ORIGINAL ARTICLE

Outcome of Stapes Surgery for Otosclerosis

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Summary

Otosclerosis is an autosomal dominant disease affecting the otic capsule. It is believed to be rare in Asian countries including Malaysia. We analyzed the results of 29 patients (35 ears) who had undergone stapes surgery for suspected otosclerosis from January 1996 to June 2002. The demographic data was analyzed. The procedure most commonly performed was stapedotomy. The closure of air bone gap after surgery was good at 2 kHz and 4 kHz compared to frequency below 2 kHz. Closure of air bone gap to within 10 dB was achieved in 74.3%. About 7.5% of our patients did not gain in average air conduction. The outcome of the procedure is comparable to those reported by authors who used the same evaluation criteria. No serious complications occurred in our patients.

Key Words: Otosclerosis, Stapedotomy, Stapedectomy

Introduction

Otosclerosis is a hereditary osseous dysplasia of the petrous temporal bone, confined to bone derived from the embryonic otic capsule. It has an autosomal dominant inheritance with incomplete manifestation and varying degrees of expressivity[1]. The disease occurs in 8 to 10% of the Caucasian population, but, of those individuals affected, only 10 to 15% have clinical symptoms. Clinical disease occurs in about 0.5% of Asians and South Americans and in about 0.1% of Africans[2]. Since it is rare in Asians, not many studies on otosclerosis from Asian countries are available[3-9,15].

In Malaysia, there is only one published study about incidence of otosclerosis in the three ethnic groups. Out of 33 patients, 58% were Indians, 30% were Chinese and 12% were Malays[6]. Although a number of centres in Malaysia are performing surgery for otosclerosis, there has not been any published review of results of the surgery. Our department is one of the leading centres for stapes surgery, receiving referrals from various parts of the country.

The objective of this study is to review dermographic data, clinical features and to evaluate the hearing outcome of all cases of stapes surgery performed in our department. We compare our results with other published series from bigger and well-established centres.

Materials and Methods

Clinical records of all cases that had undergone stapes surgery for suspected otosclerosis at the Department of Otorhinolaryngology, Universiti Kebangsaan Malaysia from January 1996 to June 2002 were reviewed.

The data analyzed included age, sex, race, operated ear, the technique, findings, hearing results and complications. Audiometric test was performed using

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standard procedures in a double-walled soundproof room. The conductive component was also confirmed using Weber and Rinne test. Latest pre-operative hearing results were compared with hearing results 1 to 6 months post-surgery. Bone conduction was not routinely tested for 250 Hz and 8 kHz, therefore only the value for 500 Hz, 1 kHz, 2 kHz and 4 kHz were obtained. Averages of the pre operative and postoperative air and bone conduction threshold at 500Hz, 1 kHz, and 2 kHz were used for comparison. In all cases, the basic surgical technique was performed except for the method of footplate removal. All patients underwent the procedure using general anaesthesia. On raising the tymanomeatal flap, the posterosuperior annulus was curetted to gain access to the long process of incus, stapes and oval window region. The diagnosis of otosclerosis was confirmed by inspection and palpation of the incus and stapes. The incudostapedial joint was then separated, stapedius tendon severed, and the crura cut. On removing the suprastructure of the stapes, a small fenestra was made in the center of the footplate (stapedotomy) using the standard perforator of increasing diameter from 0.2 to 0.6 mm. In one case, half of the footplate was removed (partial stapedectomy), while in the other case, it was removed totally (total stapedectomy). A 0.6 mm thick Schuknecht-type Teflon wire piston was fixed to the long process of the incus. Fat graft was harvested to cover the oval window.

The hearing outcome was assessed using four different methods. The first method used the mean of hearing threshold for air and bone conduction pre and post operatively. They were calculated according to the different frequencies and plotted in the pure tone audiogram form for observation of overall outcome.

The second method utilized was by measuring the closure of air bone gap (AB gap). The AB gap was calculated by subtracting the postoperative air conduction from preoperative bone conduction and was categorized into complete closure or overclosure, closure within 10 dB and others (closure more than 10 dB). Successful rate was defined as closure of air bone gap within 10 dB. This was the most widely used method of assessment by previous authors[4,11,16,17].

The third method used the residual air bone gap which was calculated by subtracting the postoperative air conduction from postoperative bone conduction as proposed by Kos et al.[10].

The last method was by calculating the average gain in air conduction at 500Hz, 1 kHz, and 2 kHz. It was obtained by subtracting the preoperative from postoperative air conduction. SPSS Version 11.0 for Windows was used for all calculation.

Results

Demographic Data

A total of 34 patients (40 ears) underwent stapes surgery for suspected otosclerosis. Only 29 patients (35 ears) were confirmed to have otosclerosis intraoperatively. Various other diagnosis were made in the remaining 5 patients namely congenital abnormal stapes, congenital abnormal incudostapedial joint, congenital stapedius footplate frontier, acquired stapes fixation and tympanosclerosis each respectively and were excluded from the study. There were 17 females and 12 males (ratio 1.4: 1) with mean age of 41.24 year (SD = 7.31 years) at the time of surgery. Ages ranged from 27 to 55 years (Figure 1). Majority of the patients' age ranged between 31 to 40 years. Majority of the patients were Malays (62.1%) followed by Indians (20.7%) and Chinese (17.2%).

Clinical features

The average duration of hearing loss was 4.5 years (3 months to 15 years). Ninety three percent of patients presented with bilateral ear disease. Amongst the 17 female patients, half of them were married; only 2 claimed that the symptoms worsened during their third and fourth pregnancy. Only two patients had family history of otosclerosis.

Of the 35 ears, 31 underwent stapedotomy, 1 partial stapedectomy, 1 stapedectomy, 1 revision stapedotomy and 1 total ossicular replacement prosthesis.

Complications

Only two of the patients developed complication. One patient developed benign paroxysmal positional vertigo which resolved after 4 months duration. The other patient developed moderate sensorineural hearing loss at 2 weeks post operatively and exploratory tympanotomy was performed. Initially the patient was well and had good closure of AB gap. Intraoperatively there was no obvious perilymph leak around the prosthesis and footplate. Despite packing of the area of the footplate, the patient persistently has moderate sensorineural hearing loss. None of our patients developed serious complication such as facial

nerve palsy, profound sensorineural hearing loss or perilymph gusher.

Hearing outcome
Method 1: Comparison of mean pre and postoperative air and bone conduction.

Figure 2 shows the mean preoperative and postoperative air and bone conduction threshold for all operated ears. The closure of air bone gap post-surgery was best evaluated at 2 kHz and 4 kHz compared to other frequencies.

Method 2: Measurement of closure of air bone gap
Closure of AB gap was categorized into 3 groups namely complete or overclosure, closure within 10 dB and closure of more than 11 dB. Table I shows the distribution of ears in the 3 categories. A total of 74.3% of operated ears had complete or overclosure and closure within 10 dB.

Method 3: Measurement of residual AB gap
Improvement of hearing was also assessed by calculating the average residual air bone gap at 500 Hz, 1 kHz and 2 kHz respectively for each ear (Figure 3). Sixty percent had residual air bone gap of less than 10 dB and 28.6% had residual air bone gap of 11 to 20 dB. In 3 ears (7.5%) the residual air bone gap was unchanged and remained greater than 20 dB post-surgery. These cases were considered unsuccessful. Overall, mean air bone gap preoperatively was 34.14dB (SD 9.13dB) and postoperatively 10.05dB (SD 10.53dB).

Method 4: Average gain in air conduction
Average gain in air conduction is estimated by calculating the average air conduction gain at 500 Hz, 1kHz and 2kHz respectively for each ear (Figure 4). In the three ears, the conduction gain was negative indicating that postoperative air conduction worsened compared to preoperative results. These cases were considered failed (7.5%). Majority of the ears had air conduction gain at 31 to 40 dB (13 ears). Overall average air conduction gain was 27dB (SD 16.4dB).

Table I : Distribution of ears according to category of AB gap closure post-stapes surgery

Category of AB gap closure	Number of ears	Percentage
Complete or overclosure	12	34.3%
Closure within 10 dB	14	40.0%
Closure of more than 11 dB	9	25.7%

Discussion

Otosclerosis is a genetically mediated metabolic bone disease that affects only the human otic capsule and ossicles. Its mode of inheritance is autosomal dominance, but both its penetrance and expressivity are variable. Only three patients in this study had probable family history of otosclerosis. About 64% of otosclerotic families in India had no history of otosclerosis[8]. It is believed that otosclerosis could be inherited in some other modes (other than dominant alone) and incomplete expression of the gene is playing a vital role in skipping generations[8]. Women are affected twice as often as are men [2]. In our patients, the ratio of women to men was 1.4:1. However, in the series from India, men to women ratio range from 1.2:1 to 1.48:1[8-9]. The age of the patients at the time of surgery ranged from 17 to 55 years, with an average of 40.03 years. Kos et al[10] in his study found an age range of 17 to 75 years with and average of 43 years. However Lippy WH et al found a late age presentation with an average age of 50 years[11]. Otosclerosis was most common amongst Malays (62.1%) which is consistent with the population distribution. Series by Ponniah and Chin revealed that Indian had the highest incidence (1:220). According to them, this can be

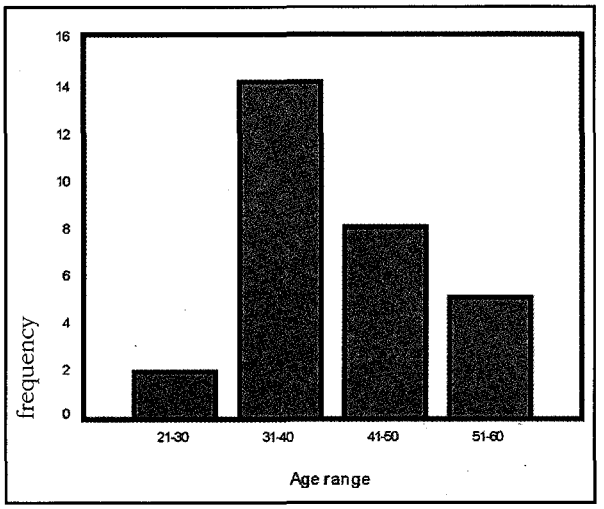

Fig. 1 : Frequency of patients by age range

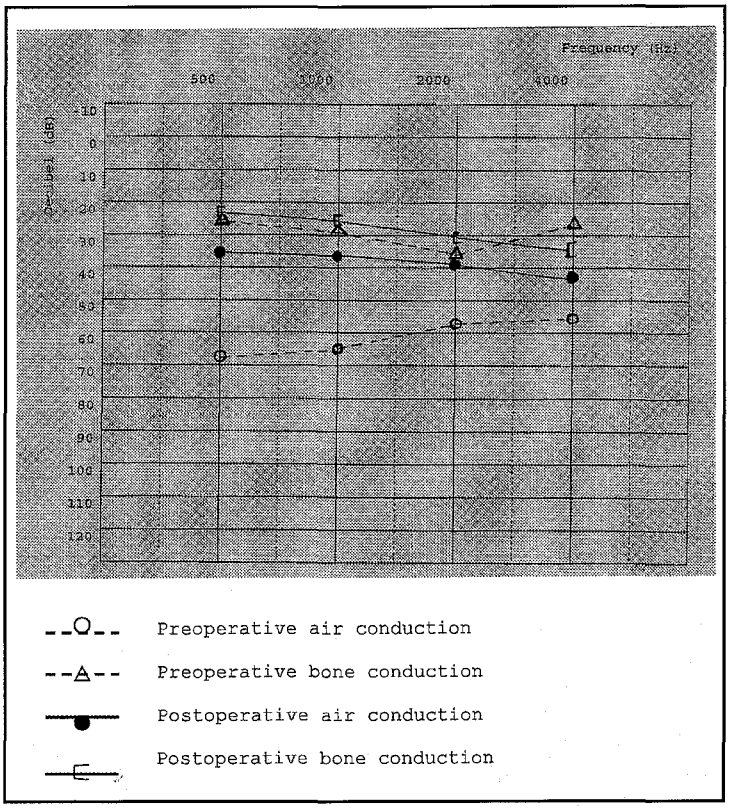

Fig. 2 : Mean preoperative and postoperative air and bone conduction threshold for stapes surgery.

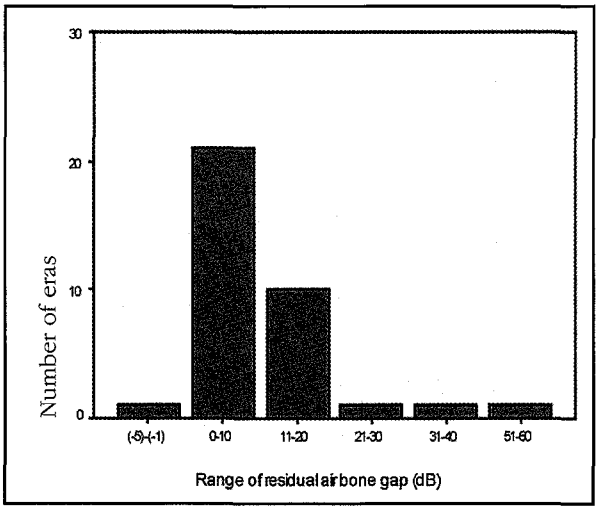

Fig. 3 : Residual air bone gap post-stapes surgery

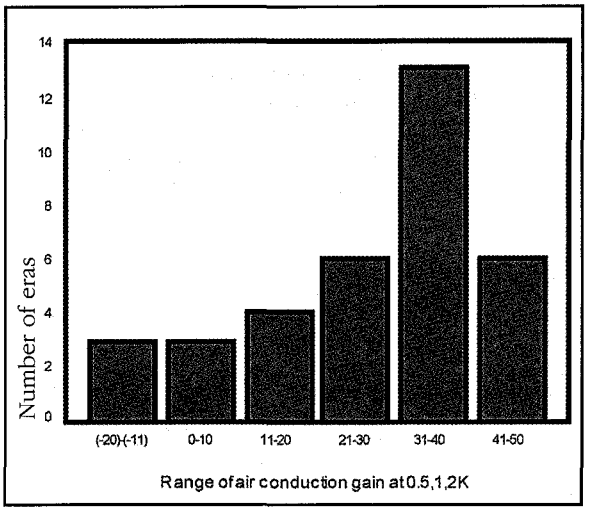

Fig. 4 : Average gain in air conduction at 500 Hz, 1 kHz and 2 kHz post-stapes surgery

explained by the fact that consanguineous marriage is very common among Indian compared to other races[6]. Leong HK reported that amongst his 50 patients who underwent stapes surgery for otosclerosis in Singapore, 70% were Chinese, 23% Indian and none in Malays[4]. In the Western series, it is more common amongst whites compared to blacks [2].

Symptoms of otosclerosis have long been recognized to manifest during pregnancy and they may accelerate rapidly during subsequent pregnancies[1]. Fifty percent of our female patients were married and only 2 claimed that the symptoms worsened during pregnancy. High concentration of estrogen is known to increase fragility of lysosomal membrane. Subsequent release of lysosomal enzymes within otosclerotic foci may result in lysis and resorption of bone.

The average number of years with hearing loss before presentation was 4.5 years. Lippy et al found a longer period of hearing loss: between 11.1 to 18.3 years[11]. Patients with otosclerosis usually present with bilateral hearing loss and tinnitus1 which was consistent in our study (93.1%). Lippy et al found that the incidence of bilaterality in 1960s was 90% and 53% in the 1990s. Leong HK and Levy et al noted a 66% incidence of bilaterality [3,12].

We used small fenestra stapedectomy (or stapedotomy) in the majority of our patients. McGee TM 1981, Shea JJ 1982 and Levy et al 1990 found that small fenestra operation to be superior to large fenestra in terms of hearing gain, easier to perform and lesser complications namely trauma to the inner ear, perilymph gusher and delayed conductive hearing loss due to migration of prosthesis[12-14].

A number of methods can be used to assess the hearing outcome post-stapes surgery. We used the method mostly used by many of the previous authors for the purpose of comparison. Usually, the average frequencies that were assessed are 500Hz, 1 kHz and 2 kHz.

Closure of air bone gap to within 10 dB was achieved in 74.3% of our patients. A review of 200 cases from Pakistan achieved closure of air bone gap within 10 dB in 83% of their patients[15]. Our series was comparable to the audit performed at the Royal College of Surgeons of England in 1994. They achieved 73% closure of AB gap to within 10 dB[16]. Shabana YK et al from Denmark found that the closure of air bone gap to within 10 dB was achieved in 76.5% of stapes surgery using laser compared to 62.7% in the conventional technique[17]. Lippy et al found overclosure occurred in 70% of their patients[11]. An audit in Singapore revealed that 64% of ears achieved closure within 10 dB for consultant group and 68% for the trainee group[4]. Our rate of success is also comparable to other authors who calculated the postoperative air bone gap by subtracting the preoperative bone conduction thresholds from the postoperative air conduction thresholds [4,16,17].

However, Kos MI et al postulated that these methods tends to artificially improve the result and even to produce overclosure of postoperative residual air bone gap since the bone conduction threshold improves after surgery[10]. Their result of residual air bone gap of less than 10 dB was achieved in 78.9% of their patients as compared to only 60% in our study. The residual air bone gap that remained greater than 20 dB in our series was 7.5% which was higher compared to the series by Kos MI et al (3.8%)[10].

The average gain in air conduction was 27 dB in our patients and majority had air conduction gain in the group of 31-40 dB. Ueda H et al also found an average gain of within 30 dB[3].

Only one patient developed sensorineural hearing loss and one benign paroxysmal positional vertigo which resolved after 4 months. There were no other cases of postoperative vertigo except transient vertigo sometimes experienced immediately post-surgery. There were no cases of facial palsy, persistant taste disturbance or persistent perilymph fistula[4].

Small fenestra stapes surgery (stapedotomy) is more superior to stapedectomy procedure because it has less complication, easier to perform and achieves better hearing gain. Even though our series is considered small, however, the outcome of our surgery is comparable with other Asian centres as well as other established centres with vast experience in stapes surgery.

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