Surgical and Non-Surgical Causes of Progressive Hearing Loss in Children: What can be done about it?

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WELL BEHAVED WOMEN RARELY MAKE HISTORY
Pediatric Progressive Hearing Loss

- Non-surgical
  - Genetic
  - CMV

- Surgical
  - Tympanic membrane retraction → Cholesteatoma
  - Tymanosclerosis
  - Otosclerosis
Pediatric Progressive Hearing Loss

- **Non-surgical**
  - Genetic
    - Connexin 26 and Enlarged Vestibular Aqueduct
    - CMV
  
- **Surgical**
  - Tympanic membrane retraction → Cholesteatoma
  - Tympanosclerosis
  - Otosclerosis
Genetic causes of SNHL

Sloan-Heggen et al 2016; Smith et al, unpublished data
GJ B2 (Connexin 26)

- DFNB1
- Gene: GJ B2 (gap junction beta 2)
- Connexin 26: protein
GJB2 (Connexin 26)

- Hearing loss ranges from mild to profound
- Majority congenital

More than 50% will have HL progression
  - generally gradual
  - occasionally precipitous
  - Influenced by genetics and other factors
GJB2 – Progressive hearing loss

- Kenna et al, 2010
- 126 patients with SNHL due to GJB2
  - 33% had bilateral profound SNHL when initially identified
  - 67% presented with mild to severe SNHL
  - 56% have had progression of their hearing loss
  - 3 of them possibly due to other causes

Kenna et al, Arch Otolaryngol Head Neck Surg. 2010
<table>
<thead>
<tr>
<th>Mutation</th>
<th>No. (%) of 225 Alleles Identified</th>
<th>Nontruncating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truncating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35delG</td>
<td>137 (53.9)</td>
<td></td>
</tr>
<tr>
<td>167delT</td>
<td>22 (8.7)</td>
<td></td>
</tr>
<tr>
<td>235delC</td>
<td>8 (3.1)</td>
<td></td>
</tr>
<tr>
<td>313_326del14bp</td>
<td>5 (2.0)</td>
<td>V37I 23 (9.4)</td>
</tr>
<tr>
<td>E47X</td>
<td>4 (1.6)</td>
<td>M34T 22 (9.1)</td>
</tr>
<tr>
<td>M1V</td>
<td>2 (0.8)</td>
<td>V84L 2 (0.8)</td>
</tr>
<tr>
<td>W24X</td>
<td>2 (0.8)</td>
<td>L90P 2 (0.8)</td>
</tr>
<tr>
<td>Q57X</td>
<td>2 (0.8)</td>
<td>N206S 2 (0.8)</td>
</tr>
<tr>
<td>176_191del16</td>
<td>2 (0.8)</td>
<td>S199F 2 (0.8)</td>
</tr>
<tr>
<td>299_300delAT</td>
<td>1 (0.4)</td>
<td>T8M 1 (0.4)</td>
</tr>
<tr>
<td>333_334delAA</td>
<td>1 (0.4)</td>
<td>G12V 1 (0.4)</td>
</tr>
<tr>
<td>453_460del8ins9a</td>
<td>1 (0.4)</td>
<td>K15T 1 (0.4)</td>
</tr>
<tr>
<td>631_632delGT</td>
<td>1 (0.4)</td>
<td>R32C 1 (0.4)</td>
</tr>
<tr>
<td>Total</td>
<td>188 (74.1)</td>
<td>I35S 1 (0.4)</td>
</tr>
</tbody>
</table>

Kenna et al, Arch Otolaryngol Head Neck Surg.2010
GJB2 – Progressive hearing loss

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Kenna et al, Arch Otolaryngol Head Neck Surg. 2010
## GJB2 - Progressive hearing loss

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>Progressive HL</th>
<th>Non-progressive HL</th>
</tr>
</thead>
<tbody>
<tr>
<td>White, non-Hispanic</td>
<td>40 (85%)</td>
<td>24 (65%)</td>
</tr>
<tr>
<td>White, Hispanic</td>
<td>3 (6%)</td>
<td>5 (14%)</td>
</tr>
<tr>
<td>Asian</td>
<td>2 (4%)</td>
<td>7 (19%)</td>
</tr>
<tr>
<td>African American and white</td>
<td>2 (4%)</td>
<td>0</td>
</tr>
<tr>
<td>Asian and white</td>
<td>1 (2%)</td>
<td>1 (3%)</td>
</tr>
</tbody>
</table>

Kenna et al, Arch Otolaryngol Head Neck Surg. 2010
GJB2 – Progressive hearing loss

Future

Miwa et al., Molecular Therapy, 2013
Enlarged Vestibular Aqueduct

Credit: NIH Medical Arts
Enlarged Vestibular Aqueduct
Enlarged Vestibular Aqueduct
Enlarged Vestibular Aqueduct

- Most common inner ear abnormality
- Normal size 0.4 - 1.0 mm
- Abnormal >1.5 mm at its midpoint
- Bilateral (up to 94%)
At birth
- Normal to profound SNHL

Progression
- Can deteriorate into early adulthood (25 dB per 6 years)
- Can have sudden decrements of hearing (65%) – can be related to head trauma/pressure changes

Enlarged Vestibular Aqueduct
Enlarged Vestibular Aqueduct

- Ascha et al, JAMA 2017

  - For each millimeter increase in vestibular aqueduct size (greater than 1.5 millimeters)
    - increase of 17.5 dB in speech reception threshold
    - decrease of 21% in word recognition scores

  - For every year after the initial audiogram
    - speech recognition threshold increased by 1.5 dB
    - word recognition decreased by an additional 1.7%
Enlarged Vestibular Aqueduct

- Up to 1/3 patients with conductive component
  - Increased pressure dampening stapes
  - 3rd window effect

- Risk of CSF “gusher” with stapedectomy and cochlear implantation
  - Some have suggested increased incidence of PLF
Enlarged Vestibular Aqueduct

- Pendred syndrome versus Nonsyndromic enlarged vestibular aqueduct (PDS/NSEVA)

- Phenotypic spectrum:
  - Sensorineural hearing loss (SNHL)
  - Vestibular dysfunction
  - Temporal bone abnormalities (bilateral enlarged vestibular aqueduct with or without cochlear hypoplasia)
  - PDS also includes development of euthyroid goiter in late childhood to early adulthood
Enlarged Vestibular Aqueduct

- Pendred syndrome
  - 50% with euthyroid goiter
  - EVA with/without cochlear hypoplasia (1.5 turns)

- NSEVA
  - No goiter
  - Only EVA present, no cochlear hypoplasia
Enlarged Vestibular Aqueduct

- **Autosomal recessive**
  - Biallelic pathogenic variants in SLC26A4 or
double heterozygosity (SLC26A4 and either FOXI1 or KCNJ10)
Enlarged Vestibular Aqueduct

- Treatment of manifestations:
  - Hearing loss
  - Goiter/hypothyroidism
Surveillance:
- Audio every 3-6 months initially, then 6-12 months
- Baseline ultrasound examination of the thyroid
  - Monitor volumetric changes (clinical and/or US)

Agents/circumstances to avoid:
- Dramatic increases in intracranial pressure can be associated with a sudden drop in hearing
  - Avoiding weightlifting and/or contact sports should be discussed with a physician
TM retraction / Cholesteatoma
Cholesteatoma - progression
Cholesteatoma - progression
Retracted Tympanic Membrane

- What can be done?
Retracted Tympanic Membrane
Retracted Tympanic Membrane
Cholesteatoma
Otologic surgery
Otologic surgery
Narrowest segment of the ear canal

Limited microscopic field of view

Limited transcanal microscopic access

Wide postauricular access
Wide endoscopic field of view
Microscope versus Endoscope
Endoscopic view
Hard-to-reach areas
Hard-to-reach areas

- Sinus tympani
- Facial recess
- Hypotympanum
- Attic
- Anterior epitympanum
Hard-to-reach areas
Cholesteatoma
Cholesteatoma
Cholesteatoma recurrence

- Recurrence rate
  - Endoscopic = 8.6%
  - Canal-wall-up mastoidectomy = up to 25%

Set up
Middle ear exploration
Anterior retraction/cholesteatoma
Anterior retraction/cholesteatoma
Ossicular Reconstruction
Ossicular Reconstruction
Houston, November 30 – December 2, 2018

San Diego, 2019
Thank you!

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