Acoustic Reflexes:
Diagnostically Valuable but Clinically Underutilized

James W. Hall III, PhD

Professor, Salus University and University of Hawaii

Adjunct Professor, University of Florida and Nova Southeastern University

Visiting Professor, American University of Beirut

Extraordinary Professor, University of Pretoria South Africa

jwhall3phd@gmail.com   www.audiologyworld.net
Acoustic Reflexes:
Diagnostically Valuable but Clinically Underutilized

• Learner Objectives
  1. Identify 4 different structures within the acoustic reflex pathways
  2. List three distinct acoustic reflex measurements
  3. Name 4 evidence-based clinical applications of acoustic reflexes in children and adults
Acoustic Reflexes: Diagnostically Valuable but Clinically Underutilized

- 0 – 5 minutes:
  - Introduction to historical perspective
- 6 – 15 minutes:
  - Acoustic reflex anatomy and pathways
- 16 – 40 minutes:
  - Acoustic reflex measurements in clinical audiology
- 41 – 55 minutes:
  - Clinical applications of acoustic reflexes in children and adults
- 56 – 60 minutes:
  - Questions and Answers
Acoustic Reflex Measurements: 
*Historical Perspective*

- Luscher (1929) In Germany observed acoustic reflex
- Jepsen (1951) Confirmed stapedius muscle acoustic reflex
- Klockhoff (1961) Clinical study of acoustic reflexes
- James Jerger (1970) applied electro-acoustic impedance device clinically in U.S.A.
- Anderson, Barr & Wedenberg (1970) Early detection of 8th nerve tumors with acoustic reflex
- Keith (1975) Acoustic reflex in neonates
- Jerger & Hayes (1976) Crosscheck principle in pediatric audiology
James Jerger
Classic Impedance Studies in Early 1970s at Methodist Hospital
And Baylor College of Medicine in Houston Texas, USA

554 ears of 336 patients age 10 mos. to 81 years
Two Impedance Devices Used for Clinical Measurements and Research Data Collection

GSI 1720
(1971)

GSI 1723
(1977)

https://peterdanielson.wixsite.com/gs-alumni/nostalgia
James Jerger Generated Considerable Research Evidence In Support of Admittance Measurements


James Jerger
First Books on “Impedance Audiometry

1975

1980
Acoustic Immittance Measurement:
My First Clinical Activity at Baylor College of Medicine
(Houston Texas)

With Larry Mauldin (circa 1975)
Early Publications on Impedance/Immittance Measures

- Hall JW III and Weaver T. Impedance audiometry in a young population: The effects of age, sex and minor tympanogram abnormality. *J Otolaryngology (Toronto)* 8: 210-222, 1979
Acoustic Reflex Amplitude in Auditory Dysfunction

*Dissertation: James W. Hall III, 1979*
An Old but Good Source of Information on the Acoustic Reflex
(Editor: Shlomo Silman, Academic Press 1984)

Chapter 1: Neurophysiological Basis
(Aage Moller)
Chapter 4: Evaluation of Response Time of Acoustic Immittance Instruments
(David Lilly)
Chapter 6: Prediction of hearing loss
(Silman et al)
Chapter 7: Magnitude and Growth
(Silman)
Chapter 8: Acoustic Reflex Latency
(Bosatra, Russolo & Silverman)
Chapter 13: Effect of Drugs and Disease
(Mangham)
Decrease in Proportion of Audiologists Who Record Acoustic Reflexes … Beginning in 1990s


Journal of the American Academy of Audiology/Vol

ear. A smaller percentage (32%) mask when there is a specified difference between the speech thresholds of the two ears. This difference, as reported by the respondents using this method, ranges from 5 to 70 dB. It appeared more common to use a set amount of masking when needed for word-recognition testing. Standard amounts were reported as 50 to 75 dB HL. Many respondents also base their masking level for word-recognition testing on the stimulus level
Nowadays Fewer Audiologists Record Acoustic Reflexes in Clinical Practice

  - Survey responses from 156 audiologists (2008 + 2009)
  - Decrease in contralateral acoustic reflex testing over time
  - Patient discomfort is reported but without evidence
  - Survey responses from 192 audiologists who perform APD assessments
  - >90% of audiologists evaluate APD in children
  - 69% of audiologists perform acoustic reflex threshold measurements vs. 97% who perform tympanometry
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• 56 – 60 minutes:
  • Questions and Answers
Acoustic Reflex Measurements

Middle Ear Muscles (Stapedius and Tensor Tympani)

• Stapedius muscle
  • Small striated muscle (smallest in the body)
  • Located in a canal posterior to tympanic cavity
  • Attached at one end to the canal and the other to the neck of the stapes
  • Innervated by a branch of the 7th (facial) cranial nerve
  • Consensual reflex (unilateral stimulus bilateral response)
  • Stimulated in various ways including
    • Acoustic reflex by sounds of about 85 dB HL
    • Gentle tactile stimulation of outer ear
    • Electrical stimulation of ear canal wall
    • Voluntary contraction (can you wiggle your ears?)
Middle Ear Muscles:
Stapedius Muscle
Acoustic Reflex Measurements

*Middle Ear Muscles (Stapedius and Tensor Tympani)*

- Tensor tympani muscle
  - Striated muscle
  - Located in a small canal above the auditory canal
  - Attached at one end to the walls of the canal and the other to the manubrium of the malleus
  - Innervated by mandibular branch of the 5th (trigeminal) cranial nerve
  - Contracts as part of general startle response
  - Response is usually transient and not repeatable
  - May play a role in tinnitus, e.g., Wescott et al (2013). Tonic tensor tympani syndrome in tinnitus and hyperacusis patients: A multi-clinic prevalence study
    Noise & Health, 15, 117-128 [Melbourne Australia]
Acoustic Stapedial Reflex Pathways According to Erick Borg

Acoustic Reflex Pathways Revisited


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Acoustic Reflexes:
Diagnostically Valuable but Clinically Underutilized

Clinical Instrumentation

- Ear canal volume
- Static compliance
- Tympanometry
  - 220 vs. 1000 Hz probe tones for adults vs. neonates
  - Multiple admittance components
  - Toynbee and Valsalva procedures
  - Fistula test
- Acoustic reflexes
  - Ipsi - and contralateral
  - Right and left ear
Acoustic Reflexes:
Diagnostically Valuable but Clinically Underutilized
*Four Clinically Feasible Measurements*

- Acoustic reflex threshold (ART)
- Acoustic reflex decay
- Acoustic reflex amplitude growth
- Acoustic reflex latency
Acoustic Reflex Measurements

*Acoustic Reflex Threshold*

(From Hall JW III. *Introduction to Audiology Today*. Boston: Pearson, 2014)

TympStar Pro quantifies minimum verified admittance change, e.g., 0.02 mmho)
Plotting Acoustic Reflex Threshold Results on an Separate Ear (Jerger) Audiogram Form
FaceBook Chatter About How Often Acoustic Reflexes are Typically Recorded in Normal Hearers
# Acoustic Reflex Thresholds in Normal Hearers with Pure Tone Thresholds < 25 dB HL

*(Hunter, 2013)*

<table>
<thead>
<tr>
<th>Study</th>
<th>Acoustic Reflex Thresholds (Contralateral Condition)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10th to 90th %ile</td>
</tr>
<tr>
<td>500 Hz</td>
<td>75 to 95 dB HL</td>
</tr>
<tr>
<td>1000 Hz</td>
<td>75 to 95 dB HL</td>
</tr>
<tr>
<td>2000 Hz</td>
<td>75 to 95 dB HL</td>
</tr>
</tbody>
</table>

Note:

- Acoustic reflexes are recorded in > 95% of normal hearers.
- Data for a 4000 Hz signal are not included and not recommended clinically due to high percentage of normal hearers with absent acoustic reflexes.
Acoustic Reflexes:
Diagnostically Valuable but Clinically Underutilized
 Clinically Feasible Measurements

• Acoustic reflex threshold (ART)
• Acoustic reflex amplitude
• Acoustic reflex decay
• Acoustic reflex latency
Acoustic Reflex Latency: Acoustic Reflex Threshold + 10 SL
(From Hall JW III. *Introduction to Audiology Today*. Boston: Pearson, 2014)
Acoustic Reflexes:
Diagnostically Valuable but Clinically Underutilized
Clinically Feasible Measurements

- Acoustic reflex threshold (ART)
- Acoustic reflex decay
- Acoustic reflex amplitude
- Acoustic reflex latency
Acoustic Reflexes: Diagnostically Valuable but Clinically Underutilized

Acoustic Reflex Amplitude

![Graph showing acoustic reflex amplitude](image-url)

Figure 20. Ipsilateral reflex amplitude for 1000 Hz signal in 10 young, normal hearing males and 10 young, normal hearing females. Data are plotted in dB (SPL in 2 cm³ cavity) on left ordinate, and in cm³ on right ordinate. Signal intensity is in dB RE: Acoustic Reflex Threshold (ART). Data are averaged for both ears. Average static compliance (cm³): males, 0.79, females, 0.80; average ear canal volume (cm³): males, 1.14, females, 1.23. Brackets (±)
Acoustic Reflexes: Diagnostically Valuable but Clinically Underutilized

Acoustic Reflex Amplitude

Figure 13. Ipsilateral and contralateral reflex amplitude for the 1000 Hz signal in three age groups of 16 subjects each (20 to 30 years, mean age 27; 40 to 60 years, mean age 50; 70 to 80 years, mean age 77). Data are plotted in cm³. Signal intensity is in dB SPL. Acoustic Reflex Threshold (ART). Data are averaged for both ears. Error bars indicate standard error of the mean.

Figure 14. Ipsilateral and contralateral reflex amplitude for the noise band signal (300-5500 Hz) in 10 subjects with central auditory dysfunction as indicated by speech audibility and 10 control subjects. Amplitude data are plotted in cm³. Signal intensity is in dB HL. Acoustic Reflex Threshold (ART). Data are averaged for both ears. Error bars indicate standard error of the mean.
Published Articles on Acoustic Reflex Amplitude (Based on PhD Dissertation)

- For further review of acoustic reflex amplitude see:
Acoustic Reflexes:
Diagnostically Valuable but Clinically Underutilized

*Clinically Feasible Measurements*

- Acoustic reflex threshold (ART)
- Acoustic reflex decay
- Acoustic reflex amplitude
- Acoustic reflex latency
Acoustic Reflex Latency:
Distortion in Measurements Due to
Time Constants of Early Analog Devices

Total of 5 time constants ~ 400 ms for GSI 1720 (Popelka, 1981)

Fig. 8  Analog electrical-output waveform (upper curve) from a commercial acoustic-imbittance instrument (Grason Stadler 1723) when procedure suggested by Popelka and Dubno (1978) was used to measure its temporal characteristics. Initial latency $L_i$, risetime $r_i$, terminal latency $L_f$, and falltime $r_f$ are identified. (After ANSI, 1982; Popelka, 1979.)

"In general the time constant is a measure of duration. More specifically, it is a measure of how rapidly a quantity such as voltage, current, displacement, sound pressure, or volume velocity changes in a circuit in response to a rapidly changing input signal." (p. 110)

“The temporal characteristics of the instrumentation can have a profound effect upon ... [acoustic reflex latency] (p. 130)
Acoustic Reflex Latency:  
Distortion in Measurements Due to  
Time Constants of Early Analog Devices


“It must be added, however, that to adequately study the temporal characteristics of the acoustic reflex (e.g., latency, rise, and decay time) using the impedance method, the output of the impedance bridge must be fed into a dual-trace storage oscilloscope. The pen-recording method is not precise enough, mostly because of the inertia of the pen recording.” (p. 302)
Factors and Parameters Possibly Influencing Acoustic Reflex Latency Measurements (From Bosatra et al, 1984)

- Stimulus Parameters
- Subject Factors
- Diseases and Disorders
- Drugs and Medications
Factors and Parameters Possibly Influencing Acoustic Reflex Latency Measurements
(Data reported by Bosatra et al, 1984)

- Stimulus parameters
  - Laterality Test Condition: Shorter latency for ipsilateral than contralateral stimulation
  - Rise time: Faster rise time results in shorter latency
  - Intensity: Higher intensity results in shorter latency
  - Frequency
    ✓ ARL differences for 500 Hz, 1000 Hz, 2000 Hz, and BBN
    ✓ No data for other frequencies
  - Duration: Probably not a factor
Factors and Parameters Possibly Influencing Acoustic Reflex Latency Measurements
(From Bosatra et al, 1984)

• Subject factors
  • Age
    ✓ Infants and young children: No data
    ✓ Advancing: Latency increases with age > 60 years
  • Gender: No data
  • Body temperature: No data
  • State of arousal (e.g., sleep): No data
  • Test ear (right versus left): No data
  • Intra-subject variability: Small (< 10 ms) or none
Factors and Parameters Possibly Influencing Acoustic Reflex Latency Measurements (From Bosatra et al, 1984)

- Diseases and disorders: Cochlear and Retrocochlear
  - Cochlear pathology:
    ✓ Meniere’s disease: No consistent effect when acoustic reflexes were present
    ✓ Sudden hearing loss: Abnormally long ARL when acoustic reflexes are present
  - Retrocochlear pathology:
    ✓ Abnormally long ARL when acoustic reflexes are present
    ✓ Significant inter-aural latency difference in unilateral pathology
Factors and Parameters Possibly Influencing Acoustic Reflex Latency Measurements 
(From Bosatra et al, 1984)

- Diseases and disorders: Central auditory nervous system
  - Brainstem
    ✓ Vascular: Normal ARL when acoustic reflexes are elevated
    ✓ Multiple sclerosis: Normal ARL
    ✓ Intra-axial tumor: Abnormally long ARL
  - Cortical:
    ✓ Normal ARL
- Drugs
  - Sedation and anesthesia: No data
  - Pentobarbital: Abnormally long ARL when present
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I predict a bright future for the Acoustic Reflex Latency Test (ARLT)
Acoustic Reflexes: Diagnostically Valuable but Clinically Underutilized

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  - Clinical applications of acoustic reflexes in children and adults
- 56 – 60 minutes:  
  - Questions and Answers
Year 2007 Joint Committee on Infant Hearing (JCIH): Protocol for Evaluation for Hearing Loss In Infants from Birth to 6 months

- Child and family history
- Evaluation of risk factors for congenital hearing loss
- Parental report of infant’s responses to sound
- Clinical observation of infant’s auditory behavior
- Audiological assessment
  - Auditory brainstem response (ABR)
  - Otoacoustic emissions (distortion product or transient OAEs)
  - Tympanometry with 1000 Hz probe tone
  - Supplemental procedures, e.g.,
    - Electrocochleography (ECochG)
    - Auditory steady state response (ASSR)
    - Acoustic reflex measurement (for 1000 Hz probe tone)
Acoustic Reflex Measurement in the Detection of Subtle Middle Ear Disorders (< 10 dB ABG)
(From Hall JW III. Introduction to Audiology Today. Boston: Pearson, 2014)
Plotting the Pattern of Results of Acoustic Reflex Measurements in Four Conditions
(Describe Reflexes by Stimulus Ear)

- Abnormal Acoustic Reflex
- Crossed (contralateral)
  Sound in one ear and probe in opposite ear
- Uncrossed (ipsilateral)
  Probe and sound in same ear

Acoustic reflex patterns ("faces")
- Conductive/efferent pattern
- Sensory pattern
- Neural pattern
- Brainstem pattern
Plotting the Results of Acoustic Reflex Measurements

VERTICAL PATTERN
Abnormal tympanogram? Abnormal OAEs?
Air bone gap in audiogram?
Mild middle ear disorder

<table>
<thead>
<tr>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contralateral (Crossed)</td>
<td>Contralateral (Crossed)</td>
</tr>
<tr>
<td>Sound Right</td>
<td>Sound Left</td>
</tr>
<tr>
<td>Probe Left</td>
<td>Probe Right</td>
</tr>
</tbody>
</table>

Abnormal Acoustic Reflex
INVERTED “L” PATTERN
Moderate or severe conductive hearing loss on right ear

Abnormal Acoustic Reflex

Contralateral (Crossed)
Sound Right
Probe Left

Ipsilateral (Uncrossed)
Sound Right
Probe Right

Contralateral (Crossed)
Sound Left
Probe Right

Ipsilateral (Uncrossed)
Sound Left
Probe Left
Acoustic Reflexes: Diagnostically Valuable but Clinically Underutilized

- Clinical Applications of Acoustic Reflexes
  - Detection of even subtle middle ear dysfunction
  - Objective differentiation of normal hearing sensitivity versus sensory hearing loss
  - Detection of 8\textsuperscript{th} nerve dysfunction
  - Detection of 7\textsuperscript{th} nerve dysfunction
  - Detection of brainstem auditory dysfunction
  - Diagnosis of auditory neuropathy spectrum disorder
  - Identification of false or exaggerated hearing loss
### SPAR Criteria

Predicting hearing loss from the acoustic reflex. *JSHD, 39, 11-22*

<table>
<thead>
<tr>
<th>Noise-Tone Difference</th>
<th>BBN ART in dB SPL</th>
<th>Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;20 dB</td>
<td>Anywhere</td>
<td>Normal</td>
</tr>
<tr>
<td>15 to 19</td>
<td>&lt; 80</td>
<td>Normal</td>
</tr>
<tr>
<td>15 to 19</td>
<td>&gt; 80</td>
<td>Normal-Moderate</td>
</tr>
<tr>
<td>10 to 14</td>
<td>Anywhere</td>
<td>Mild-Moderate</td>
</tr>
<tr>
<td>&lt; 10</td>
<td>&lt; 90</td>
<td>Mild-Moderate</td>
</tr>
<tr>
<td>&lt; 10</td>
<td>&gt; 90</td>
<td>Severe</td>
</tr>
<tr>
<td>AR not observed</td>
<td></td>
<td>Profound</td>
</tr>
</tbody>
</table>
Estimation of Hearing Thresholds with Acoustic Reflexes: A Sampling of Publications

Simplified SPAR (Sensitivity Prediction by the Acoustic Reflex)

Hearing Loss in dB HL

Pure tone signal
### Simplified SPAR (Sensitivity Prediction by the Acoustic Reflex)


<table>
<thead>
<tr>
<th>Acoustic Reflex Threshold for BBN (dB HL)</th>
<th>N</th>
<th>Pure Tone Average for 500 – 4000 Hz in dB HL</th>
<th>&lt; 35</th>
<th>&gt; 35</th>
</tr>
</thead>
<tbody>
<tr>
<td>58</td>
<td>2</td>
<td>100</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>6</td>
<td>100</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>20</td>
<td>100</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>32</td>
<td>100</td>
<td>0</td>
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</tr>
<tr>
<td>78</td>
<td>51</td>
<td>69</td>
<td>31</td>
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<tr>
<td>83</td>
<td>76</td>
<td>76</td>
<td>24</td>
<td></td>
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<td>88</td>
<td>66</td>
<td>55</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>93</td>
<td>39</td>
<td>28</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>98</td>
<td>25</td>
<td>16</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>&gt; 103</td>
<td>9</td>
<td>0</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
Identification of Hearing Loss with Acoustic Reflexes Using Pure Tone vs. BBN Signals
(Popelka, 1981)

![Graph showing acoustic-reflex thresholds for tones and noise](image)

Fig. 2. Acoustic-reflex thresholds for tones (averaged over 500, 1000, and 2000 Hz) and for a BBN noise in dB SPL as a function of average hearing level for 500, 1000, and 2000 Hz in dB HL. The lines represent the best-fit functions. (Reprinted by permission of Popelka, G. R. The acoustic reflex in normal and pathologic ears. In G. R. Popelka (Ed.), Hearing assessment with the acoustic reflex. New York: Grune & Stratton, 1981, pp. 5–31. By permission of Grune & Stratton.)
Acoustic Reflexes in Neonates: Objective Differentiation of Normal Hearing versus Sensory Hearing Loss

  - 66 full term infants
  - Acoustic reflexes recorded with 1000 Hz probe tone
  - Tone and BBN stimuli
  - All neonates had acoustic reflexes
Acoustic Reflexes in Neonates
(Kei J. Acoustic stapedial reflexes in healthy neonates: normative data* and test-retest reliability. JAAA, 23, 2012)

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Median ART (dB HL)</th>
<th>90% Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 Hz</td>
<td>80</td>
<td>70 - 95</td>
</tr>
<tr>
<td>2000 Hz</td>
<td>70</td>
<td>60 - 85</td>
</tr>
<tr>
<td>4000 Hz</td>
<td>65</td>
<td>50 - 80</td>
</tr>
<tr>
<td>BBN</td>
<td>55</td>
<td>50 – 75</td>
</tr>
</tbody>
</table>

* N = 68 ears
Acoustic Reflexes: Diagnostically Valuable but Clinically Underutilized

- Clinical Applications of Acoustic Reflexes
  - Detection of even subtle middle ear dysfunction
  - Normal hearing sensitivity versus sensory hearing loss
  - Detection of severe-profound sensory hearing loss vs. 8th nerve dysfunction
  - Detection of 7th nerve dysfunction
  - Detection of brainstem auditory dysfunction
  - Diagnosis of auditory neuropathy spectrum disorder
Acoustic Reflexes: Diagnostically Valuable but Clinically Underutilized

Severe Sensory vs. 8th Nerve Pattern

DIAGONAL PATTERN
Severe unilateral sensory hearing loss or 8th nerve auditory dysfunction on right ear?

- **Abnormal Acoustic Reflex**

<table>
<thead>
<tr>
<th>Right</th>
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<tbody>
<tr>
<td>Contralateral (Crossed) Sound Right Probe Left</td>
<td>□</td>
</tr>
<tr>
<td>Ipsilateral (Uncrossed) Sound Right Probe Right</td>
<td>□</td>
</tr>
</tbody>
</table>

- **Contralateral (Crossed) Sound Left Probe Right**
- **Ipsilateral (Uncrossed) Sound Left Probe Left**
Plotting the Results of Acoustic Reflex Measurements
(From Hall JW III. *Introduction to Audiology Today*. Boston: Pearson, 2014)
Acoustic Reflex Pattern and Audiogram in 8th Cranial Nerve (Retrocochlear) Disorder
Audiogram and Acoustic Reflex Pattern:
8th Cranial Nerve Disorder
Acoustic Reflexes: Diagnostically Valuable but Clinically Underutilized

- Clinical Applications of Acoustic Reflexes
  - Detection of even subtle middle ear dysfunction
  - Normal hearing sensitivity versus sensory hearing loss
  - Detection of 8th nerve dysfunction
  - Detection of 7th (facial) cranial nerve dysfunction
  - Detection of brainstem auditory dysfunction
  - Diagnosis of auditory neuropathy spectrum disorder
  - Identification of false or exaggerated hearing loss
Facial Nerve:
7th Cranial Nerve
Plotting the Results of Acoustic Reflex Measurements

VERTICAL PATTERN
Normal tympanogram? Normal OAEs?
Normal hearing sensitivity?
Efferent (7th CN) pattern

Abnormal Acoustic Reflex

Contralateral (Crossed)
Sound Right
Probe Left

Right

Left

Contralateral (Crossed)
Sound Left
Probe Right

Ipsilateral (Uncrossed)
Sound Right
Probe Right

Ipsilateral (Uncrossed)
Sound Left
Probe Left
Audiogram and Acoustic Reflex Pattern: 7th Cranial Nerve Disorder (Left Side)
Acoustic Reflexes: Diagnostically Valuable but Clinically Underutilized

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  - Identification of false or exaggerated hearing loss
Plotting the Results of Acoustic Reflex Measurements

**HORIZONTAL PATTERN**

Brainstem auditory dysfunction or APD

- **Abnormal Acoustic Reflex**
- **Right**
  - Contralateral (Crossed)
  - Sound Right
  - Probe Left
- **Left**
  - Contralateral (Crossed)
  - Sound Left
  - Probe Right
- **Ipsilateral (Uncrossed)**
  - Sound Right
  - Probe Right
  - **→**
  - **→**
  - **→**
  - **→**
  - **→**
  - **→**
A New Acoustic Reflex Pattern

Susan Jerger, MS; James Jerger, PhD; James Hall, MA

- A new crossed-vs-uncrossed acoustic reflex pattern has been observed in four patients with retrocochlear disorder. The new reflex pattern is characterized by a unique "uni-box" configuration. Reflexes are abnormal with sound to the affected ear on crossed stimulation only. In one additional patient, a variation of the uni-box pattern was found on supra-threshold reflex amplitude measures. We observed a large ear difference between reflex amplitude functions in the crossed condition, but not in the uncrossed condition. This observation suggests that reflex amplitude measures may be a valuable addition to threshold measures in some patients.

(Arch Otolaryngol 105:24-28, 1979)

diagnostically nonspecific inverted L-shaped pattern.

This article concerns the one exceptional reflex pattern. This unusual finding occurred in a 53-year-old woman with a large acoustic schwannoma on the right side. At surgery, the tumor was noted to displace and distort adjacent brain stem structures. Figure 1 shows this patient's audiogram and acoustic reflex results. The audiogram shows a mild sensori-neural loss in the right (eighth nerve) ear and normal sensitivity in the left ear. Pure-tone average (PTA) scores for 500, 1,000, and 2,000 Hz are 32 dB for the right ear and 1 dB for the left sound to the affected ear on crossed stimulation only.

We first suspected that the reflex abnormality in this patient was due to middle ear disorder. However, bone conduction thresholds on both ears were superimposed on air conduction thresholds. Further, tympanometry showed normal, bilaterally symmetrical, tympanograms on both ears.

In short, we appeared to be observing a unique new reflex pattern. However, we were reluctant to regard this pattern as a distinct retrocochlear sign. Several possible explanations for this unexpected finding could not be adequately ruled out retrospectively. An undetected middle ear disorder...
Acoustic Reflexes: Diagnostically Valuable but Clinically Underutilized

- Clinical Applications of Acoustic Reflexes
  - Detection of even subtle middle ear dysfunction
  - Normal hearing sensitivity versus sensory hearing loss
  - Detection of 8th nerve dysfunction
  - Detection of 7th nerve dysfunction
  - Detection of brainstem auditory dysfunction
  - Diagnosis of auditory neuropathy spectrum disorder
  - Identification of false or exaggerated hearing loss
Acoustic Reflexes in the Diagnosis of Auditory Neuropathy Spectrum Disorder (ANSD): 
*OAEs Normal and Acoustic Reflexes Absent*

  - 5% of children with hearing loss diagnosed with ANSD
  - Acoustic reflexes played role in the diagnosis
Acoustic Reflexes: Diagnostically Valuable but Clinically Underutilized

- Clinical Applications of Acoustic Reflexes
  - Detection of even subtle middle ear dysfunction
  - Normal hearing sensitivity versus sensory hearing loss
  - Detection of 8th nerve dysfunction
  - Detection of 7th nerve dysfunction
  - Detection of brainstem auditory dysfunction
  - Diagnosis of auditory neuropathy spectrum disorder
  - Identification of false or exaggerated hearing loss
Applications of Acoustic Reflexes in the Assessment of False and Exaggerated Hearing Loss

- Other terms
  - Functional hearing loss
  - Pseudohypacusis
  - Non-organic hearing loss

- Risk factors for false or exaggerated hearing loss
  - Children
    - Adolescent girls
    - Trauma (physical, sexual, psychological)
  - Adults
    - Potential compensation
    - Legal action
    - Trauma (physical, sexual, psychological)
Applications of Acoustic Reflexes in the Assessment of False and Exaggerated Hearing Loss

• Pattern of auditory findings
  • Normal otoacoustic emissions (OAEs)
  • Normal acoustic reflex thresholds for BBN signal
  • Hearing loss according to the audiogram
  • Discrepancy between PTA and SRT
  • Confirmation with other objective measures, e.g.,
    ✓ ABR
    ✓ ASSR
    ✓ Cortical auditory evoked responses
Assessment of False or Exaggerated Hearing Loss

Why Prompt Diagnosis is Important

- Elimination of unnecessary health care costs. e.g.,
  - Radiological studies
  - Laboratory studies
  - Compensation for non-existent impairment
  - Referral to specialists
- Prevention of inappropriate treatment, e.g.,
  ✓ Medical
  ✓ Surgical
  ✓ Audiological
- Prompt intervention for underlying cause or factors
  - Counseling
  - Psychological or psychiatric management
Acoustic Reflexes: Diagnostically Valuable but Clinically Underutilized

- The Long Clinical Tradition with Admittance Measurement
- Acoustic Reflex Measurement is Evidence-Based Practice
- Review of Anatomy and Physiology
- Variety of Acoustic Reflex Measurements
- Clinical Applications of Acoustic Reflexes
- CPT codes
- Summary of Advantages of Acoustic Reflexes in Clinical Audiology
Middle Ear and Acoustic Reflex Measurements: 
*Billing (CPT) Codes*

- Deleted code
  - 92569: Acoustic reflex testing, decay (deleted 2010)
- 92567: Tympanometry (impedance testing)
- 92568: Acoustic reflex testing, threshold
- 92550: Tympanometry and reflex threshold measurements
  - Do not report in conjunction with 92567 or 92568
- 92570: Acoustic immittance testing, includes
  - Tympanometry (impedance testing)
  - Acoustic reflex threshold testing
  - Acoustic reflex decay testing
  - Do not report in conjunction with 92567 or 92568
Acoustic Reflexes: Diagnostically Valuable but Clinically Underutilized

• 0 – 5 minutes:
  • Introduction to historical perspective
• 6 – 15 minutes:
  • Acoustic reflex anatomy and pathways
• 16 – 40 minutes:
  • Acoustic reflex measurements in clinical audiology
• 41 – 55 minutes:
  • Clinical applications of acoustic reflexes in children and adults
• 56 – 60 minutes:
  • Questions and Answers
Thank You!

Questions?

(https://www.pearsonhighered.com/program/Hall-Introduction-to-Audiology-Today)