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Argon laser assisted small fenestra stapedotomy for otosclerosis

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Abstract

To report and analyse our results and complications of argon laser assisted stapedotomy for primary otosclerosis. A retrospective analysis of 135 consecutive cases of primary otosclerosis operated by the senior author (JH) has been performed. The air–bone gap was calculated by using the pure tone average at 500, 1000, 2000 and 4000 Hz. A separate analysis of air–bone gap at 500, 1000 and 2000 Hz was carried out to assess the effects of a small diameter piston on low frequency hearing. Hearing at high frequencies (4000 and 8000 Hz) was also assessed to evaluate effects of small fenestra technique on high frequency hearing. Preservation of cochlear function was assessed by comparing the average pre- and post-operative bone conduction thresholds. Complications arising were analysed. The post-operative air–bone gap at 0.5, 1 and 2 kHz was 10 dB or less in 85.19% of patients and 20 dB or less in 97.04% patients. The air–bone gap at 0.5–4 kHz was $\leq$10 dB in 77.04% of patients and 20 dB or less in 97.04% patients. The majority of patients showed an improvement at 4 kHz (81.4%) and 8 kHz (60.7%). There was no change in the average pre- and post-operative bone conduction thresholds. There were no major complications. Argon laser reduces mechanical trauma to the vestibule and increases precision resulting in consistent hearing results in all frequencies and reduced post-operative morbidity.

Keywords: Otosclerosis; Stapedectomy; Laser

1. Introduction

Stapedectomy is one of the standard treatments advocated for the conductive hearing loss of otosclerosis. The technique originally described by Shea [1] consisted of removal of the stapes, including all or part of the footplate and insertion of a prosthesis to reconstitute the ossicular chain. Over the years, technical innovations, primarily in the form of the small fenestra technique and the availability of prosthesis have contributed towards improved outcomes in stapes surgery. Coincident with discussion of the advantages of large versus small oval window fenestra, [2–4] debate concerning the best method to create the fenestra itself continues [5–7].

Laser as a tool for performing stapedotomies in otosclerosis surgery has been in use over the last two decades. The use of lasers in otosclerosis was introduced in 1980 by Perkins [8] who reported good hearing results in 11 patients undergoing stapedotomies with the argon laser. In 1983, McGee [9] compared the results of small fenestra stapedotomy for otosclerosis using the argon laser with those using manual microsurgical techniques. Although at 6 months and at 1 year, the hearing results were similar, greater accuracy and reduced surgical trauma with the laser were definite advantages reported by McGee.

Lesinski [10] reported experimental and clinical data using a carbon dioxide (CO_2) laser. He compared experimental results with argon and KTP-532 lasers. Based on experimental data, he recommended using the newer CO_2 lasers, however, he also stated that the argon and KTP-532

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lasers could be used with caution on the footplate. Subsequently, Gherini et al. [11] studied the thermal effects of argon laser on a cadaver stapes and vestibule and reported no significant temperature elevations within the vestibule. To further clarify clinical use of the argon laser, a review of our experience using the argon laser in stapes surgery is presented here.

2. Materials and methods

The argon laser was used in 135 consecutive primary stapes surgical procedures over an 18-month period. Revision procedures were excluded from the study. Only those patients with at least a 3 months follow-up audiogram were included for analysis. The air–bone gap was calculated by using the pure tone average at 500, 1000, 2000 and 4000 Hz. A separate analysis of air–bone gap at 500, 1000 and 2000 Hz was carried out to assess the effects of a small diameter piston on air–bone gap closure in the low frequencies. The most recent post-operative air thresholds were compared to the post-operative bone thresholds, to calculate the air–bone gap. Hearing at high frequencies (4000 and 8000 Hz) was analysed by comparing the post-operative air conduction thresholds with the pre-operative air conduction thresholds to evaluate effect of small fenestra laser assisted stapedotomy on high frequency hearing. The average pre- and post-operative bone conduction thresholds were compared to assess cochlear function. Post-operative complications were also analysed.

3. Surgical procedure

The coherent argon laser with the endo-otoprobe was used in all cases. The majority of cases (117) were done under local anaesthesia with intravenous sedation administered and monitored by an anaesthetist. Only 18 cases in anxious adults were carried out under general anaesthesia. Local anaesthesia was obtained using 1% lidocaine hydrochloride with 1:100,000 epinephrine. The ear canals were cleaned with chlorhexidene, povidone iodine and irrigated clear with physiologic saline solution.

A standard tympanomeatal flap was elevated with exposure of the middle ear. The scutum was curetted as necessary to gain exposure of the oval window region. On confirmation of the stapedial fixation by palpation, the incudostapedial joint was separated with a joint knife. The stapedial tendon and posterior crus were vaporised with the laser at settings of 2 W and 0.2 s pulse durations. The anterior crus was fractured onto the promontory for removal of the stapes superstructure. The laser power was reduced to 1 W and 0.1 s pulse duration for use on the footplate. Using two to three bursts from the laser, a spot was created on the posterior half of the footplate, just enough to see the first leak of perilymph from the vestibule. This opening was then further dilated with serial graded perforators 0.3–0.6 mm in diameter to achieve a stapedotomy 0.4 mm in diameter. A measuring rod (0.4 mm) in diameter was occasionally used to ensure the optimum diameter of the stapedotomy. A modified Cawthorne Teflon prosthesis of appropriate length (0.3 mm diameter) with a notch at 3 o'clock was used in all cases. A blood seal was commonly used around the prosthesis. The tympanomeatal flap was then replaced. The anterior and posterior canal wall was then lined with a strip of surgical rayon dressing lubricated with cortisporin and the ear canal packed with a 1/4" ribbon gauze covered with cortisporin ointment. The patient was seen the following day for removal of the packing and subsequently seen in a week's time for the initial post-operative hearing test. If satisfactory, the patient was then seen in 3 months time for a repeat audiogram. Audiograms were subsequently obtained at 6 monthly and yearly intervals.

4. Results

A total of 135 stapedotomy procedures for otosclerosis were performed in 129 patients. All the cases operated were available for analysis. The age range was 20–78 years with the women outnumbering men, 1.5:1. Thirty-five patients in this group were operated for their second ear, while six patients had surgery in both ears for otosclerosis.

The follow-up ranged from 4 to 24 months with an average of 10 months. The hearing results are presented in Figs. 1 and 2. The post-operative air–bone gap using 0.5, 1 and 2 kHz was within 10 dB in 115 patients (85.19%), 20 dB in 16 patients (11.85%) and greater than 20 dB in 4 patients (2.96%). Analysing the air–bone gap including 4000 Hz showed 104 patients (77.04%) with a gap $\leq$10 dB and 27 patients (20%) with a gap $\leq$20 dB. Only four patients (2.96%) showed a post-operative gap of 20 dB or more. Three of these cases have since undergone revision surgery for persistent conductive hearing loss. Two amongst them were found to have a slipped prosthesis and an isolated case with incus necrosis. All these cases have had good hearing results with revision surgery. The fourth case had a perilymph gusher and has been described with the complications. One hundred and ten cases (81.48%) showed

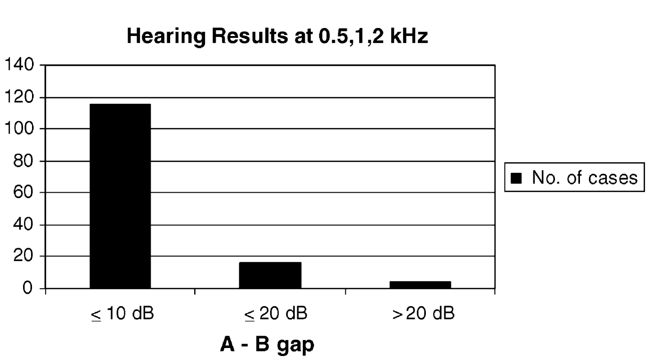

Fig. 1. Hearing results (A–B gap) at 500, 1000 and 2000 Hz.