Stapes Surgery in Profound Hearing Loss Due to Otosclerosis

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Objectives: This study was designed to determine the effectiveness of stapes surgery in patients with profound hearing loss related to far-advanced otosclerosis and if improvement in hearing is sufficient to avoid the need for cochlear implantation.

Study Design: Retrospective chart review.

Methods: We retrospectively studied the charts of 16 patients who had stapes surgery in 1 or 2 ears between 2005 and 2010 for far-advanced otosclerosis. These patients were all candidates for a cochlear implant according to our institution’s criteria but were offered stapes surgery first. Preoperative and postoperative audiologic data, surgical data, postoperative satisfaction, and telephone use were noted.

Results: Sixteen patients were included, 3 of which had had bilateral surgery. Status of the oval window was evaluated at the time of surgery. Sixteen footplates had bipolar otosclerosis, and 3 had obliterative otosclerosis. Average gain in air-conduction threshold pure-tone average was 33 dB (range, 13–52 dB) and average gain in speech perception scores was 54.4% (range, 0%–93%); 94% of the patients were satisfied by the surgery, and 94% were able to use the phone postoperatively. Overall, 87% of the patients had sufficient improvement to no longer be candidates for cochlear implantation.

Conclusion: Stapes surgery in patients with profound hearing loss due to otosclerosis is safe and can restore enough hearing to make ears aidable and averting the need to consider cochlear implantation. Level of evidence: 3, Retrospective series

Key Words: Far-advanced otosclerosis—Implants—Middle ear.

Otosclerosis is a well-known disorder of bone metabolism in the ear. Most patients have a conductive hearing loss and can clearly benefit from stapes surgery. However, there exist a small percentage of patients, who have profound mixed hearing loss because of far-advanced otosclerosis (FAO). First described by House and Sheehy in 1961 (1), it was then defined as clinical otosclerosis causing a hearing loss with air-conduction thresholds over 85 dB and bone-conduction thresholds not measurable. With time and the improvement in audiometric equipment, the definition changed, but to this day, there is no clear universal definition used. In our center, we consider patients with otosclerosis and hearing capabilities limited enough to be candidates for a cochlear implant as experiencing from far-advanced otosclerosis. These patients can be treated either with a cochlear implant or stapes surgery and hearing aid. Cochlear implantation in these patients is generally successful, but there are risks of difficult or incomplete insertion or facial nerve stimulation. Also, it demands implication in a reeducation program. Stapes surgery has more variable success rates but demands far less re-education and is less invasive and less costly. This study aims at determining if stapes surgery can improve hearing enough for the patients to no longer be considered candidates for a cochlear implant in FAO.

MATERIALS AND METHOD

We performed a retrospective review of charts from patients who underwent stapes surgery for FAO between 2005 and 2010 in our center. These patients had been referred initially for a cochlear implant evaluation and were candidates. They were offered stapes surgery first, with explanations according to the possible success and possibility of receiving an implant should the surgery fail. Our inclusion criteria were as follows: a hearing loss attributed to otosclerosis, an air-conduction pure-tone average (PTA) threshold greater than 90 dB, and an accepted
candidacy for a cochlear implant by our team, which means an open-set sentence recognition score less than 50% with well-fitted hearing aids.

When the data were available, we looked at change in bone-conduction hearing thresholds to look at possible impact on sensorineural hearing, positive or negative. Air-conduction pure tone average thresholds (average of thresholds for 500, 1,000, and 2,000 Hz) were calculated preoperatively and postoperatively to look at gain in PTA.

In our center, we use open-set sentence recognition score in free field with well-fitted hearing aids as a major candidacy criterion to evaluate auditory skills. We therefore compared scores preoperatively and postoperatively to evaluate the status of candidacy. Also, patients were reevaluated for cochlear implant candidacy based on their latest postoperative audiologic data.

RESULTS

Sixteen patients were included, 3 of which had had bilateral surgery, for a total of 19 ears (11 left ears and 8 right ears). Patients were aged from 36 to 80 years with an average of 65.5 years. Eight patients were men, and 8 were women. Status of the oval window was evaluated at the time of surgery. Sixteen footplates had bipolar otosclerosis, and 3 had obliterator otosclerosis.

Only 1 complication occurred in the form of vertigo after the surgery lasting 2 months in 1 patient, the oldest in the study. The symptoms eventually resolved on their own and did not recur.

The change in bone-conduction threshold was evaluated, although some data were unobtainable because patients had vibrotactile responses or could not be properly masked. For the others (8 patients), we found no significant change in bone conduction.

The average air-conduction PTA gain was 33 dB, ranging from 13 to 52 (Fig. 1). All patients showed improvement and none deteriorated.

Patients were assessed pre and postoperatively for cochlear implant recipient candidacy. Open-set sentence recognition scores in open field with well-fitted hearing aid were obtained. As shown in Figure 2, patients improved their scores by 54.4% on average but with a very wide distribution, from 0% to 93% gained. The data were unavailable for 1 patient who spoke neither English nor French. We generally consider a score less than 50% for implantation, but 1 patient with a preoperative score of 56% was included because the team accepted her candidacy based on severity of impairment in daily life and the progressive nature of the hearing loss.

During follow-up, when asked if globally satisfied with the surgery, 94% answered yes; 94% of patients were able to use the phone after the surgery.

According to the last audiologic date available, obtained, on average, at 1 year postoperatively, 13 of 15 were no longer candidates (87%). Again, data were difficult to interpret for the 1 patient speaking only a foreign language, but she was subjectively satisfied and felt a great improvement in her quality of life; she is now able to talk on the phone. Of the 3 other patients, one had improvement in the first 3 weeks after the surgery and then saw his hearing worsen. We suspected displacement of the prosthesis, but the patient declined revision surgery. The 2 others had revision surgery and remained candidates afterward. However, they both declined. Their sentence recognition scores improved from 0% to 25% in 1 patient and from 2% to 25% in the other, which means that, although cochlear implant was still indicated, they could have perceived an improvement.

DISCUSSION

Many different success criteria have been used in studies reporting stapes surgery in far-advanced otosclerosis, and therefore, many different success rates are found in the literature. It also is important to note that the different studies do not always use the same definition for FAO. Lippy et al. (2) defined success as improvement in 2 or more of the following: air-conduction thresholds at 500, 1,000, and 2,000 Hz, speech perception scores at 80dB and capability to wear a hearing aid. In one on his reports, Sheehy obtained a successful outcome in 46% of ears operated (3). Shea defined it as improvement of at least 20 dB of air-conduction thresholds or a closure of the air-bone gap within 10 dB and found that 67% of ears with FAO were
improved by stapes surgery (4). Calmels et al. (5) in 2007 found that only 36% of ears achieved speech perception scores over 60% after the surgery whereas Zaki et al. (6) had stated that 8 of 9 ears in their series became aidable after surgery. The efficacy of stapes surgery is obviously inconsistent in the literature. Other authors advocate for the use of cochlear implants for patients with far-advanced otosclerosis because of more predictable success rates. Patients with implants generally do well, most of them being able to use the phone with the implant (7). However, difficult insertion is reported by many (7,8), which can sometimes mean incomplete insertion and worst hearing outcomes. Also, predictors of poorer results are facial nerve stimulation, occurring in 5% to 33% of cases, and more advanced disease seen on computed tomographic scan. Facial nerve stimulation is due to conduction reaching the facial nerve when higher currents are needed to achieve thresholds in otosclerotic bone (9) or the decreased impedance of otosclerotic foci. Inactivation of electrodes often is required.

The patients in our study only needed adjustment of their hearing aids after surgery, and re-education was therefore very simple for them, which is an advantage over cochlear implant especially in the older patients. Our study was designed to determine if stapes surgery gave enough improvement, so these patients would no longer need a cochlear implant.

We obtained a 94% satisfaction and telephone use rate after the surgery of 1 (13 patients) or 2 ears (3 patients). Thirteen patients were no longer candidates for cochlear implant after stapes surgery, and the information was impossible to obtain for 1 patient who spoke neither English nor French. This gives a success rate of 87%. The 2 patients who remained candidates according to audiologic criteria were not interested in receiving an implant. Of the 2, one had revision surgery for a loose prosthesis but remained with poor hearing. The second patient was suspected of having a displaced prosthesis when his hearing suddenly worsened a few weeks postoperatively but declined revision surgery. Another patient had revision surgery for ossiculoplasty because of necrosis of the long process of the incus. This surgery improved his hearing beyond the cochlear implant criteria used at our institution, and he was therefore included in the success group.

For the subset of patients who had bilateral surgery, Table 1 shows improvements obtained in sentence recognition scores after 1 and 2 surgeries. One of the 3 would still have been a candidate after only the first ear was operated on, but the other 2 had sufficient improvement after only 1 side got stapes surgery. The advantages of binaural hearing are well recognized nowadays, and we think the 2 ears should benefit from surgery when indicated in the subset of patients suffering from bilateral disease.

### CONCLUSION

According to our results, stapes surgery is a safe and effective procedure in patients experiencing profound hearing loss due to far-advanced otosclerosis. Eighty-seven percent of patients in our series had sufficient improvement in their air-conduction PTA and auditory skills to no longer be considered candidates for a cochlear implant. Although cochlear implantation is considered by some authors the treatment of choice for such patients, it has several disadvantages including risks of incomplete insertion and facial nerve stimulation. Furthermore, it entails significantly higher costs, both financially and in terms of time spent in re-education. Because our results were all in previously unoperated ears, another question remains to be answered: would revision stapes surgery in profoundly deaf ears obtain similar results?

### TABLE 1

<table>
<thead>
<tr>
<th>Patient</th>
<th>Preoperative sentence recognition score (%)</th>
<th>Postoperative sentence recognition score after first surgery (open-set free field) (%)</th>
<th>Postoperative sentence recognition score after second surgery (open-set free field) (%)</th>
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<tr>
<td>1</td>
<td>47</td>
<td>86</td>
<td>96</td>
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Before and after stapes surgery sentence recognition scores in open field with well-fitted hearing aids for patients with bilateral disease. Left column: preoperative results. Middle column: results after 1 ear operated. Right column: results after 2 ears operated.

### REFERENCES