarded its use. Whether this was a change in preparation of Gelfoam or simply an unusual turn of events, no one really knows. Whatever the cause, I believe the eventual effect was for good.

In the search for an alternative seal for the oval window, in 1973, I chose tragal perichondrium (Fig. 3). First described by Goodhill (1961) it has many advantages. It is already in the surgical field and is plentiful. It is histologically akin to the normal oval window occupants and is consistently firm and thick enough to support even an incus homograft from the oval window to the malleus. It has had long and successful use by prominent otologists such as Goodhill and Garcia-Ibanez.

The benefits resulting from this addition to the technique have been very surprising. There has been definitely less postoperative vertigo, better improvement in hearing acuity, and reduced postoperative refixation of the crus or posthesis. Previously, there had been a 5 per cent regression during the first six months after surgery due to the posterior crus or prosthesis migrating and re-attaching to the oval window margins. This regression has been practically eliminated with perichondrium. For recent results see Table I.

The technique is shown in Figures 1, 2 and 3.

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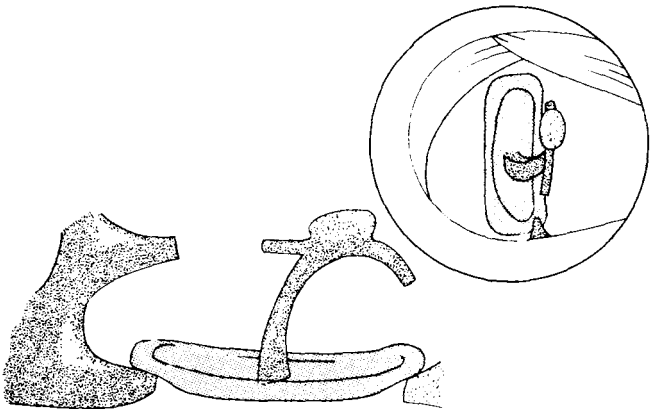


FIG. 3.
Partial Stapedectomy with tragal perichondrium.

There are three principal problems I have found in doing a stapedectomy and preserving the posterior crus.

1. *Short crus.* Occasionally, the posterior crus will fracture high leaving a short crus. Usually this can still be used since it gains length as it is rotated forward in the oval window, and, secondly, the perichondrial graft can be left a little thick to accommodate its length.

2. *Incudostapedial joint separation.* If this should occur, the stapes should still be used by placing the posterior crus in the centre of the oval window and rotating the head back into position.

3. *A fractured crural arch or pathologic otosclerotic crus.* For many years, in these instances, I simply converted the procedure at this point into a total stapedectomy and used a prosthesis. Recently, I have used homograft

TABLE I.

STAPEDECTOMY RESULTS 1973–'75.

	Ears	A/B Gap less than 10 db.	Overclosure A/B Gap	Air Conduction *worsened* by 10db.	Speech Discrimination *worsened* by 10%
Partial Stapedectomy (preservation of posterior crus, perichondrium graft).	302	95·5%	85·8%	0·6%	0%
Total Stapedectomy (perichondrium graft).	59	87%	62·1%	0%	1·6%
Piston (McGee)	5	75%	20%	0%	0%
Total Results	366	94·7%	79·2%	0·5%	0·28%

Tests not less than 6 months post-operatively.
All 'original' ears. No case suffered a severe discrimination loss.

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stapedes. Although it is a little more difficult to place the crus in position because the joint is not secure, with a little patience and practice it is not much harder to manipulate than a metal or a plastic prosthesis.

A critique of surgical factors causing cochlear loss in stapedectomy

Loss of hearing secondary to stapedectomy is utterly devastating, demoralizing, and deplorable, if preventable. These are some of the pitfalls I see:

1. *Poorly trained, poorly organized, poorly motivated, unskilled surgeons* who do an 'occasional' stapedectomy.

2. *Microscopic inorganic contamination.* Lint, fibres, powder and chemical crystals all must be kept out of the ear. Gloves should be carefully washed, plastic lint-free drapes used, and no solutions used in the ear, on grafts, or instruments.

3. *Bacterial contamination* should be controlled with an adequate 20 minute synthetic iodine preparation.

4. *Mechanical problems.* A footplate is not safe until opened enough to allow an instrument under it. If the footplate detaches and floats before it fractures, a Schuknecht 'pothole' should be made through the promontory bone at the side of the oval window. If the oval window is filled with diffuse obliterative otosclerosis and is without annular ligament markings, I prefer not to drill it out. A devastating eggbeater effect in the labyrinth is often disastrous. I use a hand auger to create atraumatically a single shaft for the reception of a piston.

If the footplate is involved with thick circumscribed otosclerosis (biscuit type), I make an indentation across it with a perforator drill, then open the labyrinth with picks and remove the footplate in two large pieces. Bottleneck constriction with promontory overhangs, especially in the posterior inferior area, must be removed before footplate removal. If this is not done, the posterior segment may flip backward into the labyrinth and be lost. Tragedies often happen because a surgeon:

1. Penetrates deep into the labyrinth instead of staying immediately underneath the footplate;

2. Timidly picks at the edge of the footplate fragment instead of getting far under it to lift it out in one piece;

3. Strips the mucous membrane off before the footplate removal and loses his 'holding sheet' which prevents fragments from falling in;

4. Allows a fragment to fall in and then 'fishes' for it;

5. Irrigates the labyrinth trying to recover a fragment or trying to remove bone dust;

6. Leaves the labyrinth open and exposed to heat and dryness over a long period of time because of slowness and poor team efficiency;

7. Does not provide good haemostasis by proper injection and procedure planning to allow a bloodless time for the oval window work.

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Complications and sequellae

1. *Fistulas and Incus erosion*

The use of the polyethylene tube swept the otologic world a few years ago. The fistulas it has produced are insidious, often asymptomatic, and very numerous. Disastrous labyrinthine and even intra-cranial complications have resulted. I have seen so many labyrinthine fistulas and incus erosions with this prosthesis that I believe that we should recommend that *all* of these be removed as soon as possible.

Foreign material prostheses frequently cause fistulas and incus erosion. Mucous membrane cannot grow into and become a part of a prosthesis. There is always a slip space and a potential fistula between the mucous membrane and the prosthetic surface. A solid oval window graft of vein or perichondrium provides some security, but how well it will withstand a lifetime of acoustically-induced vibration no one knows. On the basis of current evidence, I believe the use of prostheses in all middle ear surgery should be abandoned except for rare occasions. This is, therefore, a broad and serious criticism I offer against most stapedectomies performed today.

2. *Vestibular disturbances*

Disequilibrium and episodic vertigo can be due to a subluxated prosthesis, a subluxated footplate, an excessively long prosthesis, a fistula, hydrops, or many other causes. Differential diagnosis is often impossible without exploration.

A warning needs to be emphasized which has received very little attention in the literature. Not all postoperative vertigo is related to stapedectomy. For years, I have carefully documented every patient's preoperative history related to vertigo. Thirty-five per cent of the patients with otosclerosis have typical attacks of whirling labyrinthine vertigo *before* surgery. McCabe found that patients with otosclerosis are predisposed to episodic vertigo. If a surgeon re-operates every patient who has an episode of vertigo, sooner or later, he will needlessly re-enter 35 per cent of the ears in which he has done stapedectomies.

To reduce this problem, I suggest that one remember that the greatest risk to the inner ear occurs in those ears in which stapedectomy has been performed using an artificial prosthesis. Stapedectomy with preservation of the posterior crus using either perichondrium or vein graft has much less risk of a postoperative fistula.

3. *Granulomas*

An altered tissue healing response seems to occur in the oval window mucosa under certain conditions (Harris and Weiss, 1962). Schuknecht blamed Gelfoam. He did, however, find contaminants (Kaufman and Schuknecht, 1967). This possibility should stimulate all surgeons to be more careful in avoidance of contaminants, i.e., powder, lint, fibres,

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bacteria, etc. The treatment for granulomas recommended by Schuknecht is early complete surgical removal and regrafting with fresh tissue. I believe systemic antibiotics and steroids are also useful.

4. *Postoperative serous labyrinthitis*

Serous labyrinthitis appears to be a histochemical response of unknown aetiology frequently occurring several days postoperative, interrupting what appears to be a normal recovery pattern. This is perhaps its most unique differential point. Treatment of this condition is by steroids, and supportive care. Revision surgery is contra-indicated.

Other surgical pathology encountered during stapedectomy—acquired and congenital

Stapedectomy has introduced us to many new entities. Opening ears is as exciting as opening Pandora's box. Through these surprising pathologic discoveries, surgeons have perfected new techniques and expanded clinical knowledge. Patients have also been exposed to new dangers of serious surgical mishaps.

Congenital anomalies, such as a highly placed jugular bulb, an anomalous carotid artery or a huge persistent stapedial artery, can cause serious haemorrhage. A misplaced facial nerve can predispose to facial paralysis. A problem of labyrinthine hydrodynamics can also be encountered in which the perilymph pulsates in tremendous cerebrospinal fluid waves, predisposing the patient to postoperative tinnitus, cochlear loss, and severe disequilibrium. An abnormally patent cochlear aqueduct can also cause a perilymphatic gushet when the footplate is opened.

Acquired conductive defects, such as attic fixation, temporal bone fractures, tympanosclerosis, lightning injuries, ligamentous fixation, spontaneous fistulae, and operative dislocations, are so common that the surgeon must constantly expect, and be prepared for, their presence. These have been the downfall of many ill-prepared surgeons. These same lesions, however, have stimulated some otologists to make outstanding surgical discoveries to the benefit of all. The utilization of ossicular transplants, the sculpturing of ossicles, and their transplantation are notable examples.

Conclusions

Prophets of doom for stapedectomy are unrealistic. Despite problems, crude devices, and surgeons' clumsy efforts, the marvellous rewards of hearing restoration continue to occur and last through the years. In my opinion, the highest degree of physiologic efficiency is obtained and the greatest safety secured when either an autograft or a homograft stapes is used to reconstruct the ossicular chain. Perichondrium is an excellent seal over the open oval window.

Although I am enthusiastic about the excellent results of stapedectomy,

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I am painfully aware of the great hiatus which separates us from our goals of complete relief of symptoms, control of the otosclerotic lesion, cure of the disease itself, and ultimately and best the prevention of this osteogenic dystrophy by finding and eliminating the essential cause.

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