Reprint from LARYNGOSCOPE, Vol. 95, No. 10, October 1985.

TRANSCUTANEOUS ELECTRICAL STIMULATION FOR TINNITUS.*†

MARVIN ENGELBERG, PhD
Cleveland, OH

WILLIAM BAUER, MD
Newnan, GA.

ABSTRACT.

The use of electrical stimulation to treat tinnitus was evaluated in a two-experiment study. The stimulus was a low amperage, low frequency variable square wave applied to 13 sites on the auricle of the ear with tinnitus. The sites were selected for their increased electrical conductivity as measured by low electrical resistance readings. Experiment 1 results defined improvement as either a complete remission of the tinnitus or a decrease in the frequency of the tinnitus. Experiment 2 utilized a single blind protocol with 20 subjects comprising 33 ears with tinnitus. Eighty-two percent of the 33 ears showed improvement by either of the two criteria. The permanence of the improvement ranged from 20 minutes to at least six months. The variables associated with this procedure were discussed. The adverse effects from the stimulation were minimal.

Electrical stimulation is not a new therapeutic modality. It is most commonly utilized for pain[1] and healing of bone fractures.[2] Electrical stimulation for the treatment of tinnitus is a concept that is attracting attention from several sources. House reported reduction of tinnitus as a beneficial side-effect after cochlear implantation.[3] The alleviation of tinnitus by direct electrical stimulation of the promontory has also been described by Portmann, *et al.*[4] Recently the idea of non-invasive transcutaneous electrotherapy for severe tinnitus was explored with some success by Chouard, *et al.*[5]

Advances in electronic technology appear to make this treatment more effective than previous reports[6] of such treatment for inner ear pathology. The effectiveness of electrical stimulation depends upon the characteristics of the electrical stimulus[7,8] and the anatomical area of stimulation. The significant characteristics of the electrical stimulus are polarity, frequency, waveform, and intensity.

This paper presents clinical data on the use of transcutaneous electrical stimulation as a treatment for tinnitus. The data is presented in two experiments: experiment 1 to establish methodology and experiment 2 to validate the procedure.

Experiment 1.

MATERIAL AND METHODS.

Subjects.

Seven males and three females served as subjects. Their ages ranged from 23 to 69 years with a mean of 43 years. These subjects reported a total of 18 ears with tinnitus, individual subject information being shown in Table I.

Otological and Audiological Evaluations.

The subjects received otological and audiological evaluations. All subjects had varying degrees of sensory hearing loss, except subject 8 who had normal hearing. The tinnitus was then matched with simulated sounds from a Norwest SG-1 Tinnitus Synthesizer, the tinnitus matching consisting of the experimentor adjusting the frequency and intensity levels of the synthesizer according to the subject's instructions. An ascending procedure was utilized.[9]

Stimulation Technique.

A pulse generator with a sensing mode (Alpha Stim 2000) was used. The points of stimulation around the auricle were located by their peculiar property of very low electrical resistance with resulting high conductance of electrical current relative to the surrounding area. Empirically, through a series of trial and error, 13 such points (Fig. 1) were located which appeared to be very effective in reducing tinnitus when stimulated electrically. The sensing mode of the Alpha Stim 2000 functioned initially as an ohmmeter to record relative electrical skin resistance via a probe at the point of contact, the subject holding a ground in the ipsilateral hand (Fig. 2). The probe was moved around each of these 13 locations until a very low relative electrical resistance value was found. This value was displayed simultaneously on a VU-like meter on the instrument chassis and by an LED display on the probe handpiece. The locations on the auricle were specific and identical for each subject. Absolute electrical skin resistance was not measured. The electrical stimulus was then delivered to each point transcutaneously with the hand-held probe utilizing the treatment mode of the same instrument. Duration of stimulation to each point was between 24 seconds and two minutes. The electrical stimulus waveform was a modified square DC biphasic pulse with a frequency of 0.5, 1.0, or 2.0 Hz changing polarity at 0.4 second intervals. The current intensity was 50 μA with a maximum 36 volts. The number of treatments ranged from one to 17, the treatment schedule not exceeding three per week. The tinnitus was matched after each treatment.

TABLE I.
Subject Information.

Subject	Sex	Age (Years)	Tinnitus Duration	Tinnitus Etiology	Monaural or Binaural
1	F	47	15 yrs	Endolymphatic hydrops	B
2	M	60	38 yrs	Noise	B
3	M	69	8 yrs	Idiopathic	B
4	M	40	20 yrs	Infection	B
5	M	36	3 yrs	Diving barotrauma	B
6	M	50	2 wks	Idiopathic: sudden onset	M
7	M	40	20 yrs	Noise	B
8	F	23	1 yr	Idiopathic	M
9	M	34	12 yrs	Noise	B
10	F	32	27 yrs	Heredity	B

*Presented at the Meeting of the Southern Section of the American Laryngological, Rhinological and Otological Society, Inc., New Orleans, LA, January 12, 1985.

†From the Audiology and Speech Pathology Service, Veterans Administration Medical Center, Cleveland, OH.

Send Reprint Requests to Marvin Engelberg, PhD, Audiology and Speech Pathology Service, Veterans Administration Medical Center, 10701 East Blvd., Cleveland, OH 44106.

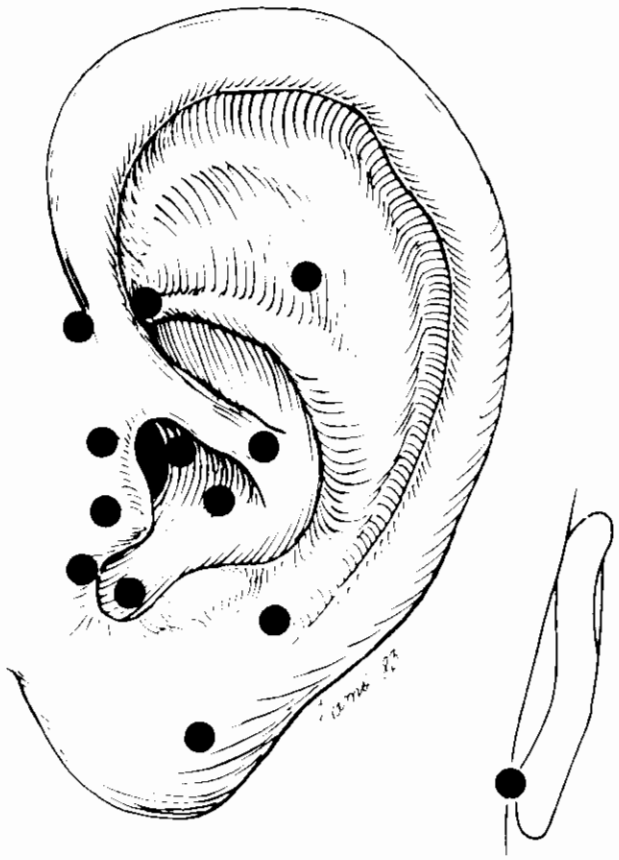

Fig. 1. Illustration of points used for electrical stimulation.

Fig. 2. Photograph demonstrating technique of electrical stimulation.

RESULTS.

The results are shown in Table II. Six of the 10 subjects reported improvement in 8 of 18 ears with tinnitus. Three additional subjects (three ears) were undecided whether improvement had occurred. Tinnitus matching confirmed a decrease in the frequency of the tinnitus in the above eight ears. The six subjects (eight ears) who reported changes in tinnitus perceived the changes as an improvement and showed a minimum 60% decrease in frequency. Tinnitus was eliminated in three of those ears. The two subjects who were not certain showed a 10% to 13% decrease in frequency. The sensation levels of the tinnitus could not be calculated because the synthesizer is not calibrated to audiometric zero. The permanence of the improvement in tinnitus was not investigated although of those subjects who reported on permanence, it varied from eight hours to two months (last contact with the experimenter).

CONCLUSIONS.

The results of this study indicate that *1.* electrical stimulation of specific loci of the auricle ipsilateral to the tinnitus was successful in the amelioration of tinnitus in most of the cases, *2.* amelioration was reported by subjects when the tinnitus was eliminated completely or reduced in frequency, and *3.* an investigation of the validity and some of the parameters of auricular electrical stimulation is warranted.

Experiment 2.

MATERIALS AND METHODS.

Subjects.

Two groups of 10 subjects, a control and an experimental, were utilized in a single-blind protocol. The subjects were assigned alternatively to one of the two groups. All subjects were male, either normal hearing or sensory hearing loss, the majority of the etiologies being either idiopathic or noise exposure. Table III details the age, etiology, duration of tinnitus, and air conduction hearing acuity. No subject was accepted for whom responses to hearing tests or simulated tinnitus sounds were deemed unreliable.

Procedure.

Baseline Evaluations. Each subject received an audiological evaluation utilizing standard commercial equipment referenced to ANSI standards. The tests administered were air conduction, speech reception threshold, most comfortable loudness level, speech discrimination (W-22 word lists), and when indicated, bone conduction, impedance battery, and tone decay. The tinnitus analysis was then accomplished with a Norwest SG-1 Tinnitus Synthesizer, the tinnitus matching consisting of the experimenter adjusting the frequency and intensity levels of the synthesizer according to the subject's instructions. An ascending procedure was utilized. These responses served as baselines.

Experimental Group Stimulation. The auricles of the subject were cleaned with alcohol to remove body oil. After the alcohol had evaporated, the auricle ipsilateral to the tinnitus was stimulated at 13 points (Fig. 1) using the Alpha Stim 2000. The treatment paradigm was identical to that in experiment 1 except that the electrical stimulus waveform had a frequency of either 0.5, 1.0, or 2.0 Hz, the current intensity was either 50 or 100 μA, and

TABLE II.
Results of Stimulation on Tinnitus Frequency.

Subject	Ear	Tinnitus Frequency (Hz)			Subject Perception of Tinnitus Improvement
		Prestimulation	Poststimulation	Percent Change	
1	Right	5820	2330	−60	Yes
	Left	2820	2720	− 4	No
2	Right	5260	4700	−11	No
	Left	4300	4200	− 2	No
3	Right	2600	1020	−61	Yes
	Left	2700	1070	−60	Yes
4	Right	3600	1050	−71	Yes
	Left	3780	1040	−73	Yes
5	Right	2560	3200	+20	No
	Left	2200	None	Infinite	Yes
6	Right	11760	None	Infinite	Yes
7	Right	5500	5500	0	No
	Left	5170	5170	0	No
8	Right	6950	None	Infinite	Yes
9	Right	3130	3150	0	No
	Left	4000	3500	−13	Not certain
10	Right	5020	4400	−12	Not certain
	Left	Could not match	Could not match	—	No

the stimulus duration was either 12 or 24 seconds. Following the monaural or bilateral stimulation, the subject was asked whether he thought improvement had occurred. The tinnitus was again analyzed. The above protocol was followed for each treatment session. The number of treatment sessions ranged from one to seven and are listed in Table IV.

Control Group Stimulation. The auricles of the subject were cleaned with alcohol. After the alcohol had evaporated, the probe was used to locate the 13 stimulation points. They were marked with a felt pen. The subject was then told that the treatment would consist of two stimulation procedures. Unbeknown to the subject, the continuous cable attached to the ground rod was replaced with an open cable. The 13 points were "stimulated." Because the ground cable was open, the circuit was not complete and current was not delivered from the probe. Following the "stimulation," the subject was asked whether the tinnitus had improved. The tinnitus was again analyzed. Without the subject's knowledge, the open cable was replaced with a continuous cable and the stimulation repeated. The subject was again asked whether the tinnitus had improved and the tinnitus was analyzed. Thus, the control subject always received the control stimulation prior to the actual stimulation.

RESULTS.

The data was analyzed for changes in tinnitus frequency. Because both groups received the stimulation, the data for this protocol were analyzed for each group and then pooled. The number of treatments refer to the number of sessions because many subjects received more than one stimulation per session.

The data in Tables IV and V compare the after-stimulation tinnitus frequency to the before-stimulation frequency. The frequency notations with a plus sign for subject 16 in Table V signify that the tinnitus was higher in frequency but there was insufficient sound pressure from the synthesizer to override the hearing loss at a higher frequency. The sensation level of the tinnitus could not be calculated because *1.* the synthesizer is not calibrated to audiometric zero and *2.* the tinnitus frequencies were not usually at frequencies utilized in discrete-frequency audiometers.

Experimental Group. Of the 17 ears treated, two (subject 8, both ears) were perceived as not having improved by stimulation. Thus, 9 of 10 subjects (90%) corresponding to 15 of 17 ears (88%) reported the stimulation as having improved the tinnitus. The decrease in tinnitus frequency for the subjective improvement ranged from 48% (after stimulation frequency was lower) in subject 3 to complete remission (none) in the six ears combined for subjects 5, 7, 9, and 10. Subject 8 did not perceive a 19% decrease as being significant.

Control Group. Of the 15 ears administered the control stimulation, in only one ear did a subject (subject 18, right ear) believe that there had been a change. Measurement indicated a 13% decrease in frequency. The range of change for the 15 ears was from +16% (after stimulation frequency was measured as higher) to −22% (after stimulation frequency was lower). The pre-stimulation tinnitus frequency ranged from 2750 Hz for patient 13 to 14,000 Hz for patient 17. Subject 14 did not receive the control protocol in the right ear because he was not aware of tinnitus in that ear until the tinnitus in the left ear had improved.

Of the 16 ears administered the actual stimulation, four (subjects 11, one ear; 13, one of two ears; 19, two ears) were perceived as not having improved. Thus, 8 of 10 subjects (80%) representing 12 of 16 ears (75%) reported the stimulation as having improved the tinnitus of at least one ear. The measured decrease in tinnitus frequency for those subjects reporting improvement ranged from 28% in subject 18 to complete remission (none) in subjects 12, 14, 15, and 18. Of the four ears not perceiving a change,

TABLE III.
Subject Information.

Subject	Age (yrs)	Tinnitus Duration (yrs)	Tinnitus Etiology	Tinnitus Ears	Hearing Loss
Experimental group					
1	37	6	Noise	Bilateral	A
2	59	5	Idiopathic	Left	A
3	51	1 wk	Dental work	Left	B
4	73	2	Idiopathic	Left	A
5	35	5	Idiopathic	Bilateral	B
6	59	39	Noise	Bilateral	A
7	30	10	Noise	Bilateral	B
8	68	5 right; 40 left	Idiopathic Noise	Bilateral	B
9	54	30	Noise	Bilateral	B
10	39	5	Idiopathic	Bilateral	B
Control group					
11	39	2	Idiopathic	Right	B
12	44	2	Idiopathic	Bilateral	C
13	74	20	Idiopathic	Bilateral	B
14	42	21	Head trauma	Bilateral	B
15	56	5	Hypertension	Left	B
16	65	37	Idiopathic	Bilateral	A
17	27	8	Noise	Left	C
18	46	1	Idiopathic	Bilateral	C
19	52	31	Noise	Bilateral	A
20	52	20	Idiopathic	Left	B

A - From 250-8000 Hz but greater in higher frequencies.
B - Higher frequencies only.
C - Normal hearing.

the tinnitus frequency changed from −15% (subject 11) to +13% (subject 19).

Combined Groups: Actual Stimulation. Improvement was perceived by the 20 subjects in 27 of 33 ears (82%). In 10 cases of these ears, there was complete remission. In the remaining 17 ears, the range of frequency decrease was from 28 to 92%. Thus, six or 18% of the tinnitus ears were reported to have not improved by stimulation.

Permanence of Improvement. The permanence (duration) of change ranged from 20 minutes to at least six months (last contact with experimentor). Subject 7 reported that the tinnitus improvement has remained constant since the stimulation of six months ago. Subject 14 reported that his tinnitus returned to prestimulation level the moment he turned on the air-conditioning in his automobile, this occurring 20 minutes after complete remission. Subject 2 reported that the improvement duration increased after each stimulation session. Individual subject data can be seen in Tables IV and V.

Effect of Subject Characteristics. Neither age, duration of tinnitus prior to stimulation, nor frequency of the tinnitus appeared to be a determinant to the success of electrical stimulation on tinnitus.

Effect of Number of Treatment Sessions. Most of the subjects received a maximum of two treatment sessions. It became apparent quite early that improvement would occur within two sessions if it were to occur at all. There was insufficient data to assess the relationship between the number of sessions and the overall success of the stimulation.

Effect of Electrical Stimulation Parameters. Different parameters of the stimulation were utilized in an informal procedure: frequency was varied from 0.5 to 2.0 Hz; current at 50 or 100 μA; duration of 12 or 24 seconds per stimulation point. There was insufficient data to obtain conclusions or trends relating to the effectiveness of the parameters.

Adverse Effects of Electrical Stimulation. Some subjects reported the current of 100 μA as "pins pricking" but were able to tolerate that amperage. Others could not tolerate greater than 50 μA. The subjects each appeared to have individual most sensitive auricular areas to electrical stimulation. There were no other adverse effects reported either during or immediately following stimulation.

DISCUSSION.

The 82% success rate in improvement in tinnitus implies a feasible treatment procedure. It might be argued that the strength of the data is weakened by *1.* the control subjects not having received the control and actual stimulations in a counterbalanced procedure so as to allow evaluation of possible influence of one stimulation on the other, and *2.* lack of double blind procedure. Neither of these two procedures could be utilized. If the actual stimulation had been administered first, continued or deterioration of the improvement from the actual stimulation would have contaminated the effects of the control

TABLE IV.
Results of Stimulation on Tinnitus Frequency in Experimental Group.

		Experimental Procedure					
Subject	Ear	Prestimulation	Poststimulation	Percent Change	Subject Perception of Change	Number of Treatment Sessions	Permanence of Change
1	Right	2520	660	−76	Yes	2	24 hrs
	Left	2030	1000	−51	Yes	2	24 hrs
2	Left	3080	800	−74	Yes	7	3+ mos
3	Left	4000	2070	−48	Yes	1	3+ mos
4	Left	4000	2050	−49	Yes	2	20 min
5	Right	6280	None	Infinite	Yes	1	4 mos
	Left	7530	None	Infinite	Yes	2	4 mos
6	Right	1700	350	−79	Yes	2	3 days
	Left	2000	350	−83	Yes	2	3 days
7	Right	5220	2000	−62	Yes	2	3+ mos
	Left	5600	None	Infinite	Yes	1	3+ mos
8	Right	3200	2595	−19	No	2	
	Left	2100	2565	−22	No	1	
9	Right	2000	None	Infinite	Yes	1	24 hrs
	Left	2000	None	Infinite	Yes	1	24 hrs
10	Right	4400	700	−84	Yes	1	8 hrs
	Left	4000	None	Infinite	Yes	1	8 hrs

stimulation. A double blind procedure was not possible because a complete electrical circuit was required to locate each of the 13 auricular points immediately prior to its stimulation. The experimenter could not have been "blind" while utilizing an open circuit because the 13 points could not have been located. Three procedures were evolved to minimize these two variables: *1.* the experimenter (Engelberg) was careful to not bias the subjects by his behavior, *2.* the subjects were asked for their perception of any tinnitus change after each stimulation, and *3.* the control subjects were not allowed to see the changes of the cables.

The reliability of tinnitus matching is worthy of discussion because it could have accounted for a significant part of the control stimulation test-retest variability being as high as 22%. On most subjects, it was very difficult to obtain an extremely close tinnitus match without the expenditure of considerable time. Four factors were involved: *1.* the complexity of the tinnitus acoustic spectrum, *2.* the inability of the Tinnitus Synthesizer to duplicate exactly the tinnitus spectrum, *3.* the difficulty of some subjects to understand the difference between frequency and intensity, and *4.* the difficulty in the subject's perception of frequency. First, few if any of the subjects reported a tonal tinnitus of only a single frequency. The large majority of the tinnitus consisted of multifrequencies sometimes being perceived as more than one distinct sound or a periodic or aperiodic pattern described at times as "chirping," "crickets," "humming," "hissing," and "waves of water." In these instances, the subject was asked to match the dominant frequency and intensity. Second, the Tinnitus Synthesizer, although containing three separate channels of selective intensity, frequency, and noise capabilities with mixing into both ears separately and simultaneously, was not able to duplicate exactly the tinnitus of the subject. It is possible that by expenditure of an unreasonable amount of time, a closer duplication could have been accomplished. Third, some subjects could not separate either the tinnitus or the stimulus from the Tinnitus Synthesizer into frequency and intensity. To them, sounds consisted of a single dimension. To others, the intensity of the sound influenced the perception of frequency and vice versa. This placed a greater burden on the experimenter to obtain a reliable matching of the tinnitus. Fourth, there were many instances where the subject perceived a tinnitus as being of low frequency when it was actually high frequency. Generally speaking, a pre-stimulation frequency perceived as less than 1000 Hz was actually above 8000 Hz. The difficulty of tinnitus matching has been documented by other investigators.[10,11]

It is unfortunate that the permanence of improvement was not greater. The majority of the subjects reported that the improvement lasted three days or less. There are four areas that may influence the permanence of improvement: *1.* the parameters of the electrical stimulus, *2.* the number of treatments, *3.* the etiology of the tinnitus, and *4.* the overall health of the patient. First, present research is being directed toward varying the parameters of the electrical stimulus: frequency, microamperage, and stimulus duration. It may be that all tinnitus is not treated maximally with the same parameters. Second, the number of treatments needs to be investigated. Most of the subjects had either one or two treatment sessions. Subject 2 was seen for seven treatment sessions, each session tending to increase the duration of improvement. He concluded after the seventh session that he could now "live" with his tinnitus and requested discharge from the program.

TABLE V.
Results of Stimulation on Tinnitus Frequency in Control Group.

		Control Procedure				Experimental Procedure					
Subject	Ear	Prestimulation	Poststimulation	Percent Change	Subject Perception of Change	Prestimulation	Poststimulation	Percent Change	Subject Perception of Change	Number of Treatment Sessions	Permanence of Change
11	Right	10000	10000	0	No	10000	8520	−15	No	1	
12	Right	3690	3573	− 3	No	3690	1760	−52	Yes	1	10 min
	Left	4060	4090	+ 1	No	4060	None	Infinite	Yes	1	36 hrs
13	Right	2750	2530	− 7	No	2750	760	−72	Yes	3	3 days
	Left	3850	4200	− 9	No	3850	4080	+ 6	No	3	
14	Right		Did not evaluate			3000	None	Infinite	Yes	1	4+ mos
	Left	3000	3500	+16	No	3000	250	−92	Yes	4	10 hrs
15	Left	5060	5080	0	No	5060	None	Infinite	Yes	1	3+ mos
16	Right	3020+	3040+	+ 1	No	3020+	1530	−49+	Yes	1	2 days
	Left	3470+	3200+	− 8	No	3470+	2320	−33+	Yes	1	2 days
17	Left	14000	14530	+ 4	No	14000	5000	−64	Yes	2	6hrs
18	Right	10000	8700	−13	Yes	10000	None	Infinite	Yes	1	2 wks
	Left	8500	8500	0	No	8500	6140	−28	Yes	1	2 wks
19	Right	5000	4000	−20	No	4000	4000	0	No	1	
	Left	4000	4600	+15	No	4600	4000	+13	No	1	
20	Left	4600	3550	−22	No	3550	1750	−51	Yes	1	36 hrs

It is conceivable that periodic reinforcement stimulations will be necessary. Third, there are numerous etiologies of tinnitus reported in the literature.[11] It would not be surprising to find that some etiologies are more resistant than others to electrical stimulation. The sample of 20 in this study is too small to statistically relate etiology to improvement. Fourth, a significant number of patients reported that their general health, both physical and emotional, significantly influenced their tinnitus. As examples, subjects 14 and 6 reported that their tinnitus was more severe when they did not sleep well. Subject 15 reported that he "notices it occasionally, usually after tension situations or pressure." The holistic approach to tinnitus has been discussed by Yanick.[13] He discusses the adverse effects that stress, inadequate diet, exercise, and nutrition can have on injured parts of the body and rehabilitation. Goodey[14] evaluates tinnitus patients for diet and restricts specific foods. The effect of the personality of the tinnitus sufferer to the tinnitus has been investigated.[15]

Although a rigorous protocol was not followed, there were numerous reports from the subjects that their hearing improved following actual stimulation. Five of the 20 subjects accounting for 9 of the 28 ears reported improvement in speech discrimination ability. Two subjects accounting for four ears also reported improvement in both the intensity and high-frequency range of hearing. An analysis of pre- and post-stimulation audiological responses revealed insignificant changes. These patients were adamant and specific regarding the improvement. Melding and Goodey[15] and Shea and Harell[16] reported this same inconsistency.

CONCLUSIONS.

Electrical stimulation appears to alleviate tinnitus either by altering the acoustic pattern of the tinnitus to one that is less annoying or by complete remission of the tinnitus. The permanence of the improvement varies greatly. The adverse effects are minimal. A significant number of subjects reported improvement in hearing activity but this could not be verified by objective evaluation. Considerable research is needed to determine the specific parameters of the treatment.

BIBLIOGRAPHY.

1. Bauer, W.: Electrical Treatment of Severe Head and Neck Cancer Pain. *Arch. Otolaryngol.*, 109:382-383, 1983.

2. Brighten, C. T. (Ed.): Symposium on Electrically Induced Osteogenesis. *Orthop. Clin. North Am.*, 15:1-179, 1984.

3. House, W. F., Berliner, K. I. and Crary, W. G.: Cochlear Implants. *Ann. Otol. Rhinol. Laryngol.*, 85:Suppl. 27, 1976.

4. Portmann, M., Cazals, Y., Negrevergne, M., *et al.*: Temporary Tinnitus Suppression in Man Through Electrical Stimulation of the Cochlea. *Acta Otolaryngol.*, 87:294-299, 1979.

5. Chouard, C. H., Meyer, B. and Maridat, D.: Transcutaneous Electrotherapy for Severe Tinnitus. *Acta Otolaryngol.*, 91: 415-422, 1981.

6. Simmons, F. B.: Electrical Stimulation of the Auditory Nerve in Man. *Arch. Otolaryngol.*, 84:24-76, 1976.

7. Aran, J. M., Wy, Z. Y., Charlet de Sauvage, R., *et al.*: Electrical Stimulation of the Ear: Experimental Studies. *Ann. Otol. Rhinol. Laryngol.*, 92:614-620, 1983.

8. Portmann, M., Negrevergne, M., Aran, J. M., *et al.*: Electrical Stimulation of the Ear: Clinical Applications. *Ann. Otol. Rhinol. Laryngol.*, 92:621-622, 1983.

9. Vernon, J., Johnson, R., Schleuning, A., *et al.*: Masking and Tinnitus. *Audiol. Hear. Educ.*, 6:5-9, 1980.

10. Vernon, J.: Attempts to Relieve Tinnitus. *J. Am. Auditory Soc.*, 2:124-131, 1977.

11. McFadden, D.: Measurement Procedures. Tinnitus: Facts, Theories, and Treatments. National Academy Press, Washington, DC, 1982.

12. McFadden, D.: Tinnitus: Facts, Theories, and Treatments. National Academy Press, Washington, DC, pp. 10-14, 59-63, 1982.

13. Yanick, P., Jr.: Tinnitus — A Holistic Approach. *Hear. Instru.*, 32:12, 14, 15, 39, 1981.

14. Goodey, R. J.: In Ciba Found Symp 85 Tinnitus. Pitman: London, pp. 234, 263, 1981.

15. McFadden, D.: Tinnitus: Facts, Theories, and Treatments. National Academy Press, Washington, DC, p. 56, 1982.