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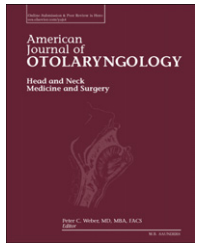

Round and oval window reinforcement for the treatment of hyperacusis

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ABSTRACT

Purpose: To present the outcomes of two patients (three ears) with hyperacusis treated with round and oval window reinforcement.

Materials and methods: Transcanal placement of temporalis fascia on the round window membrane and stapes footplate was performed. Loudness discomfort level testing was performed. Results of pre and post-operative hyperacusis questionnaires and audiometric testing were reviewed.

Results: Two patients (three ears) underwent surgery. Results from the hyperacusis questionnaire improved by 21 and 13 points, respectively. Except for a mild loss in the high frequencies, no change in hearing was noted post-operatively. Both patients reported no negative effects from surgery, marked improvement in ability to tolerate noise, and would recommend the procedure to others. There were no complications.

Conclusions: Round and oval window reinforcement is a minimally invasive option for treating hyperacusis when usual medical therapies fail. Further studies are needed to evaluate the effectiveness of the procedure in reducing noise intolerance.

1. Introduction

Hyperacusis, defined as noise intolerance to ordinary sounds, is a challenging problem encountered by otolaryngologists. Patients often present with emotional (anxiety, stress, depression), social (isolation, limitation in activities), and physical (pain, discomfort) symptoms. Individuals with hyperacusis suffer from a reduced quality of life, due to anxiety and noise-related avoidance in daily activities [1]. Although individuals with hyperacusis report varying degrees of intolerance to sound, the primary complaint is a physical and/or psychological reaction to sound. The physical properties of certain sounds elicit negative reactions in patients with hyperacusis which do not evoke an adverse reaction in an average listener [2]. The reported prevalence of hyperacusis ranges from 5.9% to 17.2%, depending on the definition of hyperacusis used and whether individuals with hearing loss are excluded in various studies [3,4].

The mechanism of hyperacusis is not completely understood, but has been related to acoustic overexposure resulting in increased gain within the central auditory pathways [5,6]. Contributing factors include a history of head trauma or acoustic trauma, hearing loss, and aging [7,8]. Hyperacusis is often accompanied by tinnitus and vice versa [9,10]. While tinnitus may arise from failure of the brain to adapt to deprived peripheral input, hyperacusis is thought to be related to an "over-adaptive" increase in response gain, as a result of afferent neuronal degeneration of auditory fibers [8].

Current commonly used treatment options for hyperacusis include avoidance of provocative stimuli, cognitive behavioral

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therapy, tinnitus retraining therapy, hearing amplification devices, and gradual sound exposure using wideband noise generators, with varied rates of success [2,11]. Although no surgical technique exists specifically for the treatment of hyperacusis, surgical intervention has been found to improve hyperacusis in patients with superior semicircular canal dehiscence (SSCD). Silverstein et al. found round window reinforcement to be an effective and minimally invasive surgical option for reducing the symptoms of SSCD [12,13]. Nikkar-Esfahani et al. noted an improvement in noise tolerance in patients with SSCD chiefly complaining of hyperacusis who underwent complete surgical occlusion of the round window [14]. Complete resolution of hyperacusis has also been reported in a case of unilateral posterior and superior canal dehiscence treated with transmastoid plugging of both defects [15].

The success of round window reinforcement in improving hyperacusis in patients with SSCD led the senior author to realize the potential benefits of performing a similar procedure in patients with a chief complaint of hyperacusis without evidence of SSCD. This paper reports the outcomes of two patients (three ears) with no evidence of SSCD, who underwent transcanal round and oval window reinforcement for the treatment of hyperacusis.

HYPERACUSIS QUESTIONNAIRE

*Please read each item below and rate it based on the Four-Point Scale.	0 NEVER Correct	1 SOMETIMES Correct	2 OFTEN Correct	3 ALWAYS Correct
1. Sounds that didn't disturb me earlier frighten me now.	❑	❑	❑	❑
2. I worry that I will never succeed in getting used to loud/uncomfortable sounds.	❑	❑	❑	❑
3. I cannot listen for a long time when I am surrounded by loud/uncomfortable sounds.	❑	❑	❑	❑
4. Because of my hypersensitivity to sound, there is tension between my partner and/or my family and myself.	❑	❑	❑	❑
5. I have to avoid certain sounds.	❑	❑	❑	❑
6. I am very scared of noise.	❑	❑	❑	❑
7. I think the hypersensitivity to sound has ruined my life.	❑	❑	❑	❑
8. When surrounded by a lot of sounds, I don't understand anything.	❑	❑	❑	❑
9. Other people distance themselves from me because I can't stand loud/uncomfortable sounds.	❑	❑	❑	❑
10. I am annoyed by sounds that are too loud/uncomfortable for me.	❑	❑	❑	❑
11. Loud/uncomfortable sounds cause physical pain in my ears.	❑	❑	❑	❑
12. I believe I won't be able to cope in everyday life if hypersensitivity to sound continues to be this bad.	❑	❑	❑	❑
13. I immediately withdraw when there are loud/uncomfortable sounds.	❑	❑	❑	❑
14. I am afraid that loud/uncomfortable sounds damage my hearing.	❑	❑	❑	❑
15. Since becoming hypersensitive to sound, I no longer enjoy music.	❑	❑	❑	❑

Date_____ Last Name _____ First Name _____

Fig. 1 – Validated hyperacusis questionnaire.

2. Methods

2.1. *Loudness discomfort level testing*

Loudness discomfort level (LDL) testing was performed after establishing pure tone thresholds at 250, 500, 1000, 2000, 3000, 4000, and 8000 Hz. Sound stimuli was presented starting at 60 dB HL and increased in increments of 5 dB HL. As the tone approaches the uncomfortable loud level, the step size is decreased in order to determine the LDL with a 1 dB resolution. This process is performed twice at each frequency, and the average of the two LDLs is recorded. The normal reference level for the LDL is traditionally accepted to be at 100 dB HL, although normal hearing individuals have been found to have LDLs between 86 and 98 dB HL [16].

The patients completed a validated hyperacusis questionnaire to rate the severity of their pre-operative and post-operative symptoms (Fig. 1) [17].

2.2. *Surgical technique*

Under general anesthesia, transcanal round window niche and oval window reinforcement was performed using a traditional transcanal tympanomeatal flap approach. If needed, the bony posterior canal was enlarged using a high-speed drill or curette to allow visualization of the ossicular chain, round window niche, chorda tympani, horizontal facial nerve, and hypotympanum. The bony lip overlying the round window niche was also removed with a one millimeter diamond drill for further exposure of the round window membrane. Temporalis fascia was obtained through a 2 cm incision above the auricle and small pieces were gently placed against the round window membrane and the stapes footplate (Figs. 2 and 3), and held in place with gelatin foam (Gelfoam). A 3 mm biopsy punch can be used to cut the fascia for the round window niche, and a 2 mm biopsy punch can be used to cut the fascia for placing over the stapes footplate. Following reinforcement, the tympanomeatal flap was repositioned and the external auditory canal was packed for one week with polyester packing strips and a small sponge.

2.3. *Patient 1*

A 64-year old male presented with a several-week history of positional vertigo consistent with benign paroxysmal positional vertigo. He was successfully treated with an Epley maneuver. On further questioning, he also reported an 18-year history of noise

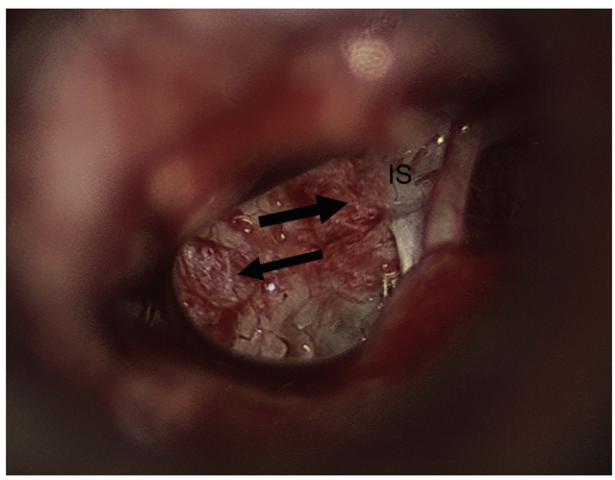

Fig. 2 – Left ear, transcanal approach. Temporalis fascia is covering the round window niche (small arrow) and the stapes footplate (big arrow). Incudostapedial joint (IS).