Outcome of stapedotomy in the treatment of otosclerosis in a tertiary care hospital: A retrospective study

Allah Noor[1], Khurshid Anwar[1], Muhammad Arif[1], Saeed Khan[1], Qaisar Khan[1], Asmatullah Khan[1]

Abstract

Objectives: The aim of this retrospective study is to assess the treatment outcome with respect to improvement in hearing after stapedotomy for otosclerosis in a tertiary care hospital.

Methods: Specifically, a retrospective study of patient's records was performed at the Department of Ear, Nose and Throat (ENT), Hayatabad Medical Complex, Peshawar, Pakistan from May 2017 to December 2019. Patients with confirmed diagnosis of otosclerosis on pure tone audiogram and typanometry were included in this study. Known otosclerotic patients who underwent revision stapedotomy and tympanosclerotic patch were excluded.

Results: Out of the total 51 patients who underwent stapedotomy, 29 (57%) were males and 22 (43%) were females, while the mean age of patients at presentation was 33±7.1 years (range=18-46 years). Post-operatively, the improvement in hearing was best (≥30dB) in 29 (56%) patients, better in 11 (22%) patients (21-30dB), good (11-20dB) in 7 (14%) patients and fair (0-10dB) in 4 (8%) patients.

Conclusions: Stapedotomy as a treatment for hearing loss in otosclerosis results in improvement of hearing thresholds in a significant number of patients.

Keywords: Otosclerosis, hearing impairment, otic capsule, stapedotomy, pure tone audiometry

INTRODUCTION

Otosclerosis is caused by abnormal resorption and deposition of bone in the region of foot plate resulting in its fixation and consequent conductive hearing loss. The etiology of otosclerosis has been anticipated by a combination of both genetic and environmental factors.

Genetic studies focused at the association between otosclerosis & several genetic variants that impact the risk of the disease development. These genes significantly modulate the bone remodeling pathways.[1] Likewise, the bone morphogenetic proteins, BMP2 and BMP4, have been correlated to the disease in large population studies. [2] Other genes related to otosclerosis are CD46, CD150 and collagen 1A1 (COL1A1). [3]

1. Hayatabad Medical Complex, Peshawar, Pakistan

Address for Correspondence: Dr. Khurshid Anwar, Assoc. Prof. ENT Khyber Girls Medical College, Peshawar, Pakistan
dr.khurshidanwar@yahoo.com
+923339344131

Studies have demonstrated autosomal dominant inheritance with rare monogenic forms which are triggered by mutation in a single gene and as such seven otosclerosis-causing genes loci have been identified in different families. [4] These findings suggest a clear familial segregation and Mendelian inheritance pattern.[5] Moreover a genome-wise analysis identifies genetic variants in the RELN gene associated with otosclerosis. [6].

In addition to genetic factors, environmental factor have also been implicated in the otosclerosis and include viruses (particularly measles), fluoride and hormones (estrogen). Numerous studies have postulated the association of otosclerosis with persistent measles virus infection.[7] The detection of viral antigen and its antibodies have been reported in samples of otosclerotic foci.[8,9] The use of measles vaccination has been correlated to the decline in the otosclerosis incidence and the shift of age from younger to the older at the onset of the disease. Fluoride deficiency is considered as the second most important environmental factor that is implicated in development of otosclerosis and its use as therapeutic agent showed lower hearing deterioration in the treated patients. [10,11] The effects of fluoride have been attributed to the inhibition of toxic proteolytic enzymes. Finally, the role of hormones such as estrogen has also been suspected in the pathogenesis of

otosclerosis; this hypothesis presumably arises from the fact that the prevalence is more common in females (1:2). [12]

The preferred and effective intervention for otosclerosis is either stapedotomy or stapedectomy. Stapedotomy is preferred as a limited opening of the vestibule reduces the risk of damage to the inner ear. Moreover, stapedotomy offers superior results than stapedectomy in terms of hearing improvement. [13] The aim of this retrospective study is to analyzes the outcomes of stapedotomy in local population, which would provide a ready reference for health care providers,

MATERIALS AND METHODS

It was a retrospective cross-sectional study conducted at Department of Ear, Nose and Throat (ENT), Hayatabad Medical Complex, Peshawar, Pakistan. Clinical records of patients, with otosclerosis who underwent stapedotomy at the ENT department of Hayatabad Medical complex, Peshawar between May 2017 and December 2019, were retrieved and studied. Ethical approval for the study was obtained from the institutional ethical review committee of Hayatabad Medical Complex, Peshawar. Patients with confirmed diagnosis of otosclerosis on pure tone audiogram and typanometry were included in this study. Patients who underwent revision stapedotomy and tympanosclerotic patch were excluded. Based on these criteria, a total of 51 patients were selected. The data collected for these patients included age, gender, ear involved, presence of tinnitus and the results of surgery.All patients had pure tone audiometry shortly before surgery, at day 1 and at three months during post-surgical follow up. The tests were performed in a sound proof booth by an experienced audiologist using the same audiometer each time. The data was compiled on the comparison of pre- and post-operative air bone gap (ABG) at 0.5, 1, 2, and 4 KHz. The ABG was calculated from air conduction and bone conduction thresholds that were recorded on the same audiogram. The post-operative hearing gain was calculated from the difference in pre- and post-operative (at 03 months follow up) ABG. For the purpose of the analysis, the resultant improvement in hearing thresholds was classified as best (>30dB), better (21-30dB), good (11-20dB) and fair (0-10dB).

RESULTS

A total of 51 patients were included in the study. The demographic details of the patients included in this study are summarized in Table 1.

Table 1: Summary of demographic details for the patients included in this study (n = 51)

Mean age at presentation	33±7.1years
Gender	
Male patients	29 (57%)
Female patients	22 (43 %)
Comorbidities	
Preoperative tinnitus	40 (78%)
Family history of otosclerosis	37 (73%)
Bilateral otosclerosis	31 (61%)
Right ear involved	15 (29%)
Left ear involved	5 (10%)
Age Distribution	
Age range	18-46 years
Patients with age ≤ 35 years	30

The improvement in hearing at three months post stapedotomy was assessed by pure tone audiometry (PTA) in all patients. It was noted that 29 (56%) of the patients showed more than 30 dB (best) improvement in hearing while it was 21 -30 dB (better), 11 – 20 dB (good) and 0 – 10 dB (fair) in 11(22%), 7 (14%) and 4 (8%) patients, respectively. (Figure1). Whereas all patients showed some improvement, none of them had deterioration in their hearing.

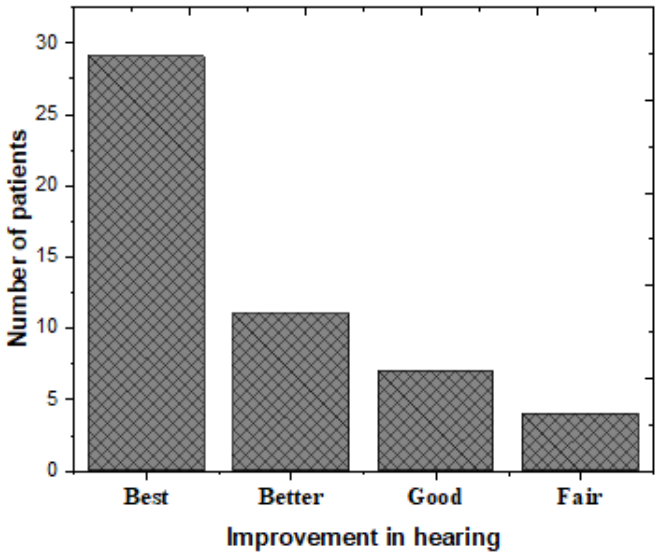

Figure 1: Summary of the improvement in hearing after three months of stapedotomy as assessed by pure tone audiometry

Subgroup analysis showed that patients younger than 35 years showed significant improvement in their hearing thresholds as compared to those aging >35 years (p-Value=0.013). However statistically the improvement in hearing thresholds with respect to gender of the patients was found to be non significant (p-Value=0.446) as shown in Table 3.

Table 2: Age distribution of patients in relation to the improvement in hearing after stapedotomy

Age group (yrs)	No. of patients	Best	Better	Good	Fair	p- value
≤ 35	30 (59%)	18 (34%)	6 (12%)	6 (12%)	0	0.013
> 36	21 (41%)	11 (22%)	5 (10%)	1 (2%)	4 (8%)	
Total	51 (100%)	29 (56%)	11 (22%)	7 (14%)	4 (8%)	

Table 3: Gender distribution of patients in relation to the improvement in hearing after stapedotomy

Gender	No. of patients	Best	Better	Good	Fair	p- value
Male	29 (56.86%)	16 (31%)	4 (8%)	6 (12%)	3 (6%)	0.446
Female	22 (43.13%)	13 (25%)	7 (14%)	1 (2%)	1(2%)	
Total	51 (100%)	29 (56%)	11 (22%)	7 (14%)	4 (8%)	

DISCUSSION

In this retrospective study, we analyzed the role of stapedotomy in the treatment of otosclerotic patients. In particular, the demographic details of the patients presented with otosclerosis were collected, summarized and analyzed. Moreover, the improvement in hearing after stapedotomy was also assessed and categorized to facilitate comparison with other similar studies.

The pattern of patient's demographic data was significantly different in some aspects from the previously reported data. For instance, a male-dominated trend was observed in the patients presenting with otosclerosis to our clinics. Specifically, the male to female patient ratio was 1.32: 1 in this study; this trend is consistent with other studies that have investigated the same population. Studies from other regions of Pakistan have reported a male to female patient ratio of 1.22:1 and 1.18:1; both these studies analyzed a large cohort of patients, 200 and 600 patients, respectively. [14,15] Another study from Pakistan showed a male to female ratio of 4:1 in a cohort of 30 patients. [16] However, this male dominant trend is in contrast to previous

studies reported from regions other than Pakistan where a female-dominated trend has reported for the patients presenting with otosclerosis. To elucidate this point, the gender-specific incidence of otosclerosis in Pakistan has been compared with other countries. Specifically, the highest female to male ratio of otosclerosis patients has been reported for Finland (3:1) followed by Spain (2.82:1) and Brazil (2.3:1). [17,19] A similar gender-based pattern of incidence has been reported for the populations of Jordan, United Kingdom, Germany China, Brazil and Saudi Arabia. [11,17,19–24] This is a critical observation which may suggest that the etiology of otosclerosis is strongly correlated to the given population group and their ethnicity.

Another interesting finding from this study was that the younger patients dominated the sample cohort. Specifically, the mean age of patients at presentation was 33±7.1 years, (range = 18-46 years). Comparing this age-based trend with other studies demonstrated that the disease is presented in younger population in Pakistan. The mean age of 43, 37, 52, 50 and 39 years have been reported for patients from Jordan, Saudi Arabia, Spain, UK and China, respectively. [15,18,21,23,24]

The surgical intervention (i.e., stapedotomy) improved the hearing in all patients, with 29 (56%) patients falling in the *best* improvement category (i.e., improving by 30-40 dB). These results are consistent with other studies, as the success rate of stapes surgery remains high in most reports. Previously, an overall treatment success (define as air bone gap: ABG ≥ 20) of 89.4% for stapedotomy has been reported. [20] The results of stapedotomy for otosclerosis in a large sample cohort showed the postoperative ABG closed to 10 dB in 94.2% of cases. [25] Moreover, functional comparison before and after stapes surgery revealed statistically significant improvement on pure tone average of air conduction/gap. [26] In addition to the high success rate, reduced vertigo (in terms of severity and duration) and shorter hospital stay has been reported for stapedotomy, as compared to stapedectomy. Overall, the results of these (and other) studies demonstrate that the stapedotomy can be used as an effective method for successful management of otosclerosis.

CONCLUSIONS

The analysis of data of patients' included in the study shows that stapedotomy as a treatment modality for otosclerosis resulted in improvement in hearing thresholds in a significant number of patients. Age of the patient was a significant determinant in achieving hearing improvement while gender of patients made no significant difference.

DECLARATIONS

Author's Contributions: The study was designed and conducted by AN, KA and AK. The data collection and analysis was carried out by AN and KA. The manuscript writing and associated assignments were performed by MA, SK and QK.

Conflict of Interests: The authors declare no conflict of interest.

Funding: No financial support is involved in conducting this study.

REFERENCES

1. Janssens K, Gershoni-Baruch R, Guañabens N, Migone N, Ralston S, Bonduelle M, et al. Mutations in the gene encoding the latency-associated peptide of TGF-beta1 cause Camurati-Engelmann disease. Nat Genet. 2000;26(3):273–5.

2. Schrauwen I, Thys M, Vanderstraeten K, Fransen E, Dieltjens N, Huyghe JR, et al. Association of bone morphogenetic proteins with otosclerosis. J Bone Miner Res. 2008;23(4):507–16.

3. Karosi T, Jókay I, Kónya J, Petkó M, Szabó LZ, Sziklai I. Expression of measles virus receptors in otosclerotic, non-otosclerotic and in normal stapes footplates. Eur Arch Oto-Rhino-Laryngology. 2007;264:607–13.

4. Thys M, Camp G Van. Genetics of Otosclerosis. Otol Neurol. 2009;30:1021–32.

5. Schrauwen I, Camp G Van. The etiology of otosclerosis: A combination of genes and environment. Laryngoscope. 2010;120(6):1195–202.

6. Bouzid A, Tekari A, Jbeli F, Chakroun A, Hansdah K, Souissi A, et al. Osteoprotegerin gene polymorphisms and otosclerosis: an additional genetic association study, multilocus interaction and meta-analysis. BMC Med Genet. 2020;21:122.

7. Potocka-Bakłażec M, Sakowicz-Burkiewicz M, Kuczkowski J, Pawełczyk T, Stankiewicz C, Sierszeń W, et al. Expression of TNF- α, OPG , IL-1β and the presence of the measles virus RNA in the stapes of the patients with otosclerosis. Eur Arch Oto-Rhino-Laryngology. 2015;272:1907–12.

8. Karosi T, Jókay I, Kónya J, Petkó M, Szabó LZ, Pytel J, et al. Activated osteoclasts with CD51/61 expression in otosclerosis. Laryngoscope. 2006;116(8):1478–84.

9. Karosi T, Kónya J, Szabó LZ, Sziklai I. Measles virus prevalence in otosclerotic foci. Adv Otorhinolaryngol. 2007;65:93–106.

10. Arnold W, Busch R, Arnold A, Ritscher B, Neiss A, Niedermeyer HP. The influence of measles vaccination on the incidence of otosclerosis in Germany. Eur Arch Oto-Rhino-Laryngology. 2007;264:741–8.

11. Daniel HJ. Stapedial otosclerosis and fluorine in the drinking water. Arch Otolaryngol. 1968;90(5):585–9.

12. Bretlau P, Causse J, Causse JB, Hansen HJ, Johnsen NJ, Salomon G. Otospongiosis and sodium fluoride. A blind experimental and clinical evaluation of the effect of sodium fluoride treatment in patients with otospongiosis. Ann Otol Rhinol Laryngol. 1985;94:103–7.

13. Alraqi A, Alshahrani M. The outcome of hearing in stapedotomy versus stapedectomy in non endemic areas. Indian J Otol 2019;5(3):114-6. DOI: 10.4103/indianjotol.INDIANJOTOL_24_19

14. Salahuddin I, Salahuddin A. Experience with stapedectomy in a developing country: A review of 200 cases. ENT-Ear, Nose Throat J. 2002;81(8):548–52.

15. Musani MA, Rauf A, Ahsan M, Khan FA. Frequency and causes of hearing impairment in tertiary care center. J Pakistan Med Assoc. 2011;61(2):141–4.

16. Ahmed S, Raza N, Ali L, Ullah S, Iqbal S. Hearing improvement after stapedotomy using teflon loop prosthesis. J Coll Physicians Surg Pakistan. 2006;16(10):659–61.

17. Ramsay H, Ktirkktiinen J, Palva T. Success in surgery for otosclerosis: Improvement and other indicators. Am J Otolaryngol. 1997;18(1):23–8.

18. Gil JLM, Palau EM, Jurado FJA, Vadillo ED, Martín JCF, Massanaa EF. Stapedotomy outcomes in the treatment of otosclerosis: Our experience. Acta Otorrinolaringológica. 2008;59(9):448–54.

19. Dall´Igna C, Teixeira VN, Dall´Igna DP, Petersen L, Rosito S. Results of stapes surgery for otosclerosis with two kinds of prothesis in residency training. Braz J Otorhinolaryngol. 2008;74(6):826–32.

20. Mahafza T, Al-layla A, Tawalbeh M, Abu-yagoub Y, Sulaiman AA. Surgical treatment of otosclerosis: Eight years experience at the Jordan university hospital. Iran J Otorhinolaryngol. 2013;25(4):233–8.

21. Crompton M, Cadge BA, Ziff JL, Andrew J, Nash R, Orl-hns F, et al. The epidemiology of otosclerosis in a British cohort. Otol Neurotol. 2019;40(1):22–30.

22. Menger DJ, Tange RA. The aetiology of otosclerosis : a review of the literature. Clin Otolaryngol Allied Sci. 2003;28(2):112–20.

23. Zhang K, Fang Y, Wang B, Cheng X, Chen B, Shu Y, et al. Frequency-specific hearing results after stapes surgery for Chinese population otosclerosis with different degrees of hearing loss. Acta Otolaryngol. 2020;140(5):356–60.

24. Alzhrani F, Mokhatrish MM, Al-Momani MO, Alshehri H, Hagr A, Garadat SN. Effectiveness of stapedotomy in improving hearing sensitivity for 53 otosclerotic patients: retrospective review. Ann Saudi Med. 2017;37(1):49–55.

25. Vincent R, Sperling NM, Oates J, Jindal M. Surgical findings and long-term hearing results in 3,050 stapedotomies for primary otosclerosis: a prospective study with the otology-neurotology database. Otol Neurotol. 2006;27(8):S25–47.

26. Dankuc D, Pejaković N, Komazec Z, Vlaski L. Functional hearing results in patients with otosclerosis before and after stapedotomy. Med Pregl. 2012;65(1-2):54–9.