FS104 FEATURED SESSION
Audiology NOW!
April 3, 2009

PEDIATRIC GRAND ROUNDS

Marilyn Neault, PhD
Amal Awdeh, AuD
Guangwei Zhou, ScD
Cheryl Edwards, MS
Brian Fligor, ScD

Children's Hospital Boston

Welcome to Children's Hospital Boston

- 397 bed pediatric medical center
- Department of Otolaryngology and Communication Enhancement
  - large
  - interdisciplinary

- Otolaryngology:
  - 13 attending MDs
  - 3 fellows
  - 3 residents
  - 43,000 visits/year
  - 6,000 surgeries/year
- Audiology:
  - 29 audiologists
  - 5 sites
  - >17,000 visits/year

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CASE #1
Atypical Unilateral Hearing Loss

Marilyn Neault, PhD

marilyn.neault@childrens.harvard.edu

In collaboration with Lynn Schwartz, MS, Ellyn Zitzer, MA, Guangwei Zhou, ScD, Margaret Kenna, MD, and Dennis Poe, MD

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Before we met her at age 13 years…

- PE tubes as toddler elsewhere (clinic #1), no audiograms
- Passed hearing screens age 4-7 years
- Mild left conductive hearing loss (at clinic #2) after ear infection at age 11-12 years
- 35-40dB left conductive hearing loss persisted (at clinic #2) after ear infection cleared; word recognition testing was not performed as hearing was worsening

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Before we met her at age 13 years…

- Because of language-based learning disability, she presented to clinic #3 for a central auditory processing evaluation at age 12 years
- CAP eval was deferred because unilateral severe hearing loss with poor word recognition was found
- MRI at clinic #3 was initially interpreted as unremarkable (later reread as showing an area of enhancement in the basal turn)
- Neuroepithelial dysfunction within the left cochlea was concluded
- Unilateral hearing loss management

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Our audiological findings: age 13 years

- **Right ear**: normal
- **Left ear**:
  - severe mixed hearing loss
  - no word recognition
  - normal tympanogram
  - absent ipsilateral acoustic reflexes
  - absent DPOAEs
  - small cochlear microphonic with absent ABR waves

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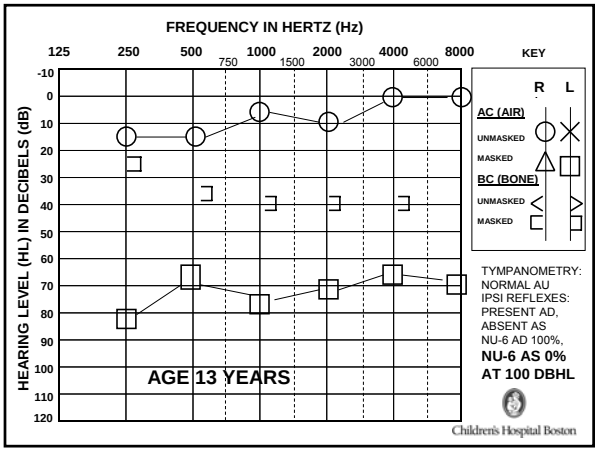

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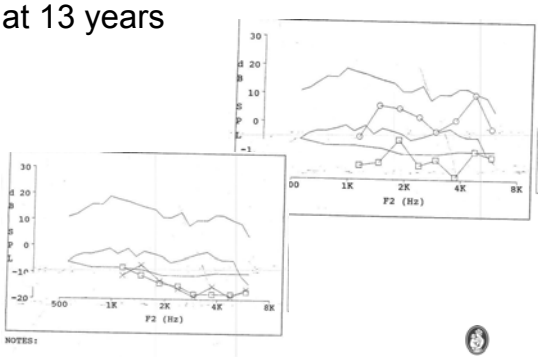
DPOAEs absent left, present right at 13 years



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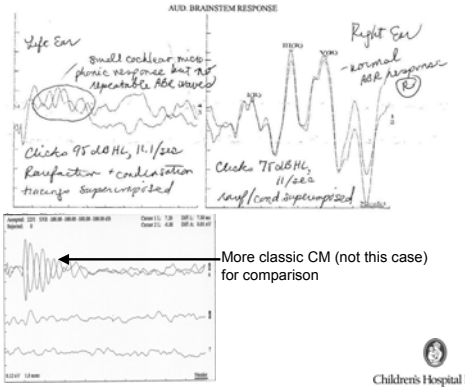
ABR at 13 years



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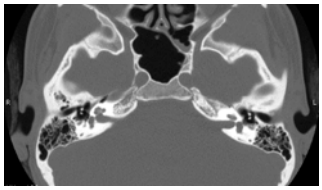
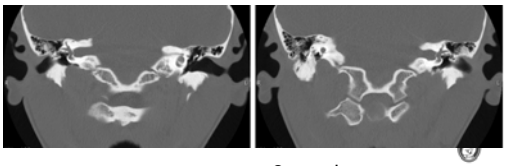
Normal IAC on CT scan



Axial



Coronal

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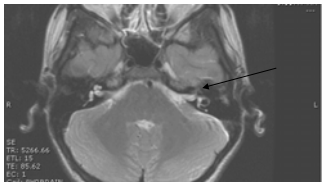
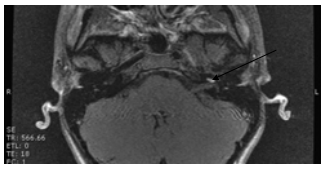


MRI FIESTA Axial View



MRI Post-Contrast Axial View

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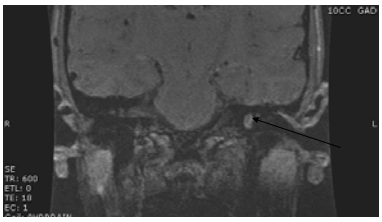
DIAGNOSIS: INTRACOCHLEAR SCHWANNOMA



MRI Post-Contrast Coronal View

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Watchful waiting

- No tinnitus, no vertigo
- NFII ruled out by Genetics
- Left hearing loss progressed to profound
- Tumor seen to grow slightly on MRI
- Decision made to remove it before it invaded the IAC

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Surgery

- Intracochlear schwannoma excised at age 16 years
- Tumor filled 2.5 turns of cochlea
- No intravestibular extension of tumor
- Postauricular, transcochlear excision
- Middle ear and Eustachian tube obliterated with soft tissue graft
- No residual tumor
- No resulting facial paresis or vertigo
- Followed annually

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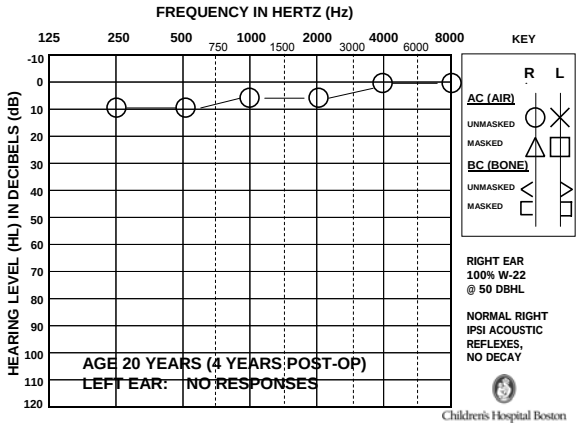

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Previously reported cases of intracochlear schwannoma

- Several isolated case studies
- May show some cochlear audiological findings
- Series of 19 patients seen over 18 years reported by Grayeli et al. (Otol. Neurotol. 2007)
  - Age 25-71 years, mean 54 years
  - Severe (11%) or profound (89%) loss seen in all patients when diagnosed
  - Consider the diagnosis for any unilateral hearing loss
  - Difficult to diagnose on MRI
  - Facial nerve at risk from tumor and removal

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Pediatric acoustic neuromas

- Rare outside neurofibromatosis type II
- Chen et al. (Am. J. Otol. 1992) reviewed 16 cases age 1-14 years; none were described as intracochlear
- Mazzoni et al. (Int. J. Ped.ORL 2007) described 10 non-NFII pediatric cases, none intracochlear
- Laury et al. (Int. J. Ped. ORL, 2009) reported a 13 year old with vestibular schwannoma in a pediatric series with unilateral neural loss

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Take Home Messages

- Schwannomas can arise in the cochlea, not just in the IAC and cerebellopontine angle
- Children can have schwannomas too
- Intracochlear schwannomas may present as the ultimate mixed hearing loss, with conductive, cochlear, and neural components developing
- Testing word recognition is important in children even if the loss appears conductive

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CASE #2
Exploring the etiology of a hearing loss: A collaborative approach

Amal G. Awdeh, AuD

Thank you to my colleagues Marilyn Neault, PhD
Guangwei Zhou, ScD and Margaret Kenna, MD

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Case History

- Initial diagnosis of hydronephrosis in-utero resolved in last weeks of gestation
- Born full term
- Gentamicin administered first 48 hours due to mother's presenting fever at delivery, thick meconium and concerns for infection
- Bilateral refer on newborn hearing screen
- No family history of childhood hearing loss

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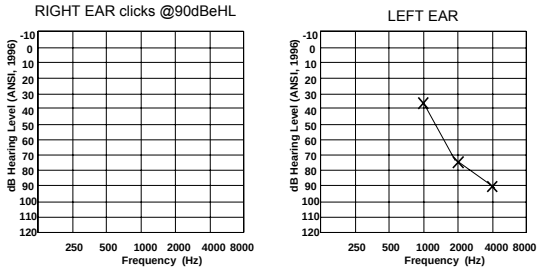
ABR estimated hearing levels (eHL) (13 days)



OTHER FINDINGS:
•Tympanometry (226 & 1000Hz) normal
•Middle Ear Muscle Reflex (MEMR) absent 1000-2000Hz; present 500Hz
•DPOAEs absent left, CNT right (noisy)

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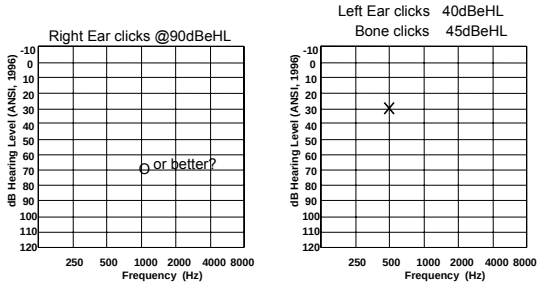
ABR eHL (1 ½ months)



OTHER FINDINGS
•Tympanometry (226&1000Hz): normal
•DPOAEs absent bilaterally (2-8KHz)
•Auditory neuropathy ruled out

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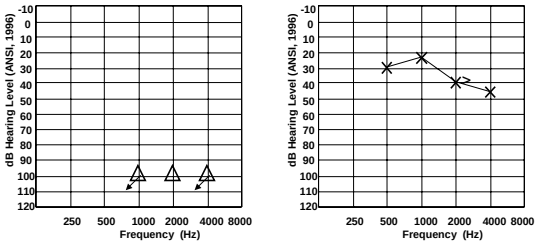
ABR eHL (2 months)



DPOAEs absent

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Interventions

- Amplification + FM for the left ear
- Early intervention: weekly home visits along with family attending a specialized parent-infant program
- Sign supported English (parents very involved in learning sign)
- Pediatric otolaryngology work-up for etiology of hearing loss in place

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Work-up to determine etiology

- CT-scan of the temporal bones unremarkable
- Genetic studies:
  - negative for mitochondrial mutations
  - negative for connexin 30 test
  - negative for Pendred syndrome
  - connexin 26 test showed 1 pathogenic mutation of 35delG (suggesting he is a carrier – not the likely cause of the hearing loss)
- Negative CMV test at 2 weeks of age
- Normal ophthalmology evaluation

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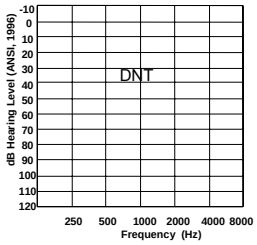
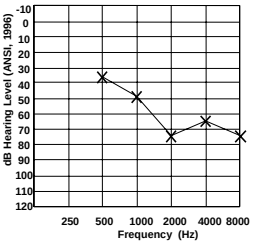
ABR eHL (4 ½ months)





Tympanometry (226&1000Hz) normal

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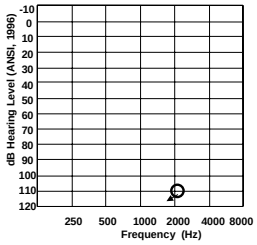
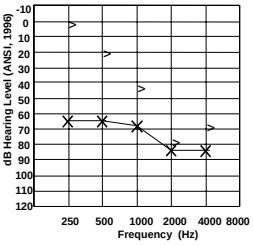
Audiogram (10 months)





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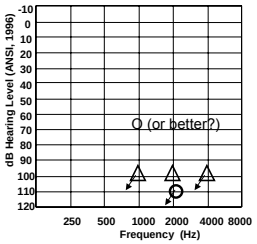
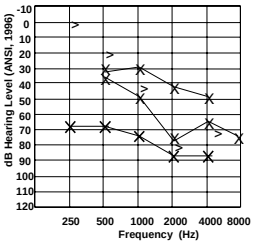
Fluctuations in hearing



O 1.5 months
△ 2 months
O 10 months



X 2 months
X 4.5 months
X 10 months

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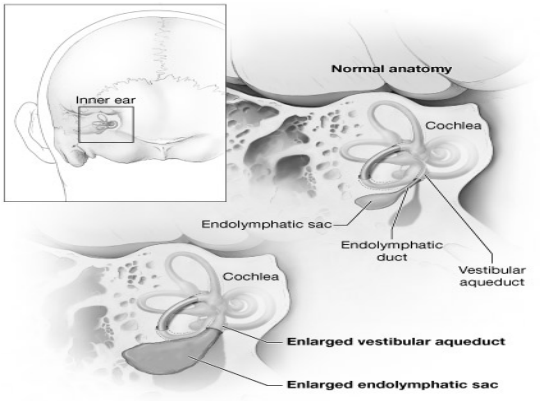

Enlarged Vestibular Aqueduct (EVA)

- Hearing loss congenital or develops later on
- Progressive/fluctuating
- May or may not be accompanied by vestibular symptoms;
- Unilateral or bilateral (Mori et al J Otolaryngol Head Neck Surg. 2008 in their systematic literature review found bilateral EVA 6 times more common than unilateral EVA)
- Previously reported in the literature as sensorineural hearing loss; however Zhou et al (Laryngoscope 11/08) suggests 80% of the 54 children with EVA in their retrospective study had either conductive/mixed hearing loss

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Enlarged Vestibular Aqueduct

- Vestibular aqueduct diameter > 1.5mm on CT-scan is generally accepted radiologic criteria (Valvassori & Clemis 1978) although there is continued debate on the normal range
- Can occur in isolation or with other cochlear malformations (ex. Mondini dysplasia)
- can be caused by mutation in the SLC26A4 gene (Chromosome 7)

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Recent hypothesis on air-bone gap in EVA

EVA acts a "third mobile window" (Merchant et al. Ann Otol Rhinol Laryngol. 2007)

- shunting of air-conducted sound away from the cochlea (through the enlarged vestibular aqueduct) elevates *air conducted* thresholds
- "third mobile window" increases the difference in impedance between the scala vestibuli side and the scala tympani side of the cochlear partition, improving *bone-conducted* thresholds.

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Testing for EVA

- Tympanometry, MEMR, DPOAEs
- Pure-tone audiometry (supra-normal bone thresholds including 250Hz)
- CT-scan or MRI imaging studies for clinical diagnosis
- VEMP - abnormally low threshold response an audiological sign in children in presence of non-middle ear related mixed/conductive hearing loss (Zhou et al, Laryngoscope 11/08)

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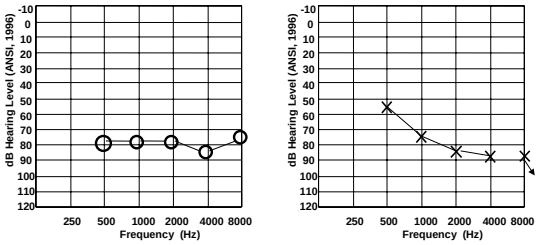
Audiogram at 17 months



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Changes in management plan

- Continue re-examining right ear
- Added amplification on the right side cautiously in light of improved thresholds (auditory nerve stimulation opportunity)
- Education on avoidance of head trauma/sudden barometric pressure changes
- Family awareness of possibility of progression
- Informational CI consult
- Early EVA diagnosis may prevent unnecessary surgical/exploratory procedure to correct low-frequency conductive loss

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Take Home Messages

- Important to try to determine site of origin of air-bone gap using tympanometry, MEMR, DPOAEs; VEMP
- EVA one of the contenders to consider when there is a conductive/mixed loss unexplained by healthy middle ears
- EVA a case of conductive hearing loss of inner ear origin

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CASE #3 AND #4
Conductive Hearing Loss in Children: Expect the Unexpected

Guangwei Zhou, Sc.D.

In collaborating with Dennis Poe, M.D., Quinton Gopen, M.D., Manali Amin, M.D., Laurie Ohlms, M.D., Dwight Jones, M.D., Jane Liberman, Au.D.

guangwei.zhou@childrens.harvard.edu

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Common Etiologies of CHL in Children

- External ear
  - Microtia and Atresia
  - Impacted cerumen
- Middle ear
  - Tympanic membrane perforation
  - Eustachian tube dysfunction
  - Otitis media with effusion
  - Irregularities of ossicular chain
  - Cholesteatoma

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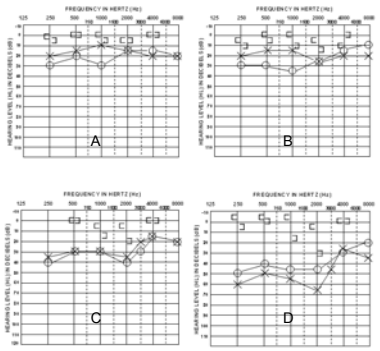
Serial audiograms of a children with CHL



Case 3:

12 yrs old girl

A.12/21/2001

B.12/10/2004

C.05/11/2006

D.02/09/2007

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Diagnosis and Treatment for Case 3

- Initially diagnosed with:
  - Eustachian tube dysfunction
  - Otitis media with effusion
  - Treated with PE tubes
- Follow-up:
  - CT scan of temporal bone
  - Malformation of ossicular chain
  - Fitted with binaural BTE

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"New" complaints

- Progression of CHL
- Sound distortion from right HA
- Dizziness/vertigo

→ Re-assessment

- Updated CT scan
- Acoustic reflex: Absent AU
- Vestibular Evoked Myogenic Potential (VEMP): Absent AS; Present AD

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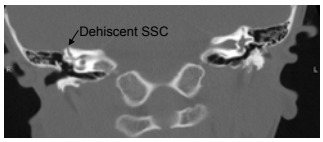
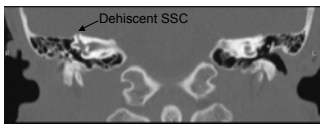


August, 2002



December, 2006

CT scans of temporal bone revealed dehiscent superior semicircular canal on the right side.

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Surgical Intervention

- Not intended to improve hearing;
- Risk of loss in hearing;
- Stop vestibular symptom.

- →Middle fossa craniotomy to plug dehiscent SCC

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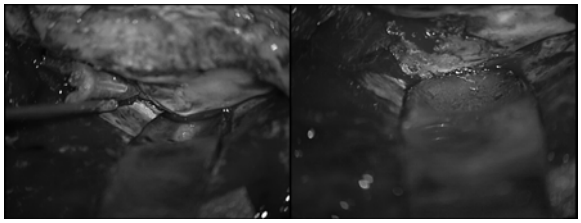
Surgical Repair / Plugging



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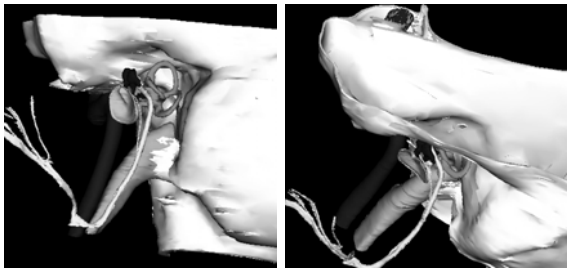
Superior Semicircular Canal Dehiscence (SSCD)

- Sound and/or pressure-induced vertigo due to dehiscence of the superior semicircular canal, Vertical-torsional eye movements.
  - **Minor et al. 1998**
- Patients can present with vestibular, auditory, or symptoms of both.
  - "**Minor Syndrome**"

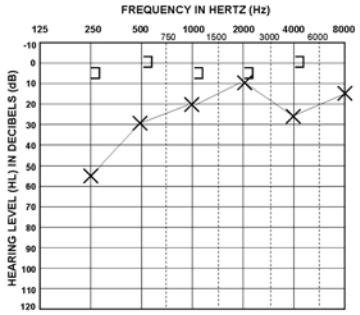
Location of SSCD in 3D



Audiology Profile of SSCD

- Low-frequency CHL, most often with better than 0 dB HL bone conduction threshold at lower frequencies (e.g., 250 and 500 Hz);
- Normal tympanometry, usually with intact acoustic reflexes;
- Abnormally low VEMP threshold and/or presence of VEMP responses with significant air-bone gap.

Case 4: CHL in a 8 yrs old boy



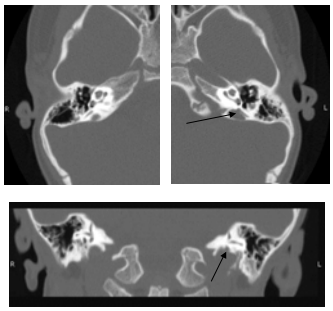
History & Management for Case 4

- Bilateral otitis media
  - Multiple sets of PE tubes
  - Improved hearing after each tube placement
  - Persistent low-frequency CHL on the left side
- Otology consultation:
  - Fixation of stapes?
  - Surgical correction?
  - CT scan of temporal bone: No EVA or SSCD

Further Evaluation for Case 4

- Audiologic testing
  - Tympanometry:
    Initially → Flat (effusion, PE tubes)
    Recent → Good mobility
  - 500 Hz tone-bursts elicited VEMP present at 70 dB nHL with high amplitude.
- Re-exam CT scan
  →Left posterior semicircular canal dehiscent to the high-riding jugular bulb.

Temporal bone CT scan revealed left PSCD



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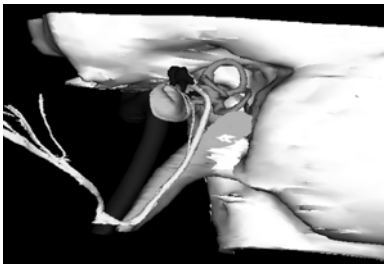
Location of PSCD in 3D



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Plan for Case 4

- Monitoring
  - Hearing loss
  - Changes in symptoms
  - No surgery planned
- Audiologic consultation
  - Use of FM system in classroom
  - Amplification?
- Avoid head injury

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Suspicious of CHL due to Non-middle ear pathologies

- Persistent air-bone gap despite treatment;
- Normal-like tympanogram, with intact acoustic reflexes;
- Unexplainable auditory complaints or findings;
- Vestibular manifestations.

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CHL attributable to Inner ear abnormalities

- Superior semicircular canal dehiscence (SSCD)
- Posterior semicircular canal dehiscence (PSCD)
- Enlarged vestibular aqueduct (EVA)
- Enlarged cochlear aqueduct
- Malformed cochlea and/or dilated vestibules
- Others

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Thank you!

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CASE #5
When Poor Reliability is Reliable

Cheryl Edwards, M.S.
cheryl.edwards@childrens.harvard.edu

With special thanks to Katie West, M.A.

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Initial Evaluation

- HS, age 4 years, presents for a hearing evaluation
- Assessed 3 times at another facility
  - First two: "inconclusive"
  - Third attempt: Normal hearing
- Parental concern continues
  - "What?", does not respond when called
  - Speech and language normal

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Initial Evaluation

- Tympanograms: normal
- Ipsilateral reflexes: present
- Responses were highly inconsistent to speech and tones
  - not expected based on dev. level
- Mild to moderate high frequency hearing loss could not be ruled out
- Re-evaluation recommended in 1 week

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Second & Third Evaluations

- DPOAEs: present bilaterally 1kHz – 6kHz
- Contralateral reflexes: present
- Play audiometry 1kHz – 4 kHz
  - Attention concerns persist
  - Normal thresholds, right
  - 25 dB HL at 1kHz, normal 2kHz – 4kHz, left
- Word recognition - WIPI
  - 40 dB HL: right 100% left 70%
- Re-eval recommended 6 mo

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Ongoing Management

- Referred to SLP
  - Developmentally appropriate artic. errors
  - Hoarse quality to voice
  - Required repetition of spoken language
- Audiological reevaluation age 5 yrs
  - Increasing parent and teacher concern
  - Discrimination errors
- Reliability again variable
  - "Stare off" for up to 30 sec intervals

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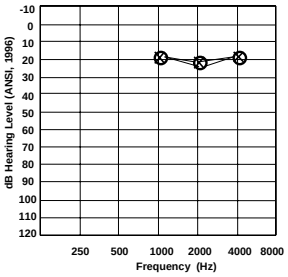
Results Age 5 Years



Word Recognition: PBK

50 dB: R 88% L 68%

Sound field FM system recommended

Referred to Neurology and Otolaryngology

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Medical Evaluations

- Neurology
  - EEG unremarkable
- Otolaryngology
  - Brain MRI was normal
  - CT revealed bilateral Mondini malformation

Subsequent Evaluations

- Mild/minimal low freq. fluctuating CHL
- Word recognition
  - poorer than expected based on pure tones
- ABR: normal
- Good days/bad days observed
- Discrimination errors persist with FM
- Presence of Mondini the explanation?

6 Years of Age

- HS began "acting deaf"
  - could only respond with visual cues
- "Staring off" behavior noted again
- 24 hour EEG
  - Abnormal bilateral spike and wave discharges activated by sleep, temporal lobe
- Diagnosis: Landau-Kleffner Syndrome

Landau-Kleffner Syndrome (LKS)

- Described 1957
- Acquired aphasia due to seizure activity
  - Spikes or sharp waves over temporal and/or parietal lobes on EEG
  - Activated by sleep, not behaviorally obvious
- Inability to recognize sounds
  - May appear HOH or deaf
  - Environmental sounds cannot be identified
- Normal pure tone audiogram

Landau-Kleffner Syndrome (LKS)

- Onset between 3-8 years
  - Males affected 2:1
  - Incidence?
- Generally normal intelligence
- Loss of receptive language skills and auditory perception
  - Disruption of developing cortical networks
  - Periods of regression and recovery

Landau-Kleffner Syndrome (LKS)

- Can read and write if skills already in place
- Some children recover completely
  - Earlier onset associated with poorer outcomes
  - Most have no seizure activity by adulthood
- About 50% are left with residual deficits
  - Functionally inappropriate connections during critical period?
  - Seizures controlled with medication
- Multiple subpial transection

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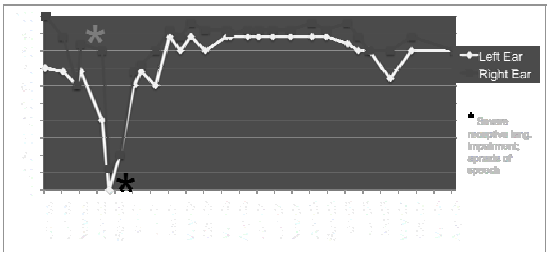
HS Word Recognition Over Time



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Auditory Processing

Age		9 years	10 years	11 years	11 years	12 years
Filtered Words	R	----	----	48	----	72
	L	----	----	44	----	36
Dichotic Digits	R	95	98	90	----	85
	L	18	30	40	----	63
Comp Sent	R	100	100	100	100	100
	L	0	0	0	0	0
		Binaural				
Pitch Patterns		0%	-----	20 %		

* No release of competition to levels 20 dB HL, R (test items presented at 50 dB HL, L)

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Treatment - HS

- Variety of medications for seizures
  - Understanding decreased if seizures were not well controlled
- Completed FastForWord
  - Some subjective improvement
- Has difficulty with learning musical instrument

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Educational Considerations

- Attention vulnerable with use of verbal information only
  - better sustained with visual or manipulative materials
- School placement was key
  - Started in auditory-oral program for HOH
  - Transferred to integrated class
  - Extremely small class size
  - Familiar teacher, consistent use of communication strategies, multimodality
  - Fluctuations occur, teacher adapts

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Educational Considerations

- Toteable sound field FM for several years
- Currently uses MicroEar FM on right ear
- Speech language pathologist
  - Monitors school program
  - Reading
    - Phonological processing
  - Higher level language

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Follow-up

- Now 15 years old
- Slightly more resistant to FM use
- Seen annually, sooner if concerns
  - Mother extremely good observer
- Scheduled for 24 hour EEG in June
  - Monitor for seizure activity

Closing Thoughts

- Parent concern drove this diagnosis
- Collaboration
- If the answers don't add up, keep looking!

CASE #6
Prescriptive Fitting of Custom Hearing Protection for a Teenage Violinist
or…
Why a pediatric audiologist still needs to know hearing science

Brian J. Fligor, Sc.D.

15-year-old violinist with unilateral tinnitus

- 15-year-old violinist complained to her PCP of ringing in her left ear. Referred to CHB Audiology for evaluation.
- Violinist for 5 years, practices 5 days per week
  - Recent increase from 60 to 90 minutes per day

Is the unilateral tinnitus due to sound over-exposure (violin practice) or something else?

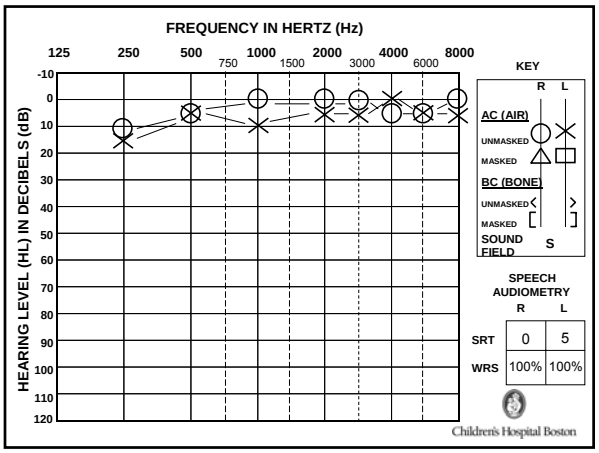
Evaluation

Primary Questions:

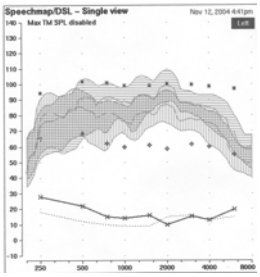
1. Does this patient have a noise-induced hearing loss (NIHL)?
2. Is this patient's violin practice the source of a hazardous sound exposure, accounting for her tinnitus, and sufficient to place her at risk for NIHL?
   (otologic and noise history otherwise unremarkable)
3. If so, what is the best approach for reducing her NIHL risk?

Elements of a Hearing Loss Prevention Program (HLPP)

- Noise Survey (assessment)
- Engineering Controls
- Audiometric Monitoring
- Education and Motivation
- Hearing Protection Devices (HPD)
  - Apply in a pediatric setting?



Real Ear sound level measure



Real Ear measures, Graphical View: Fortissimo (green curve) and mezzopiano (pink curve)

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Eardrum dB SPL: **Table view** on Verifit, 1/12 octave band RMS levels centered at audiometric frequencies.

Left Ear	Eardrum dB SPL								
Frequency (Hz)	250	500	750	1000	1500	2000	3000	4000	6000
fortissimo	57	83	97	87	97	100	89	83	76
mezzoforte	41	50	52	92	49	99	81	71	64
mezzopiano	43	88	71	82	81	92	73	63	55
Right Ear	Eardrum dB SPL								
Frequency (Hz)	250	500	750	1000	1500	2000	3000	4000	6000
fortissimo	46	78	58	85	89	96	92	77	57
mezzoforte	80	85	80	91	81	92	87	74	49
mezzopiano	52	60	82	90	90	89	87	80	57

Powersum across frequencies for Overall Level (OAL):
Convert dB SPL to intensity = $10^{(dB/10)}$

OAL dB SPL = $10*\text{Log}_{10}(10^{(L250/10)}+10^{(L500/10)}+\ldots+10^{(L6000/10)})$
(at the eardrum)

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Eardrum dB SPL: **Table view** on Verifit, 1/12 octave band RMS levels centered at audiometric frequencies.

Left Ear	Eardrum dB SPL									
Frequency (Hz)	250	500	750	1000	1500	2000	3000	4000	6000	OAL SPL
fortissimo	57	83	97	87	97	100	89	83	76	103.4
mezzoforte	41	50	52	92	49	99	81	71	64	99.9
mezzopiano	43	88	71	82	81	92	73	63	55	94.0
Right Ear	Eardrum dB SPL									
Frequency (Hz)	250	500	750	1000	1500	2000	3000	4000	6000	OAL SPL
fortissimo	46	78	58	85	89	96	92	77	57	98.3
mezzoforte	80	85	80	91	81	92	87	74	49	96.0
mezzopiano	52	60	82	90	90	89	87	80	57	95.5

Powersum across frequencies for Overall Level (OAL):
Convert dB SPL to intensity = $10^{(dB/10)}$

OAL dB SPL = $10*\text{Log}_{10}(10^{(L250/10)}+10^{(L500/10)}+\ldots+10^{(L6000/10)})$
(at the eardrum)

…But "Hazard" is measured in A-weighted decibels in the free-field

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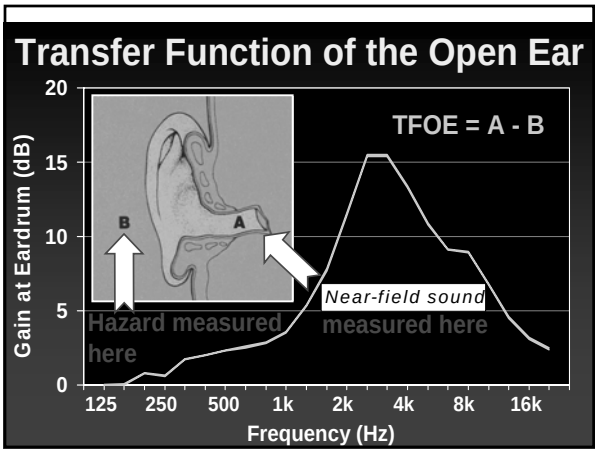

Overall dBA = Eardrum dB SPL(f) – TFOE(f) + A-weighting(f)

Frequency (Hz	250	500	750	1000	1500	2000	3000	4000	6000
Left ear TFOE	-1	-1	1	0	6	8	6	-9	-5
Right ear TFOE	4	-2	0	9	0	13	7	0	-6
A-weighting	-9	-3	0	0	0	1	1	1	0

Free-field equiv dBA =$10*\text{Log}_{10}(10^{\wedge}(L^{250}-(TFOE^{250})+(A\text{-}wt^{250})/10)+\ldots$

Powersum…

Overall dBA	Left Ear	Right Ear
music at ff	100.1	92.0
music at mf	95.2	89.5
music at mp	89.7	92.0

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Evaluation Question #2:
Is her violin practice sufficient to explain left-sided tinnitus?

i.e., given her practice duration and regularity, is her noise exposure potentially hazardous?

Overall dBA	Left Ear	Right Ear
music at ff	100.1	92.0
music at mf	95.2	89.5
music at mp	89.7	92.0

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Exposure Calculation

Equation 1

$$T = \frac{8 \text{ hours}}{2^{(L-85)/3}}$$

L = Level dBA (from REM)
T = Time to 100% Noise Dose Re: NIOSH Damage-risk

Equation 2

Noise Dose = C / T C = Exposure (practice) Time

Given free-field equivalent dBA and 90 minutes practice per day, 5 days/week:

passage at ff	dBA	Noise Dose %
Left Ear	100.1	614
Right Ear	92.0	95

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Evaluation Question #3:
What is the best way to reduce noise dose (ie, risk)?

NIOSH Damage Risk for 100% Noise Dose

Level dBA	Time 100%
85	8 hours
86	6 hours
87	5 hours
88	4 hours
89	3 hrs,10 min
90	2 hrs,30 min
91	2 hours
92	95 minutes
93	76 minutes
94	60 minutes
95	48 minutes
96	38 minutes
97	30 minutes
98	24 minutes
99	19 minutes
100	15 minutes

Option 2: Decrease exposure (practice) level

Option 1: Decrease exposure (practice) time

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Prescriptive HPD Fitting

NIOSH Damage Risk for 100% Noise Dose

Level dBA	Time 100%
85	8 hours
86	6 hours
87	5 hours
88	4 hours
89	3 hrs,10 min
90	2 hrs,30 min
91	2 hours
92	95 minutes
93	76 minutes
94	60 minutes
95	48 minutes
96	38 minutes
97	30 minutes
98	24 minutes
99	19 minutes
100	15 minutes

Option 2: Decrease exposure (practice) level

An ER9 Musicians Earplug should do it!

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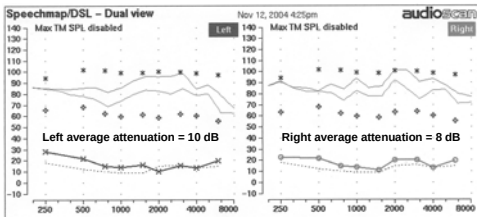
HPD Verification

How do we know the ER9 is doing what we think it does (provide 9 dB of attenuation at all frequencies)?



REM using 85 dB swept MPO signal
ER9 "in" (pink curve) and ER9 "out" (green curve)

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HPD Verification

Adequate reduction of noise dose?

Left ear overall attenuation = 10 dB
Time to 100% noise dose = 147 minutes
Noise Dose = 90 minutes/147 minutes = ~61%
Right ear overall attenuation = 8 dB
Time to 100% noise dose = 10 hours
Noise Dose = 90 minutes/10 hours = 15%

Noise Dose	No plug	with ER9
Left Ear	614%	61.4%
Right Ear	95%	15%

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Validation

Validation of fit: 2 months after initial fitting of ER9
Did it make a difference? Has use been accepted?

- ✓ Uses during *all* practice and recitals
- ✓ No tinnitus following practice
- ✓ Awareness she had headaches after practice prior to using ER9s, now headaches are absent
- ✓ Violin performance *improved*
- ✓ Practices consistently full 90 minutes
- ✓ Noticed difference in music quality when started using ER9s, but reported change in music quality was not unacceptable

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Elements of a Hearing Loss Prevention Program (HLPP)

- Noise Survey (assessment)
- Engineering Controls
- Audiometric Monitoring
- Education and Motivation
- Hearing Protection Devices (HPD)
- The finances:
  You are more obviously "selling" a service
  - 92596 "Ear Protector Evaluation"

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