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Round-Window Microcatheter–Administered Microdose Gentamicin: Results from Treatment of Tinnitus Associated with Menière's Disease

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Abstract: In this study, we review the results of Menière's disease treatment using microdose gentamicin delivered directly to the round window using the Round Window Microcatheter (IntraEar, Inc., Denver, CO). A total of 18 patients were studied, with follow-up ranging from 6 to 18 months. In 15 of 18 patients (83%), tinnitus was improved significantly throughout the follow-up period. Vertigo was eliminated in all patients, and pressure was relieved in 17 of 18 (94%). These preliminary data suggest that Round Window Microcatheter–delivered gentamicin is a safe and effective treatment for the reduction of tinnitus, vertigo, and pressure associated with Menière's disease.

Often, the treatment of Menière's disease refractory to medical therapy requires surgical intervention. In patients with intact hearing, endolymphatic sac surgery and vestibular neurectomy are two approaches used commonly. In the last several years, transtympanic gentamicin has been gaining in popularity for the treatment of Menière's disease [1, 2].

Much has been written about each of these therapeutic approaches, focusing on vertigo control and hearing preservation. However, little information is available regarding tinnitus control or cure rates in these studies. Recently, we have been using a new treatment modality for Menière's disease that is refractory to medical therapy. This treatment, which uses a sustained-release device (Round Window Microcatheter (Round Window μCath), IntraEar, Inc., Denver, CO) to deliver microdoses of gentamicin to the inner ear through the middle ear, has proved highly successful in the treatment of many symptoms of Menière's disease.

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MATERIALS AND METHODS

Eighteen patients underwent treatment with the Round Window Microcatheter between July 1997 and July 1998. All patients had Menière's disease that was refractory to medical therapy, and all were having vertigo attacks at least twice weekly. All patients reported significant subjective tinnitus.

In our institution, each patient undergoes a baseline testing battery consisting of a standard audiogram, ultra-high-frequency audiogram, otoacoustic emissions, rotational chair testing, high-speed head rotation testing, posturography, and psychophysical scaling of symptoms of vertigo, pressure, and tinnitus. This baseline test battery is conducted several times before operative intervention and then is administered every other day while the catheter is in place (10 days). Then the battery is repeated weekly for several weeks after treatment concludes and then several times a year after the immediate posttreatment period. At each of these evaluations, a tinnitus score is given, which ranges from 1 to 10 (1 signifying almost no tinnitus and 10 signifying extremely severe, almost unbearable tinnitus).

The catheter is placed under general anesthesia. A tympanomeatal flap is raised, and the round-window niche is identified. Any adhesions in the niche are removed, and the niche is sized to determine the appropriate catheter diameter (1.5, 2.0, or 2.5 mm). The catheter is brought into the field and is secured in the round-window niche. After the catheter is properly in place, 1.25 mg of gentamicin (0.125 ml of a 10-mg/ml solution) is instilled into the catheter. The tympanomeatal flap is returned to place, and an expandable sponge is used to secure the catheter in the external ear. Several sutures are placed to direct the catheter behind the ear.

At this point, two options for gentamicin instillation are possible. A manual technique (used with our first 11 patients) consists of two injections of 1.25 mg gentamicin on postoperative days 3 and 7. In the patients more recently admitted to the series, a minipump (Disetronics, Inc., Irvine, CA) is attached to the catheter at the conclusion of surgery and is set to pump 1 μl/hr for 10 days. In both cases, the patient receives 3.5–4.0 mg gentamicin (10 mg/ml) over the 10 days on which the catheter is in place. The catheter is removed in the clinic, and the eardrum is allowed to heal.

After the conclusion of the treatment and the immediate postoperative data collection, we analyze several outcome variables to determine a preliminary treatment outcome. These variables include vertigo control, disequilibrium, objective vestibular function, disability scores, hearing level, aural fullness, and tinnitus. Tinnitus outcome is determined by comparing average pretreatment tinnitus level to average posttreatment level. A reduction of three points arbitrarily is termed a significant reduction in tinnitus.

RESULTS

Eighteen patients were treated in the first year. Follow-up ranged from 6 to 18 months. Eleven patients were treated with the catheter alone, and seven patients were treated with both the catheter and a pump. In 83% (15 of 18 patients), vertigo was eliminated from the day the catheter was removed, and vertigo was absent in all the patients on the most recent follow-up. One patient (5.6%) had a hearing loss of more than 10 dB at two frequencies; otherwise hearing remained stable. Pressure was eliminated in 17 patients (94%). No patient had a reduction in objective vestibular function. No patient has a persistent eardrum perforation.

In all patients, the tinnitus remained stable from 1 week after treatment until the most recent follow-up. All patients reported a tonal quality in the tinnitus; 83% (15 of 18 patients) report a significant reduction ($>$ 3 points) in tinnitus, comparing posttreatment to pretreatment tinnitus. All these patients had tinnitus that registered 3 or less on a scale of 1–10. In the three patients who did not have a 3-point reduction, two had unchanged tinnitus, and one had a nonsignificant reduction.

DISCUSSION

Little is written about the effects of surgical intervention on tinnitus in Menière's disease. The reporters of several large series in which the results of surgical treatment or transtympanic gentamicin were discussed made no comment regarding tinnitus results [3–5]. This lack of reporting on the influence of treatment on tinnitus may be attributable to several factors. First, the fluctuating and subjective nature of tinnitus in Menière's disease renders study difficult. Second, the fact that most surgical interventions are directed at controlling vertigo and preserving hearing means that investigators focus on these two parameters. Finally, these other treatments have little effect on tinnitus.

In our microcatheter group, studying tinnitus was easier, because tinnitus was constant in our patients after treatment and was severe in most of them before treatment. We compared our outcome to that in a group of 10 patients who underwent transtympanic injection of gentamicin at our center. All those patients have more than 2 years' follow-up since treatment. In that group, using our same criteria, only 30% had a significant reduction in tinnitus. A significant difference ($p < .05$) was seen between that group and our microcatheter patients. Interestingly, the tinnitus from Menière's disease frequently is believed to be a low-frequency tonal sound. The pretreatment and posttreatment tinnitus in our patients was tonal, but we observed no significant difference between the number of patients reporting high-frequency and low-frequency tones either before or after the operation.

The explanations for the tinnitus associated with Menière's disease are varied. Shulman [6] has postulated that changes in ionic concentration caused by the mixing of endolymph and perilymph could cause potassium intoxication of the hair cells. This condition would result in contraction of the outer hair cells and a pulling down of the tectorial membrane toward the basilar membrane, with resultant effect on the inner hair cells. This effect would be manifest by spontaneous (but nonsynchronous) firing of these inner hair cells [6]. If this explanation or some variation accounts for the tinnitus, we could explain our high rate of tinnitus control. All our patients reported vertigo elimination, and more than 90% reported a reduction of pressure; however, no patients have shown a decrease in vestibular function. To explain this finding, we must postulate an effect from our treatment modality result-

ing from other than hair cell function. Perhaps if our treatment effects fluid production at the dark-cell level, the hydrops is reduced and therefore the mixing of perilymph and endolymph is eliminated or reduced.

Alternatively, some have reported that an improvement in symptoms (vertigo) with a resultant improved sense of well-being may be responsible for a reduction of other Menière's symptoms in patients after treatment. Of course, determining the exact mechanism responsible for the reduction of tinnitus in our treatment is difficult. In addition, we suspect that this 83% improvement rate is better than that achieved with other surgical treatment options.

CONCLUSION

Round-Window Microcatheter–administered microdose gentamicin is an exciting new treatment for Menière's disease. Preliminary data suggest that this treatment is an effective and safe method for controlling the tinnitus associated with Menière's disease. In addition, the treatment appears to control vertigo without a reduction in vestibular function and significantly to reduce pressure symptoms. This outcome is significantly better than that resulting from our previous group of patients treated with transtympanic gentamicin. We postulate that this difference may be due to an effect of the microdose gentamicin other than that of hair cell function. Work that is under way in our laboratory will examine this theory. Longer follow-up and work at other centers are needed to confirm these data.

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