Continuous Auricular Electrical Stimulation Quiets the Tinnitus of the Somatosensory Pulsatile Tinnitus Syndrome

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Introduction:
Tinnitus is a symptom with many different underlying etiologies. The goal of tinnitus research is to: 1) identify different tinnitus types, 2) uncover for each tinnitus type its underlying pathophysiology, and 3) find effective treatments based upon our understanding of the underlying pathophysiology of each tinnitus type.

1) Identify a Tinnitus Type: Somatosensory Pulsatile Tinnitus
We have identified a type of pulsatile tinnitus by its unique characteristics
- constant, cardiac-synchronous and high-pitched
- negative imaging; CSC; thyroid profile
- no bruits
- angular and carotid compression negative
- intense jaw or neck muscle contractions suppress the pulsations

We refer to this type of tinnitus as the Somatosensory Pulsatile Tinnitus Syndrome because it can be suppressed by somatosensory activation

2) Somatosensory Pulsatile Tinnitus Syndrome: Uncovering its Underlying Pathophysiology
Because:
- intense jaw or neck muscle contractions suppress the pulsations
- Dorsal cochlear nucleus probably plays a critical role in tinnitus generation
- One hypothesis of dorsal cochlear nucleus function is to suppress self-generated sounds such as heart beats.

We hypothesize that somatosensory pulsatile tinnitus syndrome is from a failure of the dorsal cochlear nucleus to suppress heart beats.

3) Somatosensory Pulsatile Tinnitus Syndrome: Treatment Based upon our Understanding of Its Underlying Pathophysiology
See Results

Results:
- 7 completed the trial as planned.
- 5 of the seven had sustained quieting of their tinnitus by more than 50% on their VAS scale
- The quieting plateaued after 6 to 14 P-Stim applications.
- The 5 responders had all had periods when their tinnitus was not heard.
- The 2 non-responders did not.

Excerpts, letter from Subject 11:
Date: March 24, 2010
I have been suffering for a year with pulsatile tinnitus. I felt like the Salvation Army Christmas bell ringers were in my head—specifically my right ear.

I could not sleep. I felt differently concentrated at work and began to suffer from anxiety attacks.

I am a big manager and research scientist at MIT and my job performance was definitely affected by my disability. Many people were counting on me to keep things organized and functioning, and I could barely function myself.

Monthly, sometimes weekly I visit to many different medical specialists, along with imaging and auditory tests gone me the same answer—there was nothing seriously wrong with me and I have to learn to live with the ringing....living with the ringing required medication and brought me to the line of depression.

I began my treatment on Wednesday December 18, 2008. I have returned each week for a treatment and now, three months later, the ringing has been reduced to near zero.

I am not exaggerating when I say this treatment has saved my health—physical and mental. The P-stim worked gradually; reducing the noise levels somewhat imperceptibly at first. But having kept a daily log for over three months I have tracked the progress and cannot believe it was so measurable for so long without hope of it ending.

Discussion:
This successful open trial of P-Stim for somatosensory pulsatile tinnitus syndrome supports the approach we have previously used successfully for typewriter tinnitus (1, 2, 3): (1) identify distinct tinnitus “subtypes” based upon their clinical features, (2) hypothesize a mechanism for the subtype’s pathophysiology based upon known physiology, and (3) design a treatment based upon this hypothesis.

Are the results a placebo effect? This is very unlikely for several reasons:

1. Several of the subjects had been treated with other modalities and had not sustained benefit.
2. In our initial trial of P-Stim for 22 subjects with several different tinnitus syndromes, only somatosensory pulsatile tinnitus syndrome and tinnitus with deep ear pain appeared to respond.
3. Subject 82 responded to P-Stim multiple times.
4. Initially his tinnitus quieted after 11 treatments. Over the next 6 months his tinnitus loudness gradually increased.

His tinnitus abated again with another 10 P-Stim treatments. But after another 6 months his tinnitus loudness again worsened and again it responded to more P-Stim treatments.

Many questions are raised by our results.
1. Why did 2 subjects (#8 & #9) not respond? The number of subjects who completed the trial is too small to try to answer this question. More experience is needed. One clue may be that neither subject had any periods of complete tinnitus suppression with P-Stim, despite a large number of applications.
2. What is the mechanism by which continuous electrical stimulation of the auricle quiets somatosensory pulsatile tinnitus? Is the quieting of tinnitus by auricular stimulation closely related to the quieting of tinnitus by strong muscular contractions of the head and neck? Would other subjects with other types of tinnitus, which can be quieted by intense jaw or neck muscle contractions be the subjects most likely to quiet their tinnitus with P-Stim?
3. The auricle is innervated by the upper cervical roots, the vagus nerve and the trigeminal nerve (1, 2). Is stimulation of one of these nerves more important than others? Would vagal nerve stimulation in the neck be more or less effective?
4. Is electrical stimulation necessary? Subject 11’s continued improvement after her last P-Stim may be due to her wearing in her auricle mechanical, but not electrical, acupuncture needles. These semi-permanent acupuncture needles were worn for 1 to 2 weeks.

References:
1. Levine RA, Nam EC, Melcher J. (2008) Somatosensory pulsatile tinnitus syndrome: somatic testing identifies a pulsatile tinnitus subtype that implicates the somatosensory system, such as periauricular electrical stimulation and auriculotherapy (acupuncture applied to the auricle), support the hypothesis that these modalities can benefit individuals with somatic tinnitus.
2. Levine RA, Nam EC, Melcher J. (2008) Periauricular electrical stimulation can improve tinnitus in some subjects with somatic tinnitus (3)
3. The Stimulator
P-Stim is a battery powered disposable device designed to provide 1/sec electrical pulses to the auricle for 4 successive days. The 2 mm long, 0.4 mm diameter needles are placed on the auricle at low electrical impedance points which are nearby blood vessels. Typically 2 electrodes are placed in the cymba conchae and 1 in the triangular fossa.

Methods:
The Protocol
- P-Stim was placed on either auricle by the investigator where it remained for 4 days.
- The subject then disposed of it.

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Subjects were to receive P-Stim weekly until their response plateaued.

Conclusions:
Most people with somatosensory pulsatile tinnitus syndrome respond to P-Stim treatments.
(a) 70% have sustained quieting of their tinnitus
(b) 83% have minutes to hours of no tinnitus