Treatment of tinnitus with electrical stimulation

RONALD L. STEENERSON, MD, and GAVE W. CRONIN, MHE, OTR, Atlanta, Georgia

The purpose of this study was to evaluate the treatment of tinnitus with electrical stimulation. Five hundred patients with tinnitus were treated with probe electrical stimulation. Causes of tinnitus were sensorineural hearing loss (303 patients), Meniere's disease (88), infection (25), head trauma (39), acoustic trauma (25), ototoxicity (4), and chemo-therapy (2).

Treatment involved 6 to 10 transcutaneous treatment electrical stimulation sessions biweekly. Fifty-three percent of patients showed decreases in their tinnitus as measured by a subjective rating scale. With a 3-month follow-up, 72% had no loss of benefit. Thirteen patients had temporary increases in their tinnitus. Two patients had permanent increases. Probe electrical stimulation seems to offer some benefit in about half the patients treated for annoying tinnitus. (Otolaryngol Head Neck Surg 1999121:511-3.)

The use of electrical current to alter physiologic responses has been recognized since the 1800s. Electrical stimulation has been used to treat inflammation, pain, edema, joint dysfunction, and spinal disorders. Electrical stimulation has also been used to promote tissue healing and for muscle reeducation.

Field, Graham and Hazell, and Cazals et al. were among the first to report tinnitus suppression as a result of electrical stimulation. Positive polarity was found to suppress tinnitus, and negative polarity produced a sensation of sound. Aran et al. and Cazals et al. found that tinnitus was suppressed by a positive direct current (DC) only as long as the current was applied. A negative DC was also found to damage the cochlea in the guinea pig.

In 1983 Portman et al. reported a series of patients with tinnitus who received electrical stimulation through a round window electrode with a positive DC. Tinnitus suppression was present in 66%, but there was no residual inhibition. Cazals et al. reported the same findings.

Transcutaneous electrical stimulation for tinnitus was reported by Chouard et al. in 1981, with more than one third of patients receiving significant reduction in tinnitus. Engelberg and Bauer in 1985 reported their experience with transcutaneous electrical stimulation in a small number of patients (20). They reported an 82% improvement in tinnitus. Kuk et al. reported 10 patients with annoying tinnitus treated with electrical stimulation. Using an alternating current (AC) and a tympanic membrane electrode with a maximum current of 2 mA, they reported a reduction of tinnitus in 50% of the patients. They reported up to 4 hours of residual habituation and concluded that external electrical stimulation can be effective at reducing tinnitus.

The purpose of this study is to report our results with transcutaneous electrical stimulation in the treatment of tinnitus in 500 patients.
Table 1. Cause of Tinnitus

<table>
<thead>
<tr>
<th>Cause</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meniere's disease</td>
<td>88</td>
</tr>
<tr>
<td>Sensorineural hearing loss</td>
<td>303</td>
</tr>
<tr>
<td>Infection</td>
<td>25</td>
</tr>
<tr>
<td>Acoustic neuroma</td>
<td>14</td>
</tr>
<tr>
<td>Head trauma</td>
<td>39</td>
</tr>
<tr>
<td>Acoustic trauma</td>
<td>25</td>
</tr>
<tr>
<td>Ototoxicity</td>
<td>4</td>
</tr>
<tr>
<td>Chemotherapy</td>
<td>2</td>
</tr>
<tr>
<td>TOTAL</td>
<td>500</td>
</tr>
</tbody>
</table>

Table 2. Tinnitus Improved

<table>
<thead>
<tr>
<th>Cause</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meniere's disease</td>
<td>60</td>
</tr>
<tr>
<td>Sensorineural hearing loss</td>
<td>50</td>
</tr>
<tr>
<td>Infection</td>
<td>61</td>
</tr>
<tr>
<td>Acoustic neuroma</td>
<td>54</td>
</tr>
<tr>
<td>Head trauma</td>
<td>50</td>
</tr>
<tr>
<td>Acoustic trauma</td>
<td>57</td>
</tr>
<tr>
<td>Ototoxicity</td>
<td>100</td>
</tr>
<tr>
<td>Chemotherapy</td>
<td>100</td>
</tr>
</tbody>
</table>

METHODS

Patients were selected for this study if they had tinnitus (unilateral or bilateral) severe enough to affect their lifestyle and they thought treatment was warranted. Five hundred were treated. The causes of tinnitus are shown in Table 1. Each patient gave an otologic history and underwent physical examination and pure-tone and discrimination audiology. Brain Stem audiometry was done in most patients to rule out retrocochlear lesions. History included questioning about pregnancy, cardiac pacemakers, metal plates, and so forth, which might preclude treatment with electrical stimulation. Informed consent was obtained from each patient before initiation of treatment.

Patients were asked to rate the intensity of their tinnitus using a subjective scale of 1 to 10, with 1 being hardly noticeable and 10 being intolerable. The average pretreatment intensity was 7. The average age of the 500 patients was 46 years. There were 269 men (54%) and 231 women (46%). The average duration of tinnitus was 3.2 years (range 1 month to 49 years); 298 patients (60%) had bilateral and 202 (40%) unilateral tinnitus.

The Neuroprobe 500 (PTJ, Topeka, KS) is the probe electrical stimulation system used in this program. This unit is designed to provide sub sensory, sensory, motor noxious, and nerve-block stimulation. It has 2 Separate generators that produce medium frequency (2000, 2500, 4000, or 500 Hz) AC in continuous or modulated modes. Two isolated output circuits are provided. The output is displayed on a screen and is determined in milliamperes. A probe mode and point locator is built into the system to detect low skin resistance points. A digital timer allows the therapist to select the length of treatment time. For the program at the Atlanta Ear Clinic, we used AC in the sensory motor mode.

A hand-held, gold-plated, low-voltage probe pulse system was used to deliver the transcutaneous electrical stimulation. The patient held a grounding electrode in the ipsilateral hand to the ear receiving stimulation. Twenty different points were arbitrarily selected on the external pinna and tragus of each ear. The duration of stimulation was 30 seconds repeated twice for each point. The average time of treatment for 1 ear was 25 to 30 minutes.

The stimulus waveform was an AC with a frequency (pulses delivered per second) of 1 to 10 Hz. The intensity of the current used for treatment was 0.3 to 0.6 mA. The treatment schedule was twice weekly for a total of 6 to 10 visits. At the beginning and end of each treatment session, the patient was asked to rate the intensity of the tinnitus on the 1 to 10 scale. After each treatment, the auricle was inspected for skin irritation or other local reaction. Patients who had at least 6 treatments were included in this study. No improvement after 6 treatments was considered a failure, and the treatments were discontinued.

Follow-up was by telephone or personal interview for 3 months to evaluate the outcome of treatment.
RESULTS

Fifty-three percent of patients treated received significant benefit based on an improvement of their subjective scale of at least 2 points. The average subjective symptom rating at the start of treatment was 7. The range was 3 to 10. The average scale rating at the end of treatments (6 to 10 sessions) was 4. The range at the end of treatment was 0 to 10.

Thirty-six patients (7%) had complete suppression of their tinnitus. Of the 265 patients who showed improvement, 72% had continuous benefit 3 months after treatment.

An interesting ancillary observation was that many of the patients with Meniere’s disease noticed a decrease in pressure in the treated ear. This often lasted for several weeks. The results of treatment for each subgroup of patients is shown in Table 2.

Thirteen patients believed that electrical stimulation made their tinnitus worse. The treatment was discontinued in each case, and the tinnitus returned to pre-treatment levels in 11 patients. Two patients had permanent increases in their tinnitus.

Two patients were allergic to gold, and the gold electrode caused contact dermatitis. The dermatitis cleared when treatment was stopped. There were no other complications from treatment. No attempt was made to evaluate placebo effects because this would have been difficult in a private practice setting.

DISCUSSION

Early experiments in electrical stimulation of the cochlea for profound hearing loss demonstrated tinnitus suppression in some of these patients. As a result of this observation, several authors tried transcutaneous electrical stimulation as a treatment for tinnitus. Our results treating 500 patients confirmed the optimism of Chouard et al and Engelberg and Bauer, although our results were not as favorable as Engelberg and Bauer’s, who reported an 82% success rate. Our population was much larger (500 vs 20) and may be more representative of actual expected results. Our results were equal to those of Chouard et al, and the sites of stimulation were the same.

We have noticed that tinnitus from certain causes (eg, Meniere’s disease) seem to respond well to electrical stimulation. Even though tinnitus in patients with Meniere’s disease does fluctuate, the tinnitus in the patients with Meniere’s disease that we treated was the continuous tinnitus seen later in the disease.

Electrical stimulation has been used successfully in the treatment of pain. Tinnitus has been compared with pain as a sensory response to tissue damage. One explanation for the success of electrical stimulation in the treatment of tinnitus might be an action on a gate similar to that in the pain mechanism. The gate theory of pain suggests that the perception of pain is controlled by large- and fine-diameter peripheral sensory fibers, which modified central transmission cells’ responses to painful stimuli. In a similar manner, electrical cutaneous stimulation of the auricle may have an effect on a similar gate control system, which may decrease the perception of tinnitus through cutaneous sensory fibers.

Whatever the mechanism, electrical stimulation does seem to be a safe and effective treatment of tinnitus, especially when viewed in light of the lack of success of other treatments, some of which have significant risk or greater cost. The placebo effect in this study is not known. Placebo effect is difficult to evaluate in electrical stimulation because the patient can feel the electric current; therefore it is impossible to give a sugar pill. Kuku et al detailed the difficulty in evaluating the placebo effect in electrical stimulation and also listed reasons that the placebo effect may not be significant in electrical stimulation as a treatment for tinnitus. Electrical stimulation seems to be more effective than most other reported treatments for tinnitus and is easier and safer than most. Compared with tinnitus reduction training, electrical stimulation is certainly cheaper and easier, although its success rate is less (50% vs...
CONCLUSIONS

1. Electrical stimulation as a treatment for tinnitus seems to be effective in about 50% of patients with tinnitus of various causes.

2. Electrical stimulation as a treatment for tinnitus is safe with the parameters described in this study.

REFERENCES


