

Surgical Method for Implanted Tinnitus Suppressor

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Abstract: A surgical method of fully internal tinnitus suppressor is presented. The surgical approach for the placement of the electrode is very simple and causes less injury to the cochlea. This surgical approach is quite similar to the exploratory tympanotomy. The unit is located at the seat which is drilled in the mastoid bone just behind the external ear canal. The stimulating electrode is introduced to the middle ear beneath the skin of the ear canal on the posterior bony wall. The tip of the electrode located on the promontory is secured by the fascia. The primary coil is contained in the Behind-the-Ear case.

INTRODUCTION

There is clear agreement among implant groups that tinnitus suppression is observed in the majority of patients.¹ However, implantation for tinnitus suppression was not often performed because of the cost and damage to the cochlea.

Hearing level in tinnitus patients varied from patient-to-patient. Tinnitus worsens with hearing loss. Therefore, no injury to the cochlea following the operation is allowed. Little operative injury to patients should also be required. Practical use of an implanted tinnitus suppressor has been awaited. An electrical tinnitus suppressor, which was developed at Hokkaido University according to the above mentioned concepts, was implanted into two female and five male tinnitus patients.² The objective of the study is to present the surgical procedure of an internal tinnitus suppressor.

Configuration of the device

The electrical tinnitus suppressor consists of a portable electrical stimulator with an external coil inside a Behind-

the-Ear type of hearing aid plastic case and an implanted coil in the mastoid (Fig. 1).

Wearing a Behind-the-Ear hearing aid plastic case which contains an external coil, patients sit or lie on a bed during treatment (Fig. 2).

Figure 3 shows a scheme of relationship between external and internal coil in the mastoid bone. The size of the portable stimulator is 15 cm long, 12 cm wide, and 7 cm thick. It weighs approximately 400 g and is provided with 100 V alternating current. The stimulus frequency consists of a 10 kHz sinusoidal wave modulated at 100 Hz. The duration of stimulation is variable. If the patient chooses "timer switch", it works automatically for 30 minutes. The device is activated while the patient is in a bed or a sitting position.

The size of the second coil is 6 mm wide, 5 mm thick, and 10 mm long. The coil is covered with silicone. Two or three millimeters on the electrode from the device are also covered with silicone for protection from electrode breakage and fluid influx to the device.

Incision

The skin incision is the same as that of simple mastoidectomy. The postauricular incision for exposure of the subcutaneous tissue follows the curve of the postaural fold beginning at the upper attachment of the auricle, and continuing behind the postaural fold downward to the tip of the mastoid process. The following sub-

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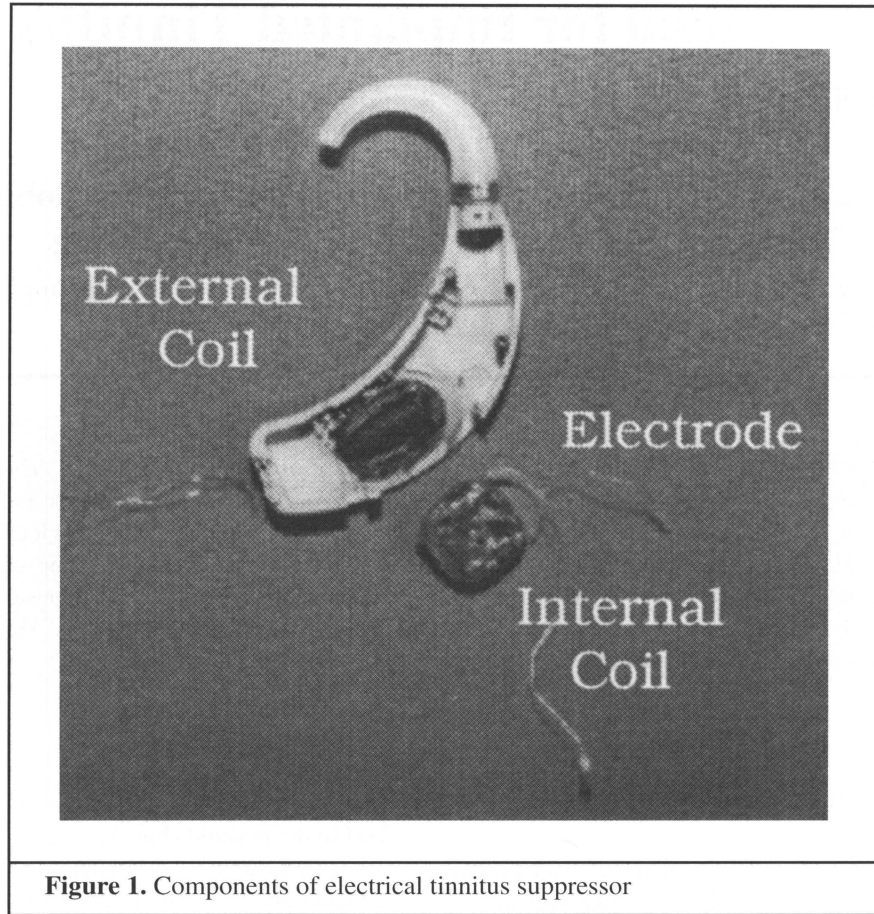


Figure 1. Components of electrical tinnitus suppressor

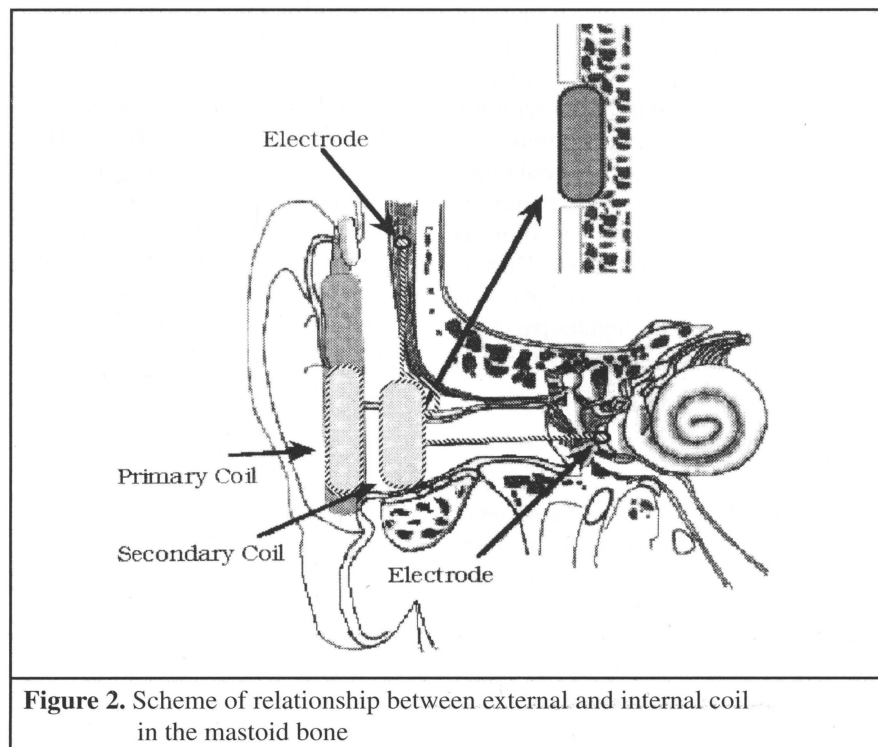


Figure 2. Scheme of relationship between external and internal coil in the mastoid bone

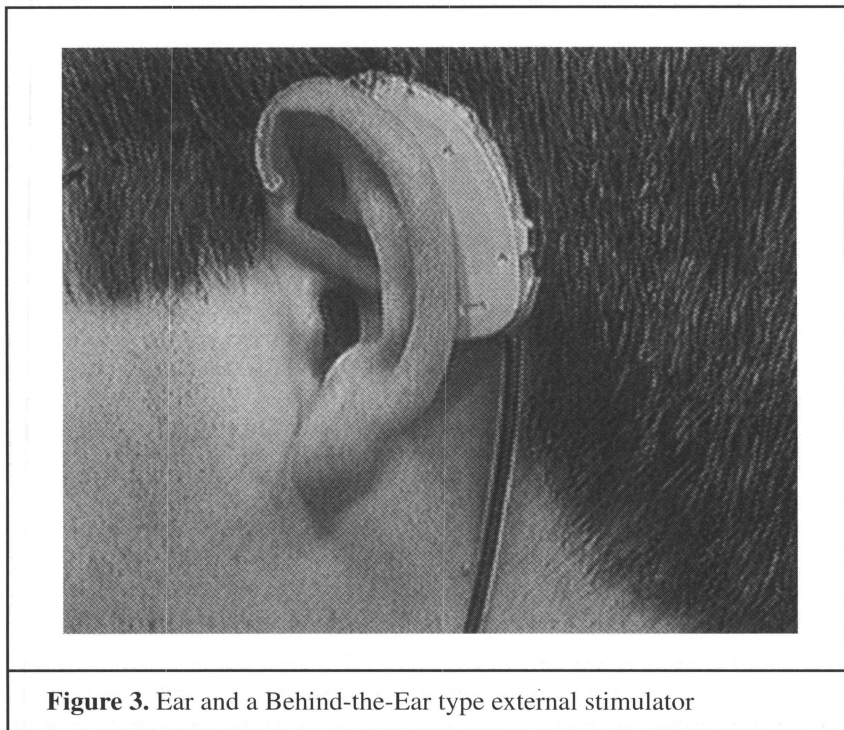


Figure 3. Ear and a Behind-the-Ear type external stimulator

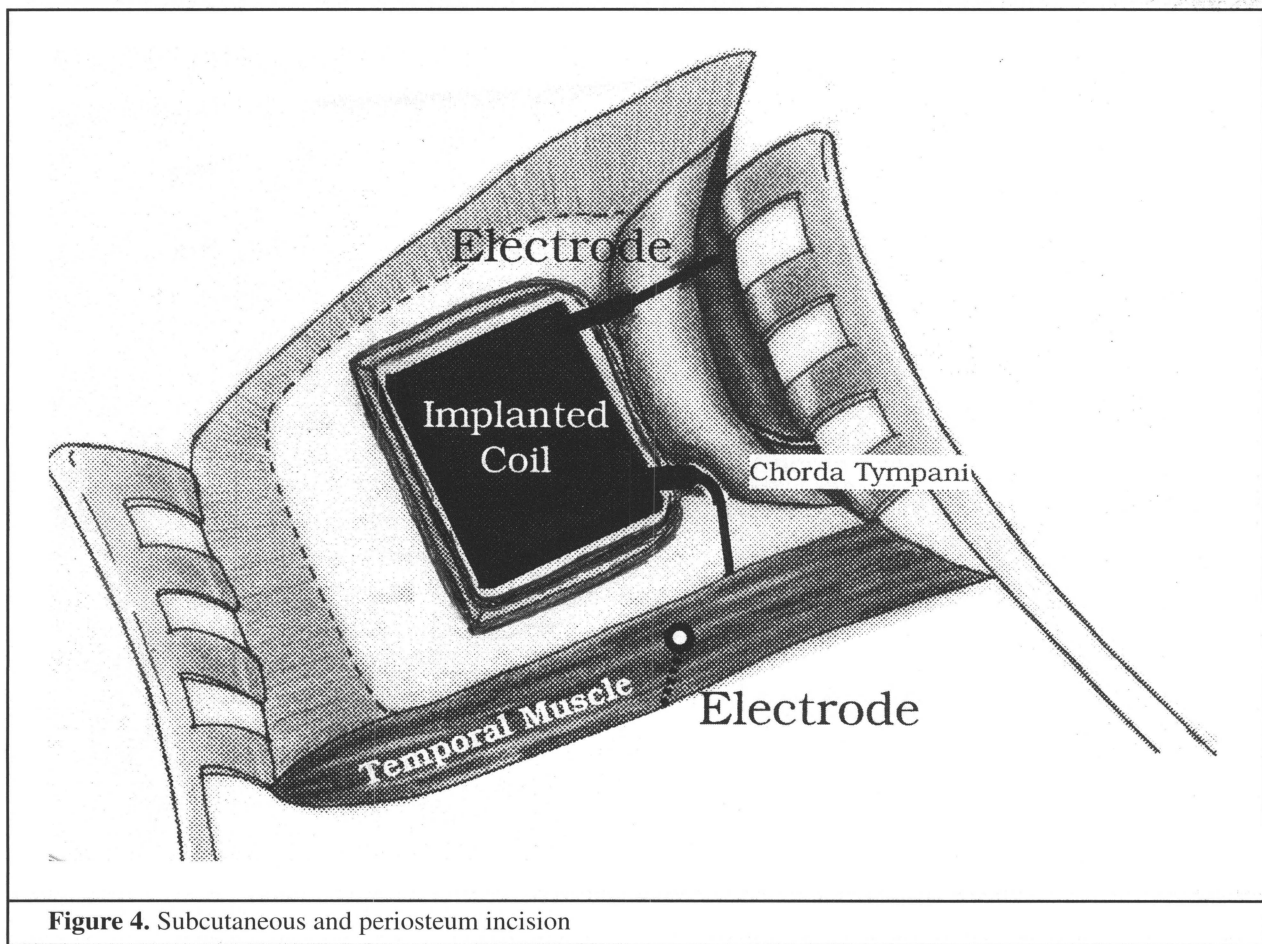


Figure 4. Subcutaneous and periosteum incision

cutaneous and periosteum incision is shown in Figure 4. The upper line runs along the attachment of the temporal muscle, curving slightly posteriorly at the lateral side of the unit, extending inferiorly at the bottom of the unit. It is important to maintain 5 mm, at least, from the edge of the device to the incision. This is raised in continuity with the skin of the posterior ear canal wall and the ear drum. Periosteum is raised on the anteriorly based pedicle and turned forward to uncover bone.

Mastoidectomy

Cortical bone removal was performed in a way similar to mastoidectomy, but the shape of the seat should be large enough to contain the unit fully. Keep in mind that the surface level of the unit in the cavity is at a level similar to the intact cortical bone (Figure 1). This procedure guaranteed that fixation method, such as using the dacron tape fixation to the mastoid bone, is not needed to secure the fixation. The position of the seat should be made so that the stimulating electrode from the belly of the unit should be kept straight to the lower part of the outer ear canal. The posterior wall of the outer ear canal is kept intact to prevent the covered silicone from contacting the skin of the ear canal.

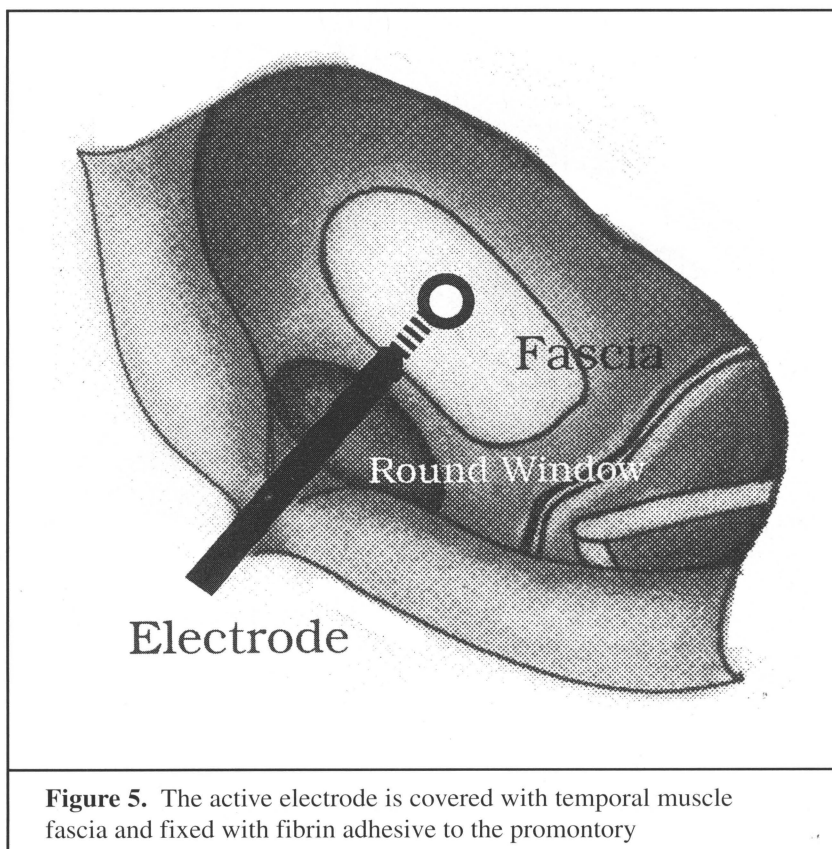
Grooving the Ear Canal

Extensive dissection has to be made in the inferior portion of the basal scala tympani and this procedure made large exposure of the round window niche, which is the most convenient position to place the electrode leads. The groove is made at the outer margin of the mastoid cortex and the bony wall of the tympanic annulus of the posterior canal wall (Figure 4), and the grooves serve as guides to the promontory. The chorda tympani nerve should be visible and care is needed to prevent injury while the groove is drilled. Teflon-coated Pt-Ir wire of 600 μm diameter is covered with the posterior ear skin. No extrusion was found, although there was no additional groove on the posterior wall of the ear canal.

The active electrode is covered with temporal muscle fascia and fixed with fibrin adhesive to the promontory (Figure 5).

DISCUSSION

The use of this suppressor is aimed at treating tinnitus patients with varying degrees of hearing loss. The device is likely to result in minimal damage to the cochlea because the stimulating electrode is placed in the vicinity



of the round window. In addition, the small size of the implanted coil, which is implanted in the mastoid, ensures that the operation for implantation involves minimal risk of injury to the patients.

What is new in the system is the usage of the Behind-the-Ear type of hearing aid case containing an external stimulator (Figure 1). Although tight contact between the stimulator and the receiver could not be obtained, this idea can make the skin incision and drilling the mastoid bone smaller. In addition, no special method, such as the dacron tape or strings fixation to the mastoid bone, was needed to secure the fixation. This is partly because the small diameter of the Pt-Ir wire, which is not covered with silicone, is too weak to extrude the stimulator. Also the mastoid bone is so flat that the subcutaneous tissue covers the device, which is completely fitted to the seat. On the contrary, the subcutaneous tissue just behind the auricle is not thick enough to allow the dacron tape or screw for fixation of strings. No extrusions of a stimulator and Pt-Ir wire underneath the skin of the external ear canal were observed. No inflammation around the stimulator and Pt-Ir wire was observed.

The most important thing for the usage of the implanted tinnitus suppressor is patient selection.³ Tinnitus suppression using the implanted device was consistent with that of an outpatient clinic, meaning that we can predict the outcome of tinnitus based on the result from electrical promontory stimulation. Patients whose tinnitus was suppressed for at least half-a-day following promontory stimulation should be selected for implantation. In addition, reduced sleep disturbances in all patients and hearing improvement made some patients and their family accept implantation of the tinnitus suppressor. However, all patients with complete tinnitus suppression could not be candidates for the device. Patients, for example, perceived with a weaker tinnitus when they

were tired or under significant stress, suggesting that tinnitus suppression depended on patients' physiological and psychological condition. Therefore, patients who seemed to be very dependent on others in his/her life style and under significant stress should be avoided to implant the device.

Although this treatment is not a cure, it is of benefit to some tinnitus patients. The efficacy of power conduction using a magnetic coupling system is not enough to apply for tinnitus patients with a higher threshold to tinnitus suppression. Further engineering studies on the device will be needed to be helpful for severe tinnitus patients.

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ACKNOWLEDGMENT

The work reported in this study was supported by a grant from the Japanese Ministry of Education.

The authors are grateful to Mr. N. Nagai for manufacturing the electrical stimulator.