The Effects of Transtympanic Micropressure Treatment in People With Unilateral Ménière’s Disease

George A. Gates, MD; J. Douglas Green, Jr, MD; Debara L. Tucci, MD; Steven A. Telian, MD

Objective: To evaluate the efficacy of a portable low-intensity alternating pressure generator, the Meniett device, in controlling the symptoms of Ménière’s disease.

Design: A randomized, placebo-controlled, double-blind, multicenter clinical trial of 4 months’ duration.

Setting: Four study sites: 3 academic medical centers and 1 private practice.

Patients: Sixty-seven people aged 33 to 71 years with established, active, unilateral cochleovestibular Ménière’s disease randomly assigned to a treatment or control group. Five cases were excluded (2 dropouts, 3 protocol violations), leaving 62 evaluable cases.

Intervention: The Meniett device was self-administered 3 times daily. The placebo Meniett device was identical but exerted no pressure. All participants had a tympanostomy tube inserted in the affected ear.

Main Outcome Measures: Participants rated vertigo and activity each day on a symptom report card. Hearing tests, electrocochleography, and questionnaires were completed at baseline, 2 months, and 4 months.

Results: The treatment group experienced significantly less severe vertigo, fewer days with definitive vertigo, and fewer days lost from work (sick days) during the follow-up period than did the control group. Hearing and electrocochleographic results did not differ between the groups. Outcomes did not differ by age, gender, laterality, or duration of symptoms. Outcomes were affected by vestibular loss and baseline level of vertigo. The tympanostomy tube had no short-term effect on vertigo symptoms. There were no complications from using the Meniett device.

Conclusion: The Meniett device is a minimally invasive, safe, and efficacious intermediate treatment for people with substantial vertigo uncontrolled by medical therapy.

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MÉNIÈRE’S DISEASE IS THE most prevalent cause of recurring attacks of spontaneous vertigo associated with fluctuant hearing loss, tinnitus, and pressure in the affected ear. The vertigo attacks are often incapacitating and may lead to chronic vestibular dysfunction and disequilibrium. In the early stages, hearing may improve between attacks, but an irreversible hearing loss occurs in the majority of cases. The unpredictability of vertigo attacks contributes additional stress, which may further exacerbate the condition. The high prevalence of Ménière’s disease in the United States (218 cases per 100,000 population) and time lost from work impose a considerable burden on those affected, their families, and employers and a significant cost to society.

The etiology of Ménière’s disease is unknown and its clinical course is cyclical and unpredictable. For about 70% of patients the vertigo attacks diminish with time. About 30% have unrelenting vertigo despite medical therapy and may require substantial use of health care resources to control their symptoms. Endolymphatic sac surgery has been a controversial but nondestructive option for such cases. However, unilateral vestibular ablation techniques (intratympanic gentamicin, vestibular nerve section, or labyrinthectomy) are more predictable but invasive methods to control the vertigo attacks.

A distended scala media (ie, endolymphatic hydrops) is the histopathologic hallmark of Ménière’s disease. Medical therapy aimed at decreasing endolymph volume (low-sodium diet, diuretic use) is the standard initial treatment. None of the current medical or surgical treatments can be expected to improve hearing. The lack of a specific, nondestructive...
tive method to control vertigo and possibly restore hearing has stimulated continuing research.

The common observation that changes in ambient pressure improve Ménière’s symptoms suggested a new approach to therapy.8 Densert et al9 demonstrated reduced symptoms and improved electrocochleographic findings in a randomized, blinded study using intermittent overpressures from a portable, low-intensity, alternating-pressure generator, the Meniett device. In a randomized, placebo-controlled clinical trial, Odkvist et al10 demonstrated greater relief of vertigo, better functionality, and improved hearing over 2 weeks with the Meniett device in 31 treatment participants compared with 25 controls. Densert and Sass11 described the favorable 2-year results of the Meniett device. In 1999 the US Food and Drug Administration cleared the Meniett device for sale as a Class II medical device.

We report the results of a clinical trial designed to evaluate the efficacy of the Meniett device in treating people with uncontrolled vertigo due to unilateral Ménière’s disease.

METHODS

EXPERIMENTAL DESIGN

This prospective, randomized, double-blind, placebo-controlled, multicenter, efficacy clinical trial had 2 arms: a treatment group, which used an active Meniett device (Medtronic Xomed Inc, Jacksonville, Fla), and a control group, which used an identical device that did not generate pressure as a placebo. Outcome assessments were done at monthly intervals for 4 months. The 4-month study period was established by the investigators as a priori time in which to ascertain treatment efficacy while considering fiscal prudence and participant compliance. Funding was provided by Medtronic Xomed as an unrestricted grant to each of the 4 study centers: University of Washington, Seattle; Jacksonville Hearing and Balance Institute, Jacksonville; Duke University, Durham, NC; and University of Michigan, Ann Arbor. Participants received no compensation. All study procedures were paid by these grants.

The protocol was approved by local institutional review boards. All participants gave informed consent. The study was conducted in compliance with the protocol, good clinical practices, and applicable regulatory requirements.

PARTICIPANTS

The study participants were 33 to 71 years old and had a clinical diagnosis of active, definite, unilateral cochleovestibular Ménière’s disease causing disruptive levels of vertigo (at least 2 definitive attacks per month for the 2 months prior to entering the study) despite at least 3 months of treatment with a low-sodium diet, with or without diuretics. Additional entry criteria were (1) documented low-frequency sensorineural hearing loss and a history of fluctuating hearing, (2) functionality level of 2 to 4,11 (3) normal auditory brainstem responses, and (4) an abnormal electrocochleogram in the affected ear, ie, SP/AP click ratio of greater than 0.39 or a toneburst SP of 2.0 µV or larger. Duration of disease was not an entry criterion. The median duration of symptoms was 4.5 years (interquartile range, 2-7 years).

Eligible participants had their vestibular status measured to cross over into active Meniett therapy and be considered part of the 2-year follow-up. Data from participants failing before

esthesis in the outpatient clinic. Meniett use was delayed for 2 weeks to exclude a short-term effect of tube placement on symptoms.13 Participants were taught to verify tube patency with a Toynbee (closed nose swallowing) maneuver prior to each device use. Occluded or extruded tubes were replaced as needed.

Follow-up assessments were scheduled at monthly intervals. At the second and fourth visits, audiometry and electrocochleography were repeated. After all assessments were completed, the participant, surgeon-investigator, and study coordinator were unblinded. Participants who wished to continue Meniett therapy were given an active Meniett device and encouraged to report their symptoms and performance levels for 2 years.

The original sample size was set at 52. An interim power analysis halfway through the study suggested the need to increase the number by at least 10.

Treatment group assignment was done using a randomized block design (balanced for every 4 subjects) based on gender and normal/abnormal caloric test results. The Meniett manager at each site received the assignment from the study monitor and both recorded the coded treatment assignment and device serial number.

Participants and evaluators were blinded to the treatment assignment. The active and inactive devices were identical in appearance and both generated a similar clicking sound and light display during operation. The devices were sealed to assure integrity.

CLINICAL TESTS

Clinical audiometric and vestibular tests were obtained using equipment, spaces, and methods conforming to the American National Standards Institute.14

Symptom Report Cards. Participants indicated on the card the maximum level of vertigo, activity, stress, and Meniett use experienced that day. Vertigo-free days were scored as 0. Days with a mild attack were scored as 1. Moderately severe attacks lasting more than 20 minutes were scored as 2; severe attacks lasting an hour or more or accompanied by nausea or vomiting were scored as a 3. A level 4 attack was the worst attack ever experienced to date. A definitive vertigo day was any day with a vertigo score of 2, 3, or 4.

Activity level was scored in a similar manner on a 0-4 scale with 0 indicating no reduction in activity; 1 a minor and 2 a moderate reduction in activity without having to cancel a planned schedule; 3, having to stay at home, leave work, or cancel a planned schedule; and 4, being bedridden or largely incapacitated during that day. A canceled activity day (ie, sick day) was any day with an activity score of 3 or 4. Use of the cards began before the initial clinic visit to record baseline symptom levels during the 1-month prerandomization assessment period.

Pressure Generator. The Meniett low-pressure generator was used to deliver 0.6-second pressure pulses at 6 Hz within the range of 0 to 20 cm H2O to the ear canal through a polyethylene tube with a close fitting cuff. The 5-minute treatment sequence had 3 cycles, each with 1 minute of pressure pulses and 40 seconds of pause. Compliance with Meniett device use was evaluated by inspecting the electronically downloaded usage data each month.

Concurrent Medical Therapy. Participants were instructed in a 1500-mg/d sodium diet to optimize symptom control. Dietary compliance was not monitored. Participants were allowed to continue taking prestudy medications as needed.

Treatment Failure and Withdrawal. Failure status was indicated by self-declaration or having monthly vertigo scores of 50 or greater for 2 consecutive months. These participants were unblinded. Those in the placebo group were given the option to cross over into active Meniett therapy and be considered part of the 2-year follow-up. Data from participants failing before
the 4-month end point were calculated as of their time of last follow-up and carried forward for the entire follow-up period.

STATISTICAL CONSIDERATIONS

Primary and Secondary Outcome Measures

Vertigo is the chief symptom for which patients with Ménière’s disease seek relief. Because vertigo is a subjective sensation, there is no alternative to patient self-report. By requiring daily self-report in a standardized format, problems with recall and perceptual variations were minimized. Vertigo frequency and severity were extracted from the symptom card counting those days in which a level 2 or greater (ie, definitive) vertigo attack occurred. Vertigo was summarized in 2 ways: (1) vertigo severity—the monthly total of counting vertigo scores and (2) vertigo frequency—the proportion of counting vertigo days per time period.

The proportion of sick days, ie, activity level 3-4, was compared across groups for the 4-month study period. Hearing thresholds averaged across 0.25, 0.5, and 1.0 kHz and electrocochleographic results were compared across groups at the second and fourth visits.

Analysis Plan

Data distributions and bivariate associations were explored using standard techniques. The primary null hypotheses were that neither vertigo severity (hypothesis 1A) nor vertigo frequency (hypothesis 1B) differed across the 2 treatment groups. The secondary null hypotheses were that neither activity level (hypothesis 2) nor hearing (hypothesis 3) differed across the 2 treatment groups. The primary outcome variable, vertigo frequency (proportion of days with definitive vertigo over the 4-month study period), was entered in multivariate regression models to explore the relationships among treatment group, baseline morbidity, age, gender, site, and vestibular test results. The time course of the change in the frequency of vertigo and sick days was explored with repeated-measures analysis of variance (ANOVA). Statistical significance was set at P≤.05. STATA version 8.0 was used for data storage and analysis.13

RESULTS

PARTICIPANTS

Of 544 inquirers, 187 passed the telephone screening process. Sixty-seven people of 116 who completed the baseline eligibility testing met entry criteria and were randomly assigned to a treatment group. On average, the baseline testing took 2 months. Two participants withdrew before their first follow-up visit. Three participants were dropped because of protocol deviations: 1 because of a nonfunctioning tympanostomy tube and 2 because entry criteria were not satisfied on subsequent case review (bilateral Ménière’s in 1 case and an atypical labyrinthine disorder in 1 case). Sixty-two participants completed the 2-month follow-up evaluation and 57 participants completed the full 4-month follow-up. Five participants declared themselves failures at the 2-month evaluation and their data were allocated to the entire 4-month period even though they did not have a 4-month evaluation.

Figure 1 describes the flow of participants through the study. The recruitment process began in February 2002 and ended October 2002. The last participant completed the 4-month follow-up in April 2003. Sixty-one participants have chosen to participate in the 2-year long-term follow-up.

Table 1 shows the results of the randomization procedure and subject characteristics: there were no significant differences in age, gender, laterality, electrocochleographic status, hearing levels, vertigo severity, handicap score, diuretic use, symptom report card completion, and Meniñ device use across the 2 groups.

Table 1 also compares study compliance. The usage data downloaded from the device indicated no difference between the median (interquartile range) number of daily treatment applications between treatment (2.7 [2.4-2.9], n=30) and control groups (2.6 [2.4-2.8], n=32) (P=.43, Mann-Whitney U test). All follow-up visits were kept by all active participants and the mean duration of the blinded follow-up period was the same for both groups.

VERTIGO

Effect of the Tube

The proportion of days with definitive vertigo was compared over the 2 weeks before and after tympanostomy tube insertion to determine if tube presence might have affected symptoms. The median (interquartile range) proportion of vertigo days for all 62 subjects during each 2-week period was 0.13 (0.07-0.36) for pre–tube placement vs 0.21 (0.07-0.36) for post–tube placement; this difference was not statistically significant (P=.34, Mann-Whitney U test).

Effect of the Meniñ Device

Figure 2 displays the total definitive vertigo by group for the baseline month and the 4 follow-up months. There was a decline in the monthly total vertigo severity in the treatment group by the first month that continued to de-
crease each month. The control participants began to have fewer vertigo days after the first month. A repeated-measures ANOVA with total definitive vertigo score per month as the dependent variable and treatment group and treatment month as the predictor variables was significant for treatment group (P = .03) but not for treatment month (P = .053). Thus, null hypothesis 1A, that vertigo severity does not differ between groups, is rejected.

Table 2 compares the proportion of days with definitive vertigo across the 4 follow-up months between the treatment and control groups. The Mann-Whitney U test is significant (P = .048). Thus, null hypothesis 1B, that vertigo frequency does not differ between groups, is rejected.

Table 3 displays the frequency of definitive vertigo attacks by month for each group. A repeated-measures ANOVA demonstrated that the mean vertigo frequencies observed for both treatment month and treatment group were statistically significantly different (see Table 3 legends for details). This indicates that both groups improved over time, and, further, that the intergroup comparison noted in Table 2 are still significantly different taking time into account.

Effects of Vestibular Weakness and Disease Severity on Vertigo

Table 4 displays the results of the multivariate linear regression in which the effect of treatment group, baseline proportion of vertigo days, and degree of vestibular loss on vertigo frequency are evaluated. This analysis shows significant and independent effects of group, baseline vertigo level, and vestibular sensitivity upon vertigo frequency (F3,59 = 5.28, P = .03). Overall, the use of the Meniett device decreased the proportion of days with definitive vertigo by about half. There was no difference in vertigo outcome based on gender, affected ear, age, duration of symptoms, study site, or medication use. These results are displayed in Figure 3.

The effects of loss of vestibular function (as measured by the bithermal caloric test) and prestudy level of vertigo upon the proportion of vertigo days (see Table 4 for coefficients and significance levels) are displayed in Figure 3. Figure 3A shows that people with more pre-treatment vestibular loss had better outcomes, more for the treatment than the control group except at the highest vestibular loss levels. In Figure 3B, a differential effect of the device is evident, showing a greater treatment effect in participants with greater baseline levels of vertigo. Controls with high baseline levels of vertigo had the least amount of spontaneous remission. In contrast, the Me-
niet device showed a larger effect in cases with high baseline vertigo levels.

**Treatment Failures**

Four control and 1 treatment group participants declared themselves study failures. No participant was ruled a failure by the investigator because of excessively high vertigo levels. There were no differences in age, gender, vestibular function, or prestudy levels of vertigo between the 5 failure participants and the remainder of the group.

Twelve participants, 9 control and 3 treatment, experienced more vertigo days over the follow-up period than they did at baseline. There was no difference in age, gender, vestibular function, or baseline vertigo levels between these 12 participants and the remainder of the group.

Table 2. Comparison of Proportion of Days With Definitive Vertigo and Sick Days During 4-Month Follow-up Between Groups*

<table>
<thead>
<tr>
<th>Outcome Variable</th>
<th>Group</th>
<th>All 4 Months</th>
<th>P Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of days with definitive vertigo, median (25th-75th percentile)</td>
<td>Control (n = 32)</td>
<td>0.13 (0.06-0.18)</td>
<td>.048</td>
</tr>
<tr>
<td></td>
<td>Treatment (n = 30)</td>
<td>0.07 (0.03-0.13)</td>
<td></td>
</tr>
<tr>
<td>Proportion of sick days, median (25th-75th percentile)</td>
<td>Control (n = 32)</td>
<td>0.02 (0.00-0.04)</td>
<td>.02</td>
</tr>
<tr>
<td></td>
<td>Treatment (n = 30)</td>
<td>0.00 (0.00-0.01)</td>
<td></td>
</tr>
</tbody>
</table>

*Hypotheses 1B and 2: The cumulative median proportion of days with definitive vertigo and the cumulative median proportion of sick days across all 4 months of follow-up does not differ between treatment and control groups.

†Mann-Whitney U test comparing between-groups cumulative proportion across all 4 months of follow-up rejects both null hypotheses.

Table 3. Frequency of Definitive Vertigo Attacks by Month for Control and Treatment Groups*

<table>
<thead>
<tr>
<th>Group</th>
<th>Baseline</th>
<th>1 Month</th>
<th>2 Months</th>
<th>3 Months</th>
<th>4 Months</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of Days With Definitive Vertigo</td>
<td>Control</td>
<td>Mean (SD)</td>
<td>0.24 (0.22)</td>
<td>0.18 (0.19)</td>
<td>0.14 (0.15)</td>
<td>0.19 (0.24)</td>
</tr>
<tr>
<td></td>
<td>95% CI</td>
<td>0.16-0.32</td>
<td>0.11-0.25</td>
<td>0.09-0.19</td>
<td>0.10-0.28</td>
<td>0.05-0.17</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment</td>
<td>Mean (SD)</td>
<td>0.20 (0.17)</td>
<td>0.11 (0.13)</td>
<td>0.09 (0.12)</td>
<td>0.08 (0.13)</td>
</tr>
<tr>
<td></td>
<td>95% CI</td>
<td>0.14-0.27</td>
<td>0.06-0.16</td>
<td>0.05-0.14</td>
<td>0.04-0.13</td>
<td>0.05-0.16</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>29</td>
<td>29</td>
</tr>
</tbody>
</table>

Proportion of Sick Days

<table>
<thead>
<tr>
<th>Group</th>
<th>Baseline</th>
<th>1 Month</th>
<th>2 Months</th>
<th>3 Months</th>
<th>4 Months</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Mean (SD)</td>
<td>0.07 (0.10)</td>
<td>0.03 (0.05)</td>
<td>0.02 (0.04)</td>
<td>0.04 (0.08)</td>
<td>0.01 (0.02)</td>
</tr>
<tr>
<td></td>
<td>95% CI</td>
<td>0.04-0.10</td>
<td>0.02-0.05</td>
<td>0.01-0.04</td>
<td>0.01-0.07</td>
<td>0.00-0.02</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>Mean (SD)</td>
<td>0.05 (0.07)</td>
<td>0.02 (0.06)</td>
<td>0.01 (0.03)</td>
<td>0.02 (0.05)</td>
<td>0.01 (0.02)</td>
</tr>
<tr>
<td></td>
<td>95% CI</td>
<td>0.02-0.07</td>
<td>0.00-0.05</td>
<td>0.00-0.03</td>
<td>0.00-0.03</td>
<td>0.00-0.02</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>29</td>
<td>29</td>
</tr>
</tbody>
</table>

Table 4. Multiple Linear Regression of the Cumulative 4-Month Proportion of Days With Definitive Vertigo (Dependent Variable) and Vertigo at Baseline, Vestibular Sensitivity, and Treatment Group (Predictor Variables)

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>SE</th>
<th>t (P Value)*</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertigo, baseline</td>
<td>0.2259</td>
<td>0.0141</td>
<td>2.17 (.03)</td>
</tr>
<tr>
<td>ENG canal weakness</td>
<td>-0.0015</td>
<td>0.0006</td>
<td>-2.35 (.02)</td>
</tr>
<tr>
<td>Treatment group</td>
<td>-0.0678</td>
<td>0.0273</td>
<td>-2.48 (.02)</td>
</tr>
</tbody>
</table>

*The overall model was statistically significant (F3,58 = 5.28, P = .003), as well as the factors vertigo at baseline, vestibular sensitivity (ENG), and treatment group. R² = 0.214.
FUNCTIONALITY

The median (interquartile range) cumulative proportion of days with canceled activity (ie, sick days, activity level 3-4) over the 4 months is displayed by treatment group. The median activity levels between groups is statistically significant (Mann-Whitney U test, \( P = .02 \)). Thus, null hypothesis 2 is rejected. The mean monthly proportion of days with definitive vertigo before and at each follow-up visit are shown in Table 3. A repeated-measures ANOVA demonstrated that the mean activity scores observed for both treatment month and treatment group were statistically significantly different (see Table 3 legends for details). This indicates that both groups had improved functionality over time, and, further, that the intergroup differences noted in Table 2 are still significantly different taking time into account. As expected, vertigo scores and activity scores were highly correlated (Pearson \( r = 0.748 \)), but vertigo was scored slightly higher than activity.

HEARING

Table 5 displays the mean (SD) average low-frequency (0.25-, 0.5-, 1-kHz) hearing thresholds for each group before and at the second and fourth follow-up visits. There was no significant change either within or across groups. Thus, we cannot reject null hypothesis 3. The follow-up electrocochleographic results did not change in a systematic way. These later data are being reported separately.

POSTSTUDY FOLLOW-UP

Fifty-one of the 61 participants who entered the 2-year follow-up are actively contributing their data. Nine participants have sought ablative surgery (5 controls and 4 treatment) and 2 have dropped out for unknown reasons. About half the participants have completed 1 year of follow-up and the last subject will finish in April 2005.

Figure 3.

A, Effects of electronystamography (ENG) canal weakness on vertigo outcome. The lower (locally weighted sums of squares) smoothed mean curves are plotted against the data points and demonstrate better outcomes for participants with greater loss of vestibular function (as measured by the bithermal caloric test), with an advantage for the treatment group except at the extremes of canal weakness. Coefficients and significance levels are shown in Table 4. B, Effect of baseline levels of vertigo on vertigo outcome. The lower smoothed curves for each group are superimposed on the data points and demonstrate poorer outcomes for participants with greater baseline levels of vertigo, with a differential effect by treatment group in which poorer control was experienced by control participants at high prestudy vertigo levels. Coefficients and significance levels are shown in Table 4.

Comment

The study was conducted as an efficacy clinical trial to demonstrate whether the device had a significant effect within narrowly defined study criteria. The study rationale was that if short-term efficacy was documented in a double-blinded paradigm, then a long-term outcomes study was warranted. Conversely, if no short-term benefit was noted, then long-term follow-up would not be necessary. Although the medium-term (+4-month) outcomes of this ongoing treatment method should, logically, be generalizable to longer treatment times, this presumption remains to be seen. Because we have documented a significant reduction in definitive vertigo and days lost from work in the 4-month study, we are continuing to monitor participants’ unblinded outcomes for a full 2 years. Of note, the 2-year results reported by Densert and Sass13 of the subjects in the Odkvist et al10 study did show a positive, long-term effect. This is the second randomized clinical trial showing efficacy of the Meniett device. A third study, with similar results, has been completed but not yet published (M. Anniko, e-mail communication, August 2003).

Guidelines for reporting the unblinded, uncontrolled clinical results of surgical therapy for Ménière’s disease have been established.12 These guidelines are based on a comparison of recalled overall vertigo severity before and 2 years after an operation. However, these guidelines, which do not require a comparison or control group, do not apply to the present study.

The participants in this study were typical people with active, classic unilateral Ménière’s disease of long duration who were having frequent vertigo attacks despite standard medical therapy. Thus, the results of this study should be applicable to similar patients, but the results may not apply to people with variant forms of Ménière’s disease.

Separating the effect of therapy from the cyclical natural history of the disorder poses difficulties for all studies of Ménière’s disease. Because the natural history is one of remission and recurrence, and because participants must have active vertigo to enroll in a study, spontaneous improvement through regression to the mean is expected. Thus, a control group is vital to con-
Table 5. Average Low-Frequency Hearing Thresholds for Control and Treatment Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Baseline</th>
<th>2 Months</th>
<th>4 Months</th>
<th>P Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean (SD)</td>
<td>n</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Control</td>
<td>32</td>
<td>51.5 (18.7)</td>
<td>32</td>
<td>52.9 (19.0)</td>
</tr>
<tr>
<td>Treatment</td>
<td>30</td>
<td>56.1 (19.7)</td>
<td>30</td>
<td>57.1 (19.3)</td>
</tr>
</tbody>
</table>

*Hypothesis 3: Average low-frequency (0.25-, 0.5-, 1-kHz) pure-tone thresholds (decibel hearing level) do not differ between groups at 2- or 4-month follow-up evaluations.

†Repeated-measures analysis of variance shows no main effect of treatment group, treatment month, or the interaction between treatment group and treatment month. The null hypothesis 3 cannot be rejected.

therapy, the ideal candidate for Meniett therapy would appear to be a person with established Ménière’s disease, reduced vestibular function, and high levels of vertigo despite adequate medical therapy.

The mechanism whereby external pressure applications might affect labyrinthine physiology is not understood. One theory is that intermittent pressure applications directly reduce endolymphatic fluid volume by outflow into the endolymphatic sac, possibly by a valving mechanism (A. Salt, e-mail communication, January 2004). An alternative possibility is that the low-intensity stimuli produced by the device may trigger reflexes that affect endolymph production, hormone production from the endolymphatic sac (atrial natriuretic peptide), and/or central vestibular compensation mechanisms. The time course of response in the present study suggests a slow and continuing process, which is compatible with the latter “signaling” theories. While understanding the mechanism of the treatment is obviously desirable, the absence of such understanding need not delay the application of a beneficial treatment.

There were no complications from the use of the Meniett device. Management of the tympanostomy tube requires periodic otologic attention for infection, plugging, and extrusion. Patients must practice water precautions, aural hygiene, and the Toynbee or Valsalva maneuver daily to assure patency. Not all adults tolerate tympanostomy tubes well, which is a limiting factor for this therapy. Use of the device without a patent tympanostomy tube may increase the symptoms of Ménière’s disease.

Reasonable attempts were made to maintain participant blinding by having sealed devices with identical appearance and acoustic properties. Whether the participants might have tested the device in some way to determine its activity is unknown. Many participants were unaware of the presence or absence of pressure sensations during device use and were unable to hear the acoustic signals during device operation because of their hearing loss. Therefore, we believe the blinding was effective and that participant equipoise was maintained.

The significant treatment effect in the treated participants relative to controls over the 4-month trial period diminished over time principally because of apparent spontaneous improvement in the control group. Further assessment over longer periods is needed to better understand the long-term effects of transtympanic micropressure treatment in Ménière’s disease.

Therapy with the Meniett device is efficacious for at least 4 months in controlling severe vertigo attacks and reducing the number of sick days. Long-term follow-up is in progress. Use of the Meniett device provides an additional treatment option prior to undertaking ablative therapy for treatment failures. We recommend that patients, physicians, and health care insurers recognize the Meniett device as a second-level therapy for Ménière’s disease.

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Corresponding author and reprints: George A. Gates, MD, Virginia Merril Bleedel Hearing Research Center, University of Washington, Box 357923, Seattle, WA 98195-7923 (e-mail: ggates@u.washington.edu).
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