Case Report

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Head and Neck Cancer Research

2022
Vol.7 No.5:001

Stapedotomy in Otosclerosis: Laser *versus* Fenestration

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Received date: July 23,2020, Manuscript No: iphncr-20-5311; **Editor assigned date:** July 28, 2020, PreQc No: iphncr-20-5311 (PQ); **Reviewed date:** August 11, 2020, QC No. iphncr-20-5311; **Revised date:** August 22, 2022, QI No. iphncr-20-5311 (QI); Manuscript No: iphncr-20-5311 (R); **Published date:** September 19, 2022

Citation: Chauhan VM, Darji D, Patel KB (2022) Stapedotomy in Otosclerosis: Laser *versus* Fenestration. Head Neck Case Res. Vol. 7 No.5:001

Abstract

Background: Otosclerosis is a localized hereditary disorder of bone metabolism of the otic capsule. The most classical manifestation is conductive hearing loss secondary to stapedial fixation. Our study compares a series of CO_2 Laser Stapedotomy (LS) with a series of Conventional Stapedotomy (CS) with respect to technical advantages, hearing results and complications.

Aims: To evaluate whether CO_2 laser fenestration in primary stapedotomy for otosclerosis is safer than conventional fenestration techniques. Prospective, interventional randomized study.

Material and methods: 40 patients (32 females, 08 males) who underwent surgery for otosclerotic disease between January 2017 and January 2018 were studied in our institute. Statistical analysis used: Paired student t test.

Conclusion: CO_2 Laser is a safe and efficient one shot technique. LS is technically less difficult, produces an atraumatic, bloodless opening in the footplate of stapes without mechanical manipulation of the stapes and less inner ear damage. The air bone gap closure is better in laser group (32 ± 3.85).

Keywords: Laparoscopic cholecystectomy; Abdominal field blocks; Ropivacaine; Local anaesthetic infiltration

Introduction

Otosclerosis is a hereditary disorder of bone metabolism of the otic capsule andenchondral bone that is characterized by disordered resorption and deposition of bone. Conductive or mixed deafness, tinnitus and, more rarely vestibular symptoms, are the clinical signs of this pathology. The onset is usually around the third or fourth decade of lifepredominating in females (M: F2:1). The disease is autosomal-dominant, with a 20%-40% penetrance. Both ears are involved in the majority of cases. Surgical management is the definitive treatment. It can be treated surgically by removing (part of) the stapes and replacing it with a prosthesis stapedotomy and stapedectomy, respectively, with aid of conventional and laser techniques [1].

The objective of this systematic review was to evaluate whether CO_2 laser fenestration in primary stapedotomy for otosclerosis is safer than conventional fenestration techniques, in terms of air-bone gap closure and adverse effects, including SNHL, vertigo, tinnitus, and footplate fractures [2].

Case Study

This is an interventional randomized study where 40 patients (32 females, 8 males) who underwent surgery for otosclerotic disease between January 2017 and January 2018 were prospectively studied in our E.N.T Department of B.J Medical College, Civil Hospital, Ahmedabad [3].

Inclusion criteria

Diagnosis of otosclerosis based on a clinical history of progressive hearing loss, normal tympanic membrane onotoscopic findings, an audiogram showing a mean conductive hearing loss >20 dB in the range of 0.5 kHz-4 kHz, the absence of cochleo-stapedial reflexes and surgery findings [4].

Exclusion criteria

People with only hearing ear, with active infection of external or middle ear and with poor medical conditions were excluded from the study. The patients were examined including history, general examination, ENT examination, Otoscopy and tuning fork test followed by microscopic examination of the ear. Pure tone audiometry and impedence audiometry were done for all cases [5].

Patients were divided into two groups

Group 1 (20 patients, 16 females, 4 males treated with conventional stapedotomy) and group 2 (20 patients, 16 females, 4 males treated with CO_2 laser stapedotomy). Surgery was always performed on the ear with the poorest air conduction threshold in the frequencies considered (0.5, 1, 2 and 3 (kHz). All surgical procedures were performed under local anesthesia. First group of patients were treated with conventional technique using perforator. Second group of patients were treated using CO_2 laser. CO_2 laser was used to vaporize the stapedial tendon, the posterior crus and to fenestrate the oval window with a one-shot technique [6]. In all

patients, hole diameter was 0.6 mm. A self-crimping Teflonself crimping piston prosthesis was used in both groups. Prosthesis length varied between 4 to 4.75 depending upon the surgical findings and diameter of used prosthesis was mostly 0.4 mm. Postoperative audiograms were obtained at 6 weeks and 9 months intervals. In all patients, 4-frequency Pure Tone Average (4-PTA) was measured for both air and bone conduction. ABG [(air conduction threshold)-(bone-conduction threshold)] was calculated at 500, 1000, 2000, and 3000 Hz. Means of preoperative pure tone average of Air Conduction (AC), ABG at 0.5, 1, 2 and 3 (kHz), and Bone Conduction (BC) at 0.5, 1, 2 and 3 kHz were compared with corresponding post operative values (ex. AC variation=preoperative AC-postoperative AC). A successful result was considered to be a postoperative ABG of atleast 10 dB. Pre and post operatively all patients were asked about tinnitus and vertigo. Intraoperative complications (floating footplate, fracture of the footplate, subluxation of the ossicular chain, perforation of tympanic membrane and perilymphatic gusher) and acute/late postoperative complications (dysgeusia, facial palsy, vertigo and hypoacusis/ deafness) were recorded [7].

Results and Discussion

Majority of the patients in both the groups were females, aged between 30 and 50 years with duration of hearing loss less than 10 years. All 40 patients had bilateral hearing loss [8]. Teflon piston was used in all cases with both the techniques (**Table 1**).

Piston	Conventional (n=20)	CO_2 laser
Teflon	20	20

Table 1: Type of piston used.

Most commonly used piston length and diameter with both the techniques were 4.5 mm and 0.4 mm respectively (**Table 2**).

Fenestration by perforator N=20			CO_2 laser N=20
Length (mm)	4	3	2
	4.25	6	7
	4.5	8	9
	4.75	3	2
Diameter (mm)	0.4	14	16
	0.5	4	3
	0.6	2	1

Table 2: Length and Diameter of piston used in patients.

The ABG gain in LS and CS groups was comparable at each frequency with better gain at low frequencies. There was a statistically significant (calculated p value <0.00001 at <0.0) reduction in ABG following surgery in both groups at frequency of 500,1000, and 2000 Hz. Paired t test were used for statistical analysis (**Table 3**) [9].

Technique	Pre-operative ABG (Mean ± SD) in dB	Post-operative ABG (Mean ± SD) in dB	Gain (Mean ± SD) in dB
Conventional	47.2 ± 5.25	21.8 ± 4.64	25.3 ± 5.15
CO_2 laser	48.53 ± 3.5	16.5 ± 2.29	32 ± 3.85

Table 3: Difference between ABG Pre and post operatively.

There was minimum difference in ABG post operatively at 6 weeks and 9 months follow up. 6 monthly Audiograms of some patients (treated later in this study design) are included in results as the hearing outcomes were better on follow up [10]. Compared to a study, patients (40) treated with CO_2 laser stapedotomy had better air-bone gap closure than the control group (40), with 6 months follow-up 82.6% had <10% ABG closure while in control group it was 75.3%. Vertigo and Chances of footplate fracture were higher in conventional technique. The post stapedotomy ABG closure between the CO_2 laser and perforator techniques, it favored the later for better hearing outcome. Though vertigo and footplate fracture incidence were significantly higher with perforator. The comparison of outcomes after using CO_2 laser and drill for stapedotomy, vertigo were seen more with laser technique while none of the patients had footplate fractures. Here, our study suggests that LS yields better results as compared with conventional stapedectomy in treatment of otosclerosis as there is a minimum difference in AB gap closure between the two techniques with CO_2 laser technique showing better improvement in hearing. All patients in laser and conventional group had ABG closure within 10 dB at the end of 6^{th} week which was confirmed by an audiogram at 9^{th} month of surgery. There are increased risk of footplate fractures and SNHL following the use of perforator. While no footplate complication or sudden deafness were recorded in patients treated with laser. Few cases of temporary vertigo and postural instability were found in cases with conventional technique. No cases of postoperative dysgeusia (due to the removal of chorda tympani) were recognized. The above considerations were made taking into account the limited size of our sample, according to functional results, lack of long-term outcomes and complications incidence as important aspects of stapes surgery.

Conclusion

From our study it can be concluded that CO_2 laser technique has shown better hearing outcome and is considered to be safer than conventional method in view of intra operative complications like footplate fractures as it offers formation of a symmetric hole with minimum inner ear mechanical trauma due to its non-touch technique. Also incidence of post-operative vertigo, vomiting and tinnitus are less with laser as compared to conventional technique. Though availability, surgeon's skills and cost of CO_2 laser still are the drawbacks.

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