EVALUATION OF VESTIBULAR FUNCTIONS IN OTOSCLEROSIS BEFORE AND AFTER SMALL FENESTRA STAPEDOTOMY

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ABSTRACT : *Vestibular functions in twenty-five patients with otosclerosis were analyzed before and after undergoing stapes surgery. Vertigo was present preoperatively in 6 patients, which disappeared completely after 4-6 weeks of surgery in all the patients indicating the usefulness of stapedectomy. Patients with otosclerosis demonstrated hypoexcitability compared to controls, which was statistically significant for right cold and hot irrigation. Our results showed equal caloric abnormalities in patients with mixed hearing loss and conductive loss. Patients with obliterative focus at surgery had impaired vestibular functions compared to non-obliterative foci without any statistical significance. A longer piston used at surgery tends to produce more vestibular damage compared to a smaller piston. Finally, the degree of vestibular dysfunction seems to be inversely proportional to the hearing result.*

Key Words : Otospongiosis, Vertigo, Stapes surgery, Electronystagmography.

INTRODUCTION

Symptoms pertaining to vestibular disturbances have long been observed in otosclerotic patients.^{1,2} Clinical evidence has shown 3-35% of otosclerotic patients to have vestibular involvement³. Morales-Garcia (1972)⁴ has reported greater percentage of caloric abnormalities in ears with cochlear involvement compared to pure conductive deafness. Lot of studies has been done to evaluate the sensorineural loss after stapedectomy but there is relative paucity of reports regarding evaluation of vestibular functions following stapedectomy in which there is significant risk of vestibular damage due to opening of oval window and reconstruction of ossicular chain. This has prompted us to study the vestibular functions in patients with otosclerosis before and after stapedotomy.

MATERIALS AND METHODS

The study population consisted of twenty five patients with otosclerosis who underwent unilateral stapedotomy in the Department of Otolaryngology, Postgraduate Institute of Medical Education and Research, Chandigarh India between July 1995 and October 1996. Fifteen age and sex matched volunteers having normal hearing served as the control group. Patients with any systemic disease or any other local diseases that might affect the audiovestibular function were excluded. All patients underwent a small fenestra stapedotomy by an anterior

tympanotomy approach, first to confirm the diagnosis, then to note the type of otosclerotic focus and finally to put a Teflon prosthesis for improvement of hearing. The fenestra was created using Rosen's perforator. No vein graft or any soft tissue closure was done in any of these cases. A 0.6-mm thick Teflon piston was used in all patients. Audiologic examination were carried out using a clinical audiometer calibrated according to ISO standards.

Assessment of vestibular functions was done by Fitzgerald and Hallpike caloric test in both control and study groups. Electronystagmography recorded the nystagmus so produced. The water temperature was controlled with the thermostat. The nystagmus so produced was recorded using a single channel electronystagmograph. The corneoretinal potentials were recorded by a pair of electrodes placed on the patient's temples. A third electrode placed on the forehead served as ground electrode. The voltages picked up by the electrodes were fed to a nystagmograph, which filtered and amplified the eye position signals. The output of nystagmograph was fed to a strip chart recorder. The various parameters like latency (time lag between the stimulus and onset of nystagmus, duration of nystagmus, total amplitude, total number of beats and maximum speed of slow component were studied. The maximum speed of slow component was measured by inspecting the tracing, locating the point

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at which the response was most intense and measuring the slow phase velocity of several nystagmus beats at that point. The above mentioned parameters were studied in all the subjects. The procedure was repeated in the patients approximately 4 weeks following surgery.

Comparison of the results in between the study and control group was done by student 't' test. Preoperative and postoperative comparison within the study group was done by paired 't' test. One way analysis of variance test was applied where the comparison has been done in more than two groups. The data was found to be normally distributed.

RESULTS

14(56%) patients had bilateral mixed hearing loss, 8(32%) had bilateral conductive hearing loss and 3 patients had unilateral conductive hearing loss.

Postoperative hearing improvement The patients were divided into three groups according to postoperative air bone gap as Excellent (A-B gap, 0-10 dB=15 patients), Good (A-B gap, 11-20 dB=6 Patients) and Fair (A-B gap>20 dB=4 Patients). There was no patient with postoperative dead ear.

Vestibular symptoms

The patients were questioned regarding the presence of rotatory vertigo at the time of initial clinical examination and later after the surgical procedure. Six patients had vertigo preoperatively. 12 patients complained of dizziness following surgery lasting for 48 hours. Two patients had a longer duration of vertigo i.e. 5 days. No patient complained of vertigo 4-6 weeks after stapedotomy.

Vestibular functions

A. Normal Vs Otosclerotic Patients

The various parameters of the nystagmus evoked by bithermal caloric stimulation in control and otosclerotic patients were calculated and analyzed.

Latent period : The mean values of the latent period of nystagmus in otosclerotic patients was greater than the control group for all irrigations, with t value significant only for Left cold caloric ($P<0.05$). (Fig. I).

Duration of nystagmus : The mean values of total duration of nystagmus in otosclerotic patients were increased for all irrigations as compared to the control with t values significant for left cold caloric ($P<0.05$). (Fig.II)

Table - I

Preoperative Vs post-operative analysis of nystagmus (MSS) in patients with mixed loss.

Caloric	Preoperative	Postoperative	Paired test	t.p.value
RCC	21.38±7.9	14.29±5.94	3.292	<0.01
LCC	18.31±9.0	16.13±9.19	1.096	>0.05
RHC	15.21±5.4	12.16±6.23	1.737	>0.05
LHC	15.48±7.6	11.87±6.62	1.864	>0.05
UW	13.75±9.7	13±10.15	0.179	>0.05
DP	12.55±10.9	14.72±11.51	0.685	>0.05

Significant value 't 15' at 0.05 probability = 2.13.

Table - II

Preoperative Vs postoperative analysis of nystagmus (MSS) in patients with conductive loss.

Caloric	Preoperative	Postoperative	Paired test	t.p.value
RCC	21.38±8.67	15.24±9.59	2.309	<0.05
LCC	20.16±7.29	14.08±4.41	2.741	>0.05
RHC	15.80±12.75	10.12±5.37	1.604	>0.05
LHC	12.86±7.95	9.92±4.71	1.206	>0.05
UW	16.34±11.16	23.53±17.15	-0.963	>0.05
DP	11.66±10.44	13.48±10.44	-0.538	>0.05

Significant value of 't 8' at 0.05 probability = 2.306.

Fig. 1 : Showing mean latency of nystagmus between control and otosclerotics

Amplitude and total beats : The mean values of total amplitude and total beats of nystagmus in otosclerotic

Fig. II : Showing mean total duration of nystagmus between control and otosclerosis.

Fig. III : Showing mean total amplitude of nystagmus between control and otosclerosis.

Fig. IV : Showing mean total beats between control and otosclerosis.

patients were less for all irrigations compared to the control with t value significant for right cold caloric and right hot caloric ($P < 0.05$). (Fig. III & IV).

Maximum speed of slow component : The mean value was less in otosclerosis with no significant difference. ($P > 0.05$).

Fig. V : Showing hearing improvement Vs vestibular function (MSS).

B. Preoperative Vs Postoperative vestibular functions

Preoperative and postoperative analysis of nystagmus of patients with mixed hearing loss and pure conductive loss is shown in Table 1 and 2. The mean values of maximum speed of slow component were decreased in postoperative patients as compared to preoperative status in both groups with a significant value for Right cold caloric in mixed hearing loss group and Right cold caloric and Left cold caloric in conductive hearing loss. There was no significant difference in unilateral weakness and directional preponderance before and after surgery in both groups.

C. Vestibular functions in stapedectomized patients

1. Obliterative Vs non-oblitative focus

The mean values of maximum speed of slow component for both the groups did not show a significant difference.

2. Piston Size

The mean values of maximum speed of slow component for all caloric irrigation were greater in patients with a smaller piston compared to the group with a longer piston. The difference however was not statistically significant.

3. Degree of postoperative hearing improvement

Patients with excellent hearing improvement had increased mean value of maximum speed of slow component for all irrigation except left hot caloric as compared to the group with satisfactory hearing improvement. The increase was significant for right cold caloric irrigation (Fig.V).

4. Unilateral weakness and directional preponderance

These were calculated on the basis of MSS for both the study group and controls. Amongst the otosclerotic patients, 3(12%) patients had unilateral weakness. An

increase of unilateral weakness was noted after surgery in 6 patients (24%). Only 1 (4%) patient had directional preponderance both preoperatively and post operatively.

DISCUSSION

Studies concerned with vestibular involvement in otosclerosis are less numerous than those with cochlear involvement. Approximately 25-30% of otosclerosis patients has been reported to have vestibular symptoms in the form of vertigo before surgery^{2,5}. Fisch (1965)⁶ carried out electronystagmography investigation of vestibular function and found 28% patients having spontaneous or positional nystagmus in addition to evidence of cochlear dysfunction. Meurmann (1969)³ in an electronystagmographic study of a group of otosclerotic subjects found similar results. Morales-Garcia(1972)⁴ opined that vestibular involvement might occur without the cochlea necessarily becoming involved. Yoon et al (1990)⁷ found affection of vestibular aqueduct and subsequent endolymphatic hydrops in a temporal bone study of otosclerotic patients. Vertigo was present preoperatively in 6 cases (24%) of cases in our study. Vertigo disappeared postoperatively (4 weeks) in all these six cases thereby indicating that stapedectomy is probably helpful. Many authors have reported similar observations⁸⁻¹⁰. A probable mechanism that has been suggested by these authors is that the vertiginous crisis are due to repeated ruptures of the membranous labyrinth which result from intralabyrinthine pressure changes brought about by changes in volume of inner ear fluids. Following stapedectomy, the mobile ossicles with the prosthesis in foot plate established a compensatory mechanism that prevents the occurrence of pressure changes and subsequent disappearance of vertigo.

Evaluation of vestibular functions between controls and otosclerotic patients revealed hypofunction in the later. Similar observations have been reported by Virolainen (1972)¹¹ who found highly significant caloric hypoexcitability in otosclerotic patients compared to healthy subjects.

Morales-Garcia(1972)⁴ observed that the ears with cochlear involvement showed a greater percentage of caloric abnormalities than the ears with a purely conductive deafness. Virolainen(1972)ⁿ and Cody et al (1978)¹² too reported enhanced vestibular symptoms and depression of vestibular functions as the sensorineural hearing loss progressed. On the contrary, analysis of our results

showed equal caloric abnormalities in patients with mixed and conductive hearing loss.

Increased vestibular damage can be expected to occur in otosclerosis with obliterative focus due to advanced otosclerotic vascular or histochemical changes of inner ear fluids. However results of this study did not demonstrate any difference obliterative and nonobliterative focus. Vestibular hypofunction was also seen with a longer piston (3.75-4.0 mm). Compared to a smaller size piston (3.25-3.5 mm), with no significant statistical difference. (P>0.05).

Patients with excellent hearing improvement had increased Maximum speed of slow component value as compared to other patients indicating thereby that there is less marked vestibular hypofunction in patients with excellent hearing improvement. However, observations of Morwicz et al (1992)¹³ are at variance.

They reported that recent symptoms of peripheral vestibular dysfunction made no difference in postoperative hearing improvement.

Virolainen" observed unilateral weakness and directional preponderance measured from Maximum speed of slow component in 56.7% and 48% otosclerotic patients respectively. Our figures for unilateral weakness and directional preponderance are much lower. 12% patients had unilateral weakness, which increased to 24% following surgery. 4% patients had directional preponderance both preoperatively and postoperatively.

The results of this study therefore demonstrate that patients suffering from otosclerosis show vestibular disturbances in the form of hypofunction on caloric stimulation that tends to become severe postoperatively. The patients with complete air bone closure have resultant less hypofunction.

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