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Original Article

Minimally traumatic stapes surgery for otosclerosis: Risk reduction of post-operative vertigo

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Abstract

Background: The author (Dr. Shiao) modified traditional stapes surgery (TSS) specifically for patients with otosclerosis. The proposed technique, referred to as minimally traumatic stapes surgery (MTSS), reduces the risk of subjective discomfort (i.e. vertigo and tinnitus) following surgery. This paper compares the effectiveness of MTSS with that of TSS.

Methods: The medical records of patients with otosclerosis after stapes surgery (TSS or MTSS) were analyzed. Outcome variables included post-operative vertigo, tinnitus, and hearing success. Multivariate logistic regression analysis was used to determine the correlation between surgical technique and outcome variables.

Results: TSS was performed in 23 otosclerosis ears and MTSS was performed in 33 otosclerosis ears. The risk of post-operative vertigo was significantly lower among patients that underwent MTSS (27%) than among those that underwent TSS (83%, $p < 0.001$). No differences in the incidence of tinnitus were observed between the two groups. Post-operative audiometric outcomes were also equivalent between the two groups. However, multivariate logistic regression analysis revealed a correlation between post-operative vertigo and surgical technique ($p < 0.001$).

Conclusion: MTSS involves a lower risk of vertigo than does TSS. MTSS helps to prevent damage to the footplate, thereby reducing the risk of footplate floating. Therefore, MTSS provides a means to overcome some of the limitations associated with the narrow surgical field in Asian patients.

Keywords: Footplate floating; Minimally traumatic; Otosclerosis; Stapes surgery; Vertigo

1. Introduction

Otosclerosis is a primary focal disease involving the bony labyrinth. It is among the best known and most easily manageable causes of conductive hearing loss in adult patients. Caucasians are most affected by clinical otosclerosis, with an incidence of 0.3−0.4%, which is approximately four times higher than that found in Asian populations.[1−4] According to data in the Taiwan National Health Insurance Research Database, an estimated 130 to 160 stapes surgeries are conducted each year among the 2.2 billion residents of Taiwan.[5]

Otosclerosis is treated exclusively using stapes surgery.[6] The evolution of stapes surgery involved the development of a variety of techniques to improve surgical outcomes.[1] However, most refinements to surgical techniques have been aimed

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

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at correcting hearing impairment, which has led to an over-emphasis on hearing performance.[2,7−12] A number of complications associated with post-operative quality of life, such as surgery-related vertigo and tinnitus, have not been comprehensively addressed.[13]

The author (Dr. Shiao) modified traditional stapes surgery (TSS), the conventional approach to otosclerosis treatment, to develop novel surgical techniques which reduce the risk of subjective discomfort (i.e. vertigo and tinnitus) among otosclerosis patients following surgery. The proposed technique is referred to as minimally traumatic stapes surgery (MTSS) and involves (1) the sequential modification of surgical steps used in traditional stapes surgery (TSS) as well as (2) the application of a CO_2 laser. This paper seeks to quantify the effectiveness of MTSS compared to TSS.

2. Methods

2.1. Patient data

We conducted a retrospective cohort study of 56 ears (53 patients) with otosclerosis. In all cases, stapes surgery was performed by the same surgeon (Dr. Shiao) between August 2010 and March 2015 at the Taipei Veterans General Hospital, a tertiary referral center in Taiwan. The diagnosis of otosclerosis was based on a clinical history of progressive hearing loss, normal otoscopic findings, and audiograms presenting conductive or mixed hearing loss. The absence of stapes reflex and normal tympanometry were compulsory for this diagnosis. The cochlear capsule was evaluated using high-resolution computed tomography (CT) to verify the occurrence of otosclerosis, and the clinical diagnosis was confirmed surgically as well as pathologically.

Among the 53 patients, 12 (23%) had a history of vertigo and 40 (75%) had a history of tinnitus. Nonetheless, all of the patients were free of vertigo and tinnitus preoperatively. Patients who underwent revision surgery, had insufficient audiometric data, or possessed incomplete follow-up data were not included in this evaluation. This study was approved by the Institutional Review Board of the Taipei Veterans General Hospital.

2.2. Surgical techniques

Fig. 1 and Video. Surgery was performed using an endaural procedure under general anesthesia. For this, the tympanomeatal flap was elevated and the chorda tympani nerve was identified and preserved. With TSS, the incudo-stapedial joint was separated with a joint knife and the stapedial tendon was cut with scissors, then the anterior and posterior crus with footplate were down-fractured with a microhook and removed. A fenestra of 0.7 mm in diameter was made at the junction of the posterior one-third and anterior two-thirds of the footplate with a microdrill. A piston was inserted into the 0.7-mm hole on the footplate.

Supplementary video related to this article can be found at https://doi.org/10.1016/j.jcma.2017.08.022.

In 2012, Dr. Shiao modified the procedures of TSS due to the high risk of instability of the footplate (e.g. footplate floating) associated with fracturing the stapes arch. Footplate floating can cause post-operative vertigo and/or sensorineural hearing loss. TSS was modified as follows: The stapes tendon and posterior crus were first vaporized using a CO_2 laser (Fig. 1A and B). Specifically, single-pulse laser power of 2−3 W was applied to the stapes tendon, whereas laser power of 3−5 W was applied to the posterior crus. After the oval window was identified, a few laser spots (single pulse, 2−3 W) were directed at the lower half of the footplate (Fig. 1C and D), whereupon a fenestra (0.7 mm in diameter) was made in the same area using a microdrill (Fig. 1E). A piston was then inserted into the 0.7-mm hole on the footplate (Fig. 1F and G), and the incudo-stapedial joint was separated to facilitate the removal of the anterior crus of the stapes (Fig. 1H and I). Since 2012, all ears presenting otosclerosis at the hospital have been treated using MTSS.

For ears treated in this study, the length of prostheses was 4.25 or 4.5 mm and the diameter of prostheses was 0.5 or 0.6 mm. The piston wire loop was either crimped manually using a McGee crimper (conventional piston) or secured to the long process of the incus by applying heat using a Gyrus SMart heat applicator (Nitinol piston). A small number of tiny connective tissue plugs were used to seal the piston−footplate

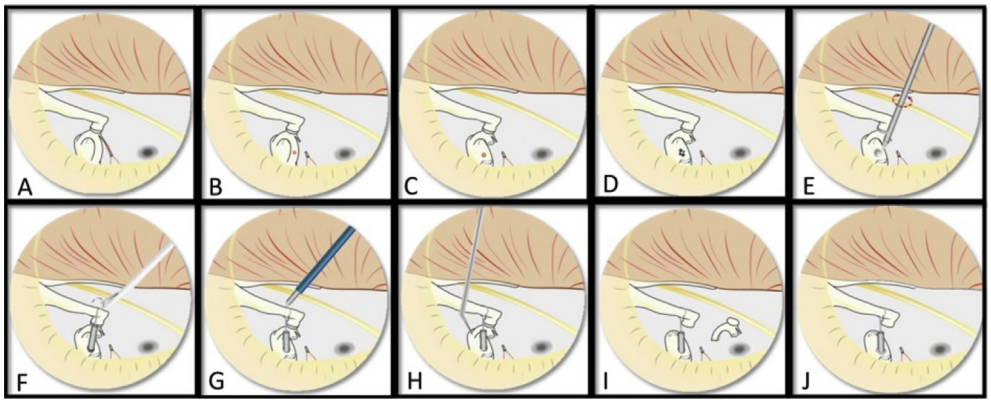

Fig. 1. Surgical steps involved in minimally traumatic stapes surgery. (A) middle ear. (B) the stapes tendon and posterior crus vaporized using a CO_2 laser. (C and D) laser spots directed at the lower half of the footplate. (E) a fenestra made at the footplate using a microdrill. (F and G) a piston inserted into the fenestra of the footplate. (H-J) the incudo-stapedial joint separated to facilitate the removal of the anterior crus of the stapes.

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