THE LINK BETWEEN TINNITUS AND MYOFASCIAL TRIGGER POINTS

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The 2 most common causes of tinnitus are:
  1. Hearing Loss
  2. Muscle problems of the head and neck
1. How does hearing loss cause tinnitus
2. SOMATIC COMPONENT OF TINNITUS –
   Head & Neck disorders are related to tinnitus
   a. How I came to this conclusion from my clinical experience
   b. How this led to the concept of the SOMATIC TINNITUS SYNDROME
      SOMATIC TESTING examining for SOMATIC modulation of tinnitus
      Somatosensory Pulsatile Tinnitus Syndrome
3. HOW does the Somatosensory [Proprioceptive] System cause tinnitus

4. WHY does the Somatosensory [Proprioceptive] System cause tinnitus

5. HOW to treat the Somatic Component of tinnitus
   - Current status
Background: Review auditory anatomy & physiology
Background: Review auditory anatomy & physiology
Background: Review auditory anatomy & physiology
Background: Review auditory anatomy & physiology

AUDITORY Pathway

Cochlea

Auditory Nerve

Ventral Cochlear Nucleus

Dorsal Cochlear Nucleus

Brain
• Dorsal cochlear nucleus

• Ventral cochlear nucleus
How hearing loss causes tinnitus
How hearing loss causes tinnitus

Hypothesis: DISINHIBITION of DORSAL COCHLEAR NUCLEUS

AUDITORY Pathway

Cochlea

Auditory Nerve

DECREASED Auditory Nerve Spontaneous Activity

Brain

INCREASED Dorsal Cochlear Nucleus Spontaneous Activity

Ventral Cochlear Nucleus

Dorsal Cochlear Nucleus

EAR TINNITUS

INCREASED Auditory Nerve Spontaneous Activity
Talk Outline -1

1. How does hearing loss cause tinnitus

2. SOMATIC COMPONENT OF TINNITUS –
   Head & Neck disorders are related to tinnitus
   a. How I came to this conclusion
      from my clinical experience
CASE 1
(facial muscles)

- Somatic Disorder: **RIGHT** FACIAL PAIN from smile exercises

- Tinnitus: Began Immediately, **RIGHT** UNILATERAL
  - audiogram unchanged
CASE 2
(cervical muscles)

- Somatic Disorder: left post auricular pain,
  - From fall on ice

- Tinnitus: LEFT UNILATERAL
  - audiogram unchanged
  - tinnitus was closely associated with head movements

February 1989
March 1992

CASE 3
(jaw muscles)

- Somatic Disorder: double cleft palate
- Tinnitus: Began Immediately with Yawning
  - LEFT UNILATERAL
  - audiogram symmetric
  - tinnitus stops with jaw pressure
  - louder with temple pressure, but not if opposed
March 1992

**CASE 4**
(evocable)

- **Somatic Disorder:** None
- **Tinnitus:** RIGHT only whenever R malar pressure
- **80 year old physician**
CASE 5
(upper cervical)

- Somatic Disorder: **RIGHT C2 Block**

- **Tinnitus:** Began Immediately, **RIGHT UNILATERAL**
  - audiogram normal
  - tinnitus matched to 6 kHz, 5 dB SL
  - tinnitus unchanged > 17 years

May 1994
CASE 6
(neck muscles)

- **Somatic Disorder:** Left lateral suboccipital muscles enlarged and tender

- **Tinnitus:** Began Immediately with neck manipulation
  - intermittent **LEFT UNILATERAL**
  - mixed Left hearing loss
  - following my neck exam her Left tinnitus began
    » Muscle tension much increased
Had been highly distressed for 7 months due to **RIGHT** ear tinnitus,
No Tinnitus for 2 months.
Audiogram normal.
Right sternocleidomastoid contraction elicited tinnitus identical to her prior right ear tinnitus.

CASE 7
(Neck Muscle)

Quiescent unilateral tinnitus reactivated by Neck muscle contraction
1. How does hearing loss cause tinnitus

2. SOMATIC COMPONENT OF TINNITUS –
   Head & Neck disorders are related to tinnitus
   
   a. How I came to this conclusion from my clinical experience
   
   b. How this led to the concept of the SOMATIC TINNITUS SYNDROME
SOMATIC TINNITUS SYNDROME: CLINICAL FEATURES

• Somatic disorder of head or upper (lateral) neck
  – temporally associated with the tinnitus

• Usually UNILATERAL Tinnitus IPSILATERAL to the somatic disorder

• No associated hearing change at onset

• Often fluctuating, may be intermittent or cyclical
Talk Outline -1

1. How does hearing loss cause tinnitus

2. SOMATIC COMPONENT OF TINNITUS –
   Head & Neck disorders are related to tinnitus
   
   a. How I came to this conclusion from my clinical experience
   
   b. How this led to the concept of the SOMATIC TINNITUS SYNDROME
      SOMATIC TESTING
      examining for SOMATIC modulation of tinnitus
In addition to the series of cases of “Somatic Tinnitus” that appear to be accounted for by somatosensory (proprioceptive) auditory interactions.

We (as well as many others) had noted that many tinnitus patients had found that they could modify their tinnitus by head and neck muscle contractions.

We refer to this as SOMATIC MODULATION of tinnitus.
- and about 13 years ago we began to collect systematic data.
When interviewed, ~20% of our clinic patients report somatic modulation.
EXAMPLE of Somatic Modulation

- 56 y.o. man

- Left ear tinnitus: Began Immediately, following a yawn
  - tinnitus disappears with jaw pressure
  - tinnitus increases with left temple pressure
    » but not if opposed by right temple pressure
SOMATIC MODULATION of Tinnitus

How PREVALENT in a TINNITUS CLINIC?
“Somatic Testing”

- Twenty-five brief forceful muscle contractions or compressions
  - Involving **head, neck, and jaw**
- For each contraction, subjects reported any tinnitus changes
Clinical Subjects (N=128)

Somatic testing changed tinnitus in 76% of clinical tinnitus subjects

No Change 24%

Tinnitus Changed 76%

Levine, 2000
SOMATIC MODULATION of Tinnitus

How PREVALENT in Non-clinical Subjects?
All Non-Clinical Subjects (60 Subjects)

Aware of Tinnitus 20%

Unaware of Tinnitus 34%

No Tinnitus 45%
Non-Clinical Subjects With tinnitus (54%)
Somatic testing changed tinnitus
In 75% of Non-Clinical subjects who had **ONGOING TINNITUS AT THE TIME OF TESTING**

- No Change 25%
- Tinnitus Changed 75%
Non-Clinical Subjects
Without tinnitus (45%)
Somatic testing elicited tinnitus

In 50% of **Non-Clinical** subjects initially **WITHOUT TINNITUS**

- Tinnitus elicited 50%
- No tinnitus elicited 50%
SOMATIC MODULATION of tinnitus

• Is as common in a NON-CLINICAL population as in a CLINICAL population
SOMATIC TESTING can often induce transient tinnitus in non-tinnitus subjects.
SOMATIC TESTING of PROFOUNDLY DEAF (N=14)

11 WITH tinnitus
  6 could modulate their tinnitus

3 WITHOUT tinnitus
  2 had transient tinnitus (unilateral)
SOMATIC MODULATION of tinnitus

• Somatic Modulation does not require a functioning ear

• Somatosensory-auditory neural interactions within the central nervous system can account for somatic modulation of tinnitus
• Somatic modulation is a fundamental attribute of tinnitus.

• Somatosensory-auditory neural interactions within the central nervous system can account for
  – the Somatosensory Tinnitus Syndrome
  – Somatic Modulation of tinnitus
  – Inducing tinnitus in non-tinnitus subjects with somatic testing
1. How does hearing loss cause tinnitus

2. SOMATIC COMPONENT OF TINNITUS –
   Head & Neck disorders are related to tinnitus
   a. How I came to this conclusion from my clinical experience
   b. How this led to the concept of the SOMATIC TINNITUS SYNDROME
      SOMATIC TESTING examining for SOMATIC modulation of tinnitus
      Somatosensory Pulsatile Tinnitus Syndrome
• I have been advocating “Somatic Testing” as a routine part of the clinical examination because it can elucidate these interactions.

• Now I will show how it has led to the identification of a new clinical entity, the “somatosensory pulsatile tinnitus syndrome.”
Somatosensory Pulsatile Tinnitus Syndrome: Somatic Testing Identifies a Pulsatile Tinnitus Subtype That Implicates the Somatosensory System

Robert Aaron Levine, MD, Eui-Cheol Nam, PhD, MD, and Jennifer Melcher, PhD
SOMATIC TESTING has become a routine part of the tinnitus evaluation

58 yo man with non-lateralized **PULSATILE** tinnitus

<table>
<thead>
<tr>
<th>Age</th>
<th>58</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>M</td>
</tr>
<tr>
<td>Tinnitus Description</td>
<td>slightly lower in pitch than a teakettle</td>
</tr>
<tr>
<td>Onset</td>
<td>bilateral</td>
</tr>
<tr>
<td>Audiogram</td>
<td>normal</td>
</tr>
<tr>
<td>Jugular Compression</td>
<td>negative</td>
</tr>
<tr>
<td>Carotid Compression</td>
<td>negative</td>
</tr>
<tr>
<td>Somatic Testing</td>
<td>Multiple maneuvers abolish AS; AD decreased 70% &amp; non-pulsatile from L SCM contraction</td>
</tr>
<tr>
<td>Other</td>
<td>Arteriogram negative; ipsilateral tinnitus louder with upward ear canal pressure</td>
</tr>
</tbody>
</table>

Left ear pulsatile tinnitus **abolished** with multiple maneuvers

With left sternocleidomastoid contraction

Right ear pulsatile tinnitus became **non-pulsatile** and 70% quieter

**Somatosensory pulsatile tinnitus syndrome**
13 cases of pulsatile tinnitus with no etiology
  - 6 non-lateralized, 7 unilateral
  - constant, cardiac-synchronous and high-pitched
  - negative imaging, CBC, thyroid profile
  - no bruits
  - jugular compression negative
  - carotid compression negative in 10 of 13

Somatic Testing Suppressed Pulsations in Every Subject
  - 9 abolished their tinnitus
  - 4 suppressed the pulsatile quality
    » It was replaced by a high-pitched, non-pulsatile tinnitus
A 14th patient had these same features but her left pulsatile tinnitus was intermittent.

When examined she was experiencing no tinnitus.

Pressure against her left auricle from behind, at its attachment to the skull, transiently induced her left pulsatile tinnitus.

We conclude that

pulsatile tinnitus can be both induced and suppressed by activation of the somatosensory system of the head or upper lateral neck.
Continuous auricular electrical stimulation has quieted (by >50%) the tinnitus of 2/3 of our subjects with somatosensory pulsatile tinnitus syndrome.
Talk Outline - 2

3. HOW does the
   Somatosensory [Proprioceptive] System cause tinnitus
Neurology of Hearing Loss Tinnitus

AUDITORY Pathway

Cochlea

Auditory Nerve

Ventral Cochlear Nucleus

Dorsal Cochlear Nucleus

Brain
SOMATIC TINNITUS SYNDROME: CLINICAL FEATURES

UNILATERAL Tinnitus

Somatic disorder of head or upper neck

Unilateral Tinnitus IPSILATERAL to the somatic disorder
Note that above the level of the cochlear nuclei, the auditory system is both crossed and uncrossed.

For unilateral tinnitus, then, it likely originates from the cochlear nuclei, auditory nerve or cochlea.
Neural Circuitry of Somatic Tinnitus: An Hypothesis
Somatic disorder of head or upper neck

Neural Circuitry of Somatic Tinnitus: An Hypothesis

V
VII
IX
X
C2
STT
VCN
DCN
CST (VII,IX,X)
Pons
Medulla
MSN
FC
Spinal Cord
Unilateral Tinnitus
IPSILATERAL
to the somatic disorder

Neural Circuitry of Somatic Tinnitus: An Hypothesis
SOMATIC TINNITUS SYNDROME
Hypothesis: DISINHIBITION of DORSAL COCHLEAR NUCLEUS

SOMATIC Pathway

Head

Cranial Nerves

Dorsal Cochlear Nucleus

INHIBITION

Medullary Somatosensory Nucleus

Spinal Nerves

Neck

Brain
Only stimuli that activate pinna muscle receptors, such as stretch or vibration of the muscles connected to the pinna, were effective in driving DCN units, whereas cutaneous stimuli such as light touch, brushing of hairs, and stretching of skin were ineffective.

Kanold, P.O. and Young, E.D. (2001) Proprioceptive information from the pinna provides somatosensory input to cat dorsal cochlear nucleus.
The Neurology of **UNILATERAL** Tinnitus

1. Hearing loss tinnitus – Disinhibition of DCN
2. Somatic (somatosensory, proprioceptive) tinnitus -- Disinhibition of DCN
Levine, RA. (1999) Somatic (craniocervical) tinnitus and the dorsal cochlear nucleus (DCN) hypothesis
3. HOW does the Somatosensory [Proprioceptive] System cause tinnitus

4. WHY does the Somatosensory [Proprioceptive] System cause tinnitus
   i.e. Why does the Somatosensory [Proprioceptive] System project to the Dorsal Cochlear Nucleus

   **Because the DCN is a Pattern Recognizer**
WHY DO PROPRIOCEPTIVE INPUTS FROM THE NECK PROJECT TO THE DCN?

**Because the DCN is a Pattern Recognizer**

The DCN is involved in up-down and front-back sound localization (Sutherland et al., 1998).

By using spectral cues – modifications in the acoustic spectra produced by the interactions of sound with the external ear, the DCN can determine the sound location with respect to the ear.

However, in order to know the position of the sound in SPACE, it needs to know the position of the head (ears).

The position of the head (ears) is provided by the proprioceptive input from the neck muscles and tendons.

Oertel & Young (2004)
WHY DO PROPRIOCEPTIVE INPUTS FROM THE NECK PROJECT TO THE DCN?

BECAUSE THE DCN IS A PATTERN RECOGNIZER

Neck Muscles

Provide HEAD POSITION information extracted from the neck somatosensory (proprioceptive) inputs.

By integrating these two kinds of information the central nervous system can infer where in space a sound source is located.
WHY DO PROPRIOCEPTIVE INPUTS FROM THE HEAD (JAW) PROJECT TO THE DCN?

BECUSE THE DCN IS A PATTERN RECOGNIZER
The Electrosensory Nuclei of the mormyrid electric fish and the Dorsal Cochlear Nucleus (DCN) have a similar STRUCTURE (both are CEREBELLUM-like) therefore The Electrosensory Nuclei of fish and Dorsal Cochlear Nucleus (DCN) probably have a similar FUNCTION

Bell, Bodznick, Montgomery, Bastian (1997)
The electrosensory nuclei of fish use “SENSORY SUBTRACTION” to subtract out self-generated ELECTRICAL signals from the total signal in the electrosensory nuclei to obtain the environmental ELECTRICAL signals.

The DCN has a CEREBELLAR-LIKE organization resembling that of these electrosensory nuclei which leads to the hypothesis that
The DCN hypothesis
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Inputs from the head (jaw) muscles to the DCN allows the DCN to use “SENSORY SUBTRACTION” to subtract out self-generated ACOUSTICAL signals from the total signal in the DCN to obtain the environmental ACOUSTICAL signals.

These self-generated *acoustical* signals are our respirations, chewing, vocalizations, and HEART BEATS.

(Haenggeli et al. 2005; Shore 2005).
Recall that a distinct characteristic of the somatosensory pulsatile tinnitus syndrome is that Somatic Testing Suppressed Pulsations (heart beats) in Every Subject

This suggests that this type of pulsatile tinnitus involves the somatosensory system and may be due to a failure of the DCN to suppress the normal self-generated sound of our heart beats.

Suppression of pulsatile tinnitus with somatosensory activation from somatic testing may represent a temporary correction of this malfunction.
Neurology of Somatosensory Tinnitus

AUDITORY Pathway
- Cochlea
- Auditory Nerve
- Ventral Cochlear Nucleus
- Dorsal Cochlear Nucleus

SOMATIC Pathway
- Head
- Cranial Nerves
- Spinal Nerves
- Medullary Somatosensory Nucleus
- INHIBITION

Levine, RA. (1999) Somatic (craniocervical) tinnitus and the dorsal cochlear nucleus (DCN) hypothesis
We conclude that

THE DORSAL COCHLEAR NUCLEUS TINNITUS HYPOTHESIS

Can not only account for

Somatic tinnitus and somatic modulation of tinnitus, but can also account for the SOMATOSENSORY PULSATILE TINNITUS SYNDROME
CONCLUSION:

THE LINK BETWEEN TINNITUS AND MYOFASCIAL TRIGGER POINTS IS THROUGH PROJECTIONS FROM THE PROPRIOCEPTIVE SYSTEM TO THE AUDITORY BRAIN -- IPSILATERAL DORSAL COCHLEAR NUCLEUS
3. HOW does the Somatosensory [Proprioceptive] System cause tinnitus

4. WHY does the Somatosensory [Proprioceptive] System cause tinnitus i.e. Why does the Somatosensory [Proprioceptive] System project to the Dorsal Cochlear Nucleus

5. HOW to treat the Somatic Component of tinnitus - Current status
HOW TO TREAT THE SOMATIC COMPONENT OF TINNITUS?

Deactivate the trigger points
Deactivate the trigger points

**Travell & Simon:** Masseter and SCM

**Wyant:** *Injected* Ipsilateral Splenius and Scalenes
- No tinnitus up to 4 months

**Estola-Partanen,** 2000: 178 subjects *injected* within 10 days 15% transiently had no tinnitus

**Wright and Bifano,** 1997: *TMD treatments*
Tinnitus resolved in >50% of those with moderate to severe tinnitus
Deactivate the trigger points

Teachey: **INJECTIONS** of Upper Trapezius, Levator scapulae & SCM
“Tinnitus is one of the more difficult symptoms in the head and neck to effectively treat”

Sanchez: **PRESSURE RELEASE** of 8 muscles: infraspinatus, levator, upper trapezius, splenius, SCM, masseter and temporalis
8% tinnitus abolished for more than 3 months
better response if
normal hearing
quieting with somatic testing
Deactivate the trigger points

**Levine:**
31 yo M with 1 year of Left tinnitus 2 weeks after striking head; all studies normal
Large fluctuations but always heard
Left splenius trigger point (TP)
pressure on TP doubles tinnitus loudness
*Injection* of TP – no tinnitus for 3 hrs
Deactivate the trigger points

Levine:
80 yo F with symmetric congenital hearing loss
Left ear tinnitus after bumping head against door (1 month earlier).
No neck pain but mild Left sided headache
Within 10 mins in bed, tinnitus starts
Left splenius trigger point

With *icing and stretching* tinnitus resolved
3. HOW does the Somatosensory [Proprioceptive] System cause tinnitus

4. WHY does the Somatosensory [Proprioceptive] System cause tinnitus
   i.e. Why does the Somatosensory [Proprioceptive] System project to the Dorsal Cochlear Nucleus

5. HOW to treat the Somatic Component of tinnitus
   - Current status
   - Future Directions
Systematic studies that characterize
(1) the tinnitus
(2) the location of trigger points
and
(3) response to treatments
• Collaborators

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