

Forty Years of Stapes Surgery

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Objective: This study reports the results of 14,449 stapedectomy operations performed during the past 40 years.

Study Design: The study design was a retrospective case review. Approximately 100 operations were selected from each of the past 40 years, for a total of 5,444 operations, from which the results with the whole group were extrapolated.

Setting: All operations were performed in a hospital during the first 30 years and in an ambulatory surgery center in the past 10 years.

Patients: All patients in the study were the private patients of the author and were operated on by him personally. These patients had otosclerosis only.

Interventions: Stapedectomy was performed on all patients.

Main Outcome Measures: The change in hearing after the operation was reported. Using the hearing of the average for 500, 1,000, and 2,000 Hz, the criteria for success were defined

as closure of the air-bone gap to 10 dB or less and no decline in speech discrimination of >10%.

Results: In the primary stapedectomy group, success was achieved in 95.1% of ears after 1 year, 94.7% of ears after 2-5 years, and 62.5% after >30 years. In the revision stapedectomy group, success was achieved in 71.1% after 1 year, 62.4% after 2-5 years, and 59.4% after 6-36 years.

Conclusions: The immediate success rate after primary and revision stapedectomy declines slowly over time, because of delayed conductive hearing loss and further sensorineural hearing loss, more than one would expect in matched control subjects without otosclerosis. Stapedectomy has stood the test of time as the first successful microsurgical operation.

Key Words: Stapedectomy—Stapes surgery—Otosclerosis—History of medicine, 20th century.
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Forty years have passed since the first stapedectomy and reconstruction of the sound-conducting mechanism of the middle ear operation (1). During those 40 years, otology has had a second Renaissance, more important than the first at the end of the last century, which continues and increases to this day. The most important contributor to that Renaissance, Dr. Harold F. Schuknecht, has just passed away and will be sorely missed. This report is dedicated to his memory out of respect for his great contributions to otology, especially stapedectomy, and for the help he so often and so generously gave to me. Schuknecht was the second person to report a series of stapedectomy operations to the Second Symposium on Mobilization of the Stapes in San Francisco in May 1958 (2). These operations involved a tantalum wire prosthesis with a loop at the end resting on the fragments of the fractured footplate to reconstruct the sound-conducting mechanism of the middle ear.

After 40 years and hundreds of publications on otosclerosis and stapedectomy, it now is possible to agree on most of the basic information about otosclerosis and the principles of restoring hearing by stapedectomy.

During the past 40 years, I have performed 14,449 stapedectomy operations (Fig. 1). For this report, 100 or more stapedectomy operations were selected randomly for study from each of the 40 years, for a total of 5,444 operations (Fig. 2).

PATIENT INFORMATION

The patient age at operation ranged from 8 patients who were 10 years old or younger to 196 patients who were 80 years or older, with 3,753 (26%) between 50 and 59 years and 10,253 (71%) between 40 and 69 years of age. The average age was 52 years, and the patients' ages ranged from 6-89 years (Fig. 3). There were 64% females and 36% males, and there were equal numbers of right and left ears. In 51%, one ear was operated on, and in 49%, both ears were operated on. The otosclerotic focus was anterior in 58%, in the rim in 25%, obliterated in 11%, in the footplate in only 5%, posterior in 0.5%, and inferior in 0.4%. The otosclerosis was found in the round window in 0.3%, as well as in the oval window, and was in the round window only in 0.2% (Fig. 4).

TECHNIQUE OF OPERATION

Primary stapedectomy was performed on 76% of patients, and revision stapedectomy was performed on

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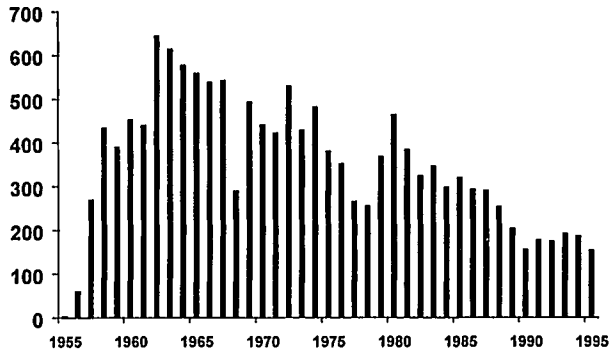


FIG. 1. Number of stapedectomy operations performed from 1955-1995.

24%, the percentage increasing after the first few years but leveling off at approximately 20%.

The entire footplate was removed in 29%, especially in the first 20 years, and half or fewer than half of the footplates were removed in 71% of patients, especially in the second 20 years. Using a hand-held fiber-optic probe with argon laser, I now cut across the footplate and remove only the posterior half or make an opening in the thin center of the footplate if the margins are obliterated.

The oval window opening was sealed with the vein in 55%, with the lining membrane of the middle ear in 25%, with Gelfoam (Upjohn Co., Kalamazoo, MI) in 9%, with perivenous loose connective tissue in 7%, and with fascia and perichondrium, for example, in 4% (Fig. 5). For many years, I have used only compressed vein from the back of the patient's hand, adventitia down.

The original Teflon piston was used in 59% of ears, especially in the beginning. However, after the development of the platinum Teflon cup piston prosthesis in the late 1960s, this prosthesis was used in almost all operations, primary and revision (Fig. 6).

RESULTS OF OPERATION

Using the hearing of the average for 500, 1,000, and 2,000 Hz, the criteria for success were defined as closure

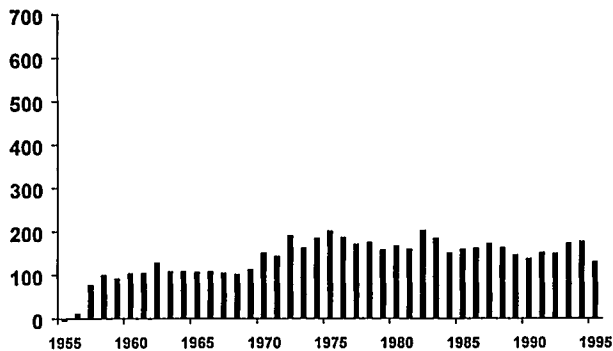


FIG. 2. Stapedectomy operations selected for this study.

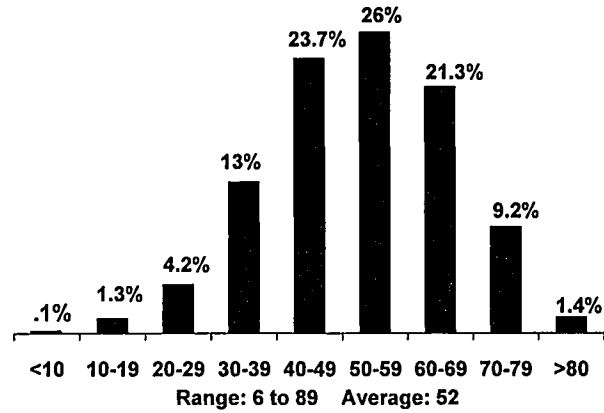


FIG. 3. Age of patients at operation.

of the air-bone gap to 10 dB or less and no decline in speech discrimination of >10%. In the primary stapedectomy group, success was achieved in 95.1% of ears after 1 year, 94.7% of ears after 2-5 years, 89.9% after 6-10 years, 79.8% after 11-20 years, 74.1% after 21-30 years, and 62.5% after >30 years (Fig. 7). In the revision stapedectomy group, success was achieved in 71.1% after 1 year, 62.4% after 2-5 years, and 59.4% after 6-36 years (Fig. 8). Further sensorineural hearing loss occurred in 1.8% of primary operations and 4% of revisions.

The long-term success rate using vein as the oval window seal was 87.8%, using lining membrane of the middle ear was 89.7%, using perivenous loose connective tissue was 88.7%, and using Gelfoam (Upjohn Co., Kalamazoo, MI) was 80.3% (Fig. 9).

The causes of delayed conductive hearing loss with failure of previously successful operations were as follows: dislocation of the prosthesis in 41.5% of ears, eversion of the lining membrane of the vestibule, with or without erosion of the lower incus in 26.3% of ears, bony or fibrous closure or both of the oval window in 15.7% of ears, epitympanic fixation of the incus or malleus or both in 14.3% of ears, and other causes in 2.2% (Fig. 10). Most ears were suitable for and subjected to revision operations. Over time, sufficient sensorineural hearing loss occurred in approximately 30% of patients who under-

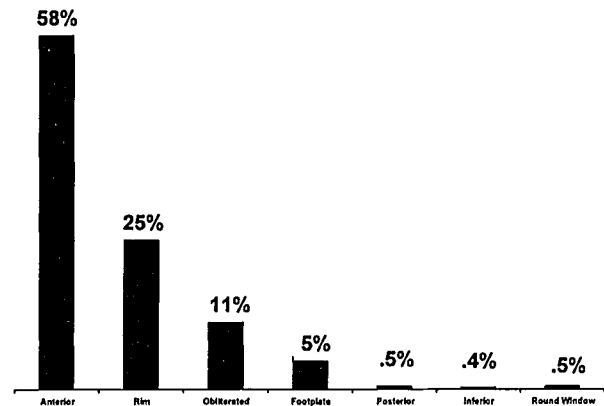


FIG. 4. Location of otosclerotic focus.

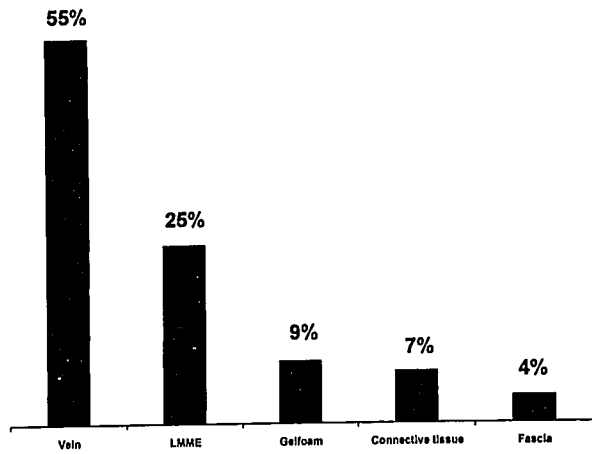


FIG. 5. Material of oval window seals.

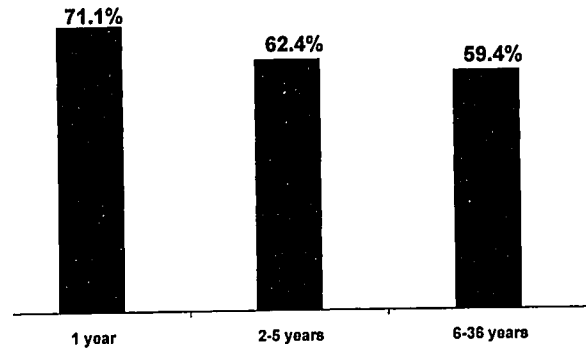


FIG. 8. Success rate of revision stapedectomy.

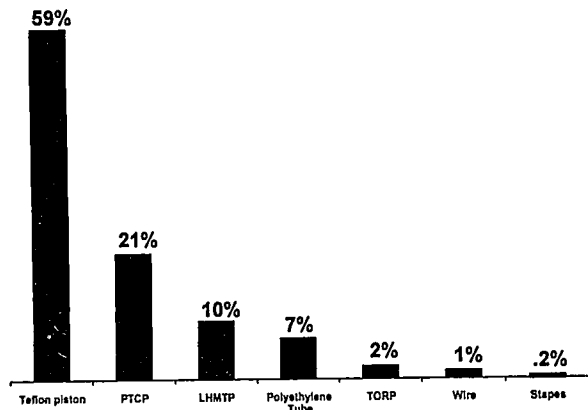


FIG. 6. Types of prostheses used.

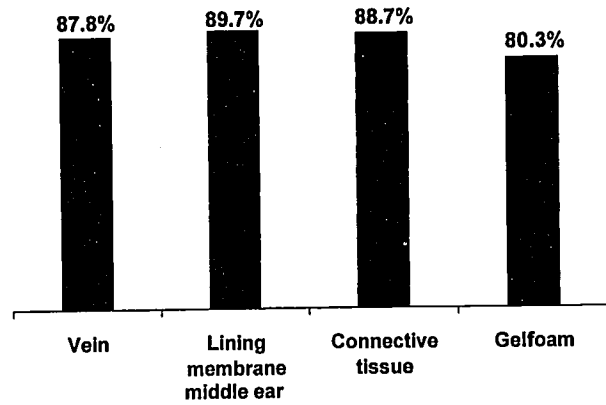


FIG. 9. Success rate of oval window seals.

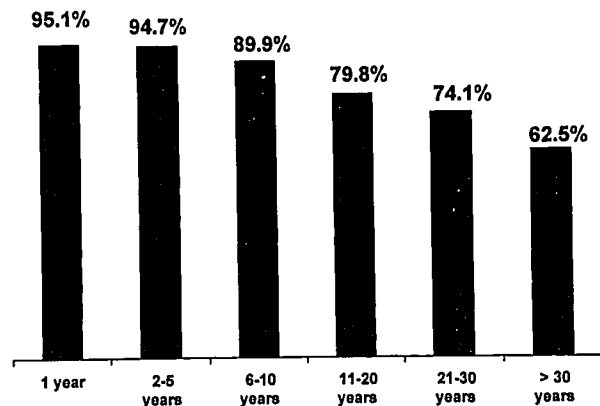


FIG. 7. Success rate of primary stapedectomy.

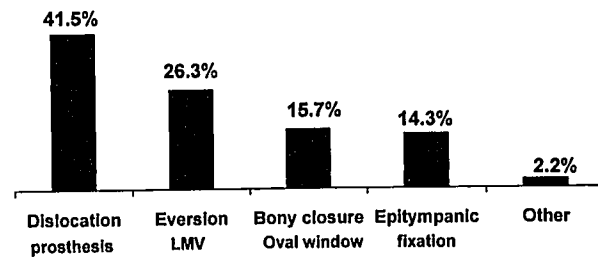


FIG. 10. Causes of delayed conductive hearing loss.

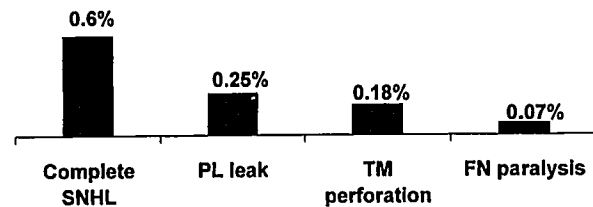


FIG. 11. Complications of stapedectomy.

went successful operations previously and who required the use of a hearing aid.

COMPLICATIONS

Complications included complete sensorineural hearing loss in 86 ears (0.6%), perilymph leak in 37 ears (0.25%), tympanic membrane perforation in 27 ears (0.18%), and temporary facial nerve paralysis in 11 ears (0.07%) (Fig. 11).

SUMMARY AND CONCLUSIONS

During the past 40 years, I have performed 14,449 stapedectomy operations. Results were good from the beginning, with gradual improvement, especially since the introduction of the Teflon cup piston prosthesis and the hand-held fiber-optic probe with argon laser. Beginning with 95% success during the first year in primary stapedectomy operations and 70% in revision operations, there was a small decline that began after 6–10 years and that increased after 20 and 30 years. There was a further sensorineural hearing loss in 1.8% of patients who underwent primary operations and 4% of those who underwent revisions. Complete sensorineural hearing loss occurred in 0.6% of patients. In approximately 30%, there was a significant sensorineural hearing loss that occurred after 20 years, which is more than one would expect in matched control subjects without otosclerosis. This presumably is because of invasion of the cochlea by the otosclerotic process, plus the natural hearing loss that comes

with age. To prevent this, I routinely administer sodium fluoride and calcium for 2 years to those with widespread otosclerosis at operation or with rapidly progressive sensorineural hearing loss or both. Currently, there are fewer patients needing stapedectomy because of immunization against measles. The virus, which invades the osteocytes in the otosclerotic focus, is the stimulus for the development of the clinical disease (3). In the past 100 years, the treatment of otosclerosis has passed from the extraction of the stapes, while the patient was under local anesthesia, with a head mirror illuminated by an oil lamp to the molecular biology analysis of the genes of patients with otosclerosis and mild osteogenesis imperfecta, as reported recently by McKenna (4).

Overall, stapedectomy and reconstruction of the sound-conducting mechanism of the middle ear has been a successful operation, restoring the hearing in most patients, and has stood the test of time for 40 years.

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