Evaluation and Treatment of Pulse-synchronous Tinnitus
Recorded January 24, 2013

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Tinnitus

• Perception of sound in the absence of an external sound source
• Objective tinnitus:
  – Arising from a true, objective mechanical sound source within the body
• Subjective tinnitus
  – A purely electrochemical phenomenon
    • Arising in the ear
    • Arising in the central nervous system

Objective tinnitus

• Non-pulse synchronous
  – Middle ear myokymia
    • Tensor tympani
    • Stapedius
  – Palatal myoclonous
  – Ear canal or ear drum foreign bodies
    • Hair
    • Cockroach
• Pulse synchronous
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Pulse Synchronous Tinnitus

- Abnormal sound production
  - Middle ear vascular tumors
  - Carotid artery abnormalities
    - Aberrant carotid artery
    - Carotid bruit
  - Dural AVM
  - Sigmoid sinus anomalies
  - Idiopathic intracranial hypertension
  - Transverse sinus stenosis

- Abnormal sound perception
  - Eustachian tube dysfunction
    - ET obstruction
    - Patulous ET
  - Middle ear effusion
  - Cerumen impaction
  - Superior canal dehiscence (3rd mobile window syndromes)
  - Meniere’s disease
  - Migraine?

Normal Anatomy:
CT Temporal bone

Normal anatomy:
Dural venous sinuses
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Evaluation:

History
• Onset
• Laterality
• Rhythmicity and quality
• Temporal factors
• Positional factors
• Previous trauma
• Associated symptoms:
  • Headache
  • Blurry vision
  • Hearing loss
  • Autophony or audible respirations

Evaluation: Physical exam
• Complete Head, Neck and Neurotologic exam; fundoscopic exam
• Palpation of pulse
• Auscultation
  – Over mastoid process
  – In ear canal
  – Neck
• Neck rotation
• Vascular compression
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Evaluation: Diagnostic testing

• Complete audiogram with immitance
• Temporal bone CT scan
  – 0.6 mm overlapping cuts
  – axial and coronal views
  – reformats in plane of SSCC
• MRA/MRV vs. CTA/CTV
• Catheter angiography

Three important causes of PST

• Superior semicircular canal dehiscence syndrome
• Idiopathic intracranial hypertension
• Sigmoid sinus diverticulum and sinus wall dehiscence ("Sinus wall anomalies")

Superior semicircular canal dehiscence syndrome

Diagnostic highlights:
• Autophony and aural fullness
• Sensitivity to sounds
• Vertigo in response to loud sounds or pressure
• Conductive hearing loss with intact reflexes
• Decreased thresholds and increased amplitude on VEMP (Ocular VEMP's)
• CT findings
Post-op CT scan

Right mastoidectomy
Normal left superior canal
Posterior crus
Right superior canal

Third mobile window syndromes

• Superior canal dehiscence syndrome
• Enlarged vestibular aqueduct
• Deficient cochlear modiolus
• Labyrinthine fistulae
  – Trauma
  – Tumors
  – Carotid artery erosion

### Idiopathic Intracranial Hypertension (IIH)

**Typical patients**
- Female>>Male
- Obese
- Elevated cerebrospinal fluid pressure, without obstructions to outflow
- aka Benign Intracranial Hypertension (BIH) or Pseudotumor cerebri (PTC)

**Signs and symptoms**
- Headaches
- Nausea/vomiting
- Blurry vision
- Normal CT and MRI
- Pulse synchronous tinnitus

### Sinus Wall Anomalies

- Sigmoid sinus diverticulum
- Sinus wall dehiscence
Pathophysiology

• Venous outflow stenosis?
  • Ipsilateral
  • Contralateral
• Intracranial hypertension?
• Osseous deficiency?
• Turbulent flow?
• ???

Radiographic Diagnosis
Radiographic Diagnosis

Patients
- Retrospective study approved by University of Maryland Institutional Review Board (Protocol #HP-00044282; PI: David J. Eisenman)
- 33 patients (35 ears) that had surgery for Sigmoid Sinus Diverticulum or Dehiscence (SSDD) from 2007-13
- Uniform surgical technique for all patients

Patients
- 33 patients (2 bilateral)
  - 30 female
  - 3 male
- Laterality
  - 28 right ears
  - 7 left ears
- Majority with markedly elevated BMI
  - Mean 35 (18-24.9= normal; 25-29.9= overweight; >30= obese)
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Repair of sigmoid sinus diverticulum
Outcomes

- Age range: 14-70 years (median 47 years)
- Symptom duration 3 months- >10 years
- 26 right ears; 7 left ears
- All but 3 patients with complete relief from Pulse-synchronous tinnitus (PST) at last follow-up
- All 3 failures were on left side (??)
- Follow-up 3-41.5 months (median 11.5)
  - No recurrences over follow-up period

Complications

- Patient LM
  - 21 year old female
  - Dehiscence without significant diverticulum
  - PST audible in external auditory canal
  - Uneventful procedure; immediate relief from PST
  - 24 hours post-op presented with visual loss and elevated intracranial pressure
Complications

• Patient MA
  – 34 year old female
  – Right PST
  – Uneventful procedure; immediate relief from PST
  – Progressive post-operative headache beginning immediately after surgery

Conclusions

• PST can be due to abnormal production or abnormal perception of a vascular somatosound
• Unlike idiopathic, non-rhythmic tinnitus, a specific cause can be identified in a majority of cases
• Many of these cases have treatable interventions with a high rate of cure
• Radiographic findings of sinus wall anomalies may be subtle and are easily overlooked
• Objective criteria have yet to be delineated
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Q&A

To ask a question, please type your question into the chat box in the lower left corner of the screen and click on the “Send” button located right below the box.