External Anatomical Landmarks of the Ear

- Triangular fossa
- Crura of antihelix
- Crus of helix
- Anterior incisure
- Meatus
- Tragus
- Lobe
- Concha
- Helix
- Antihelix
- Posterior sulcus
- Antitragus
- Intertragic incisure
- Scapha
Anatomy of the Ear

Courtesy NIH Website
“Ear Infections in Children”
Anatomy of the Ear

- External Ear
- Middle Ear
- Inner Ear
- Pinna
- Auditory Canal
- Tympanic Membrane

Ossicular Chain
- Malleus
- Incus
- Spapes

Stapedial Muscle

Oval Window

Cochlea
Hearing

• Sound energy stimulates the TM (eardrum) vibrating the ossicular chain. Vibratory motion of the stapes is transmitted through the oval window into the cochlea.

• Cochlea translates the sound energy into meaningful neuronal impulses to the brain.
1. Something vibrates and creates a sound wave.
2. The sound wave travels to the ear and is collected by the outer ear.
3. The sound wave then moves into the ear canal.
4. When it reaches the end of the ear canal, the sound waves bump up against the eardrum.
5. The ear drum vibrates with these sound waves.
6. The vibration moves tiny bones in the middle ear.
7. These bones carry vibrations into the inner ear to a fluid-filled tube called the cochlea.
8. The fluid inside the cochlea vibrates a series of tiny hairs called cilia, which are attached to auditory nerves.
9. The movement of these cilia stimulates the nerve cells, and they send signals to the brain via auditory nerve.
10. The brain processes these signals into the sounds we hear.

Tympanometry - Definition

- Tympanometry measures the compliance of the TM and ossicular chain and estimates middle ear pressure.
- Compliance = Freedom of Movement (cc)
How it Works

Tympanometry utilizes two energy sources:
• Pressure
• Sound

Units:
1. Pressure = daPa (deca Pascals)
2. Sound = Hz (Frequency) dB (Loudness)
3. Compliance = cc
How it Works

• Pressure is introduced from +200 to – 300
• Sound is constant at 226 Hz and 85 dB
• Compliance is measured in terms of volume (cc)
How it Works

• Pressure changes on the x-axis (horizontal)
• Compliance changes on the y-axis (vertical)
Values

ECU 1.7 cm$^3$ PEAK 0.7 cm$^3$ L
SR 70 daPa - 18 daPa
1.5 cm$^3$
Values

ECV: 1.5 cm³  PEAK: 0.5 cm³ R
GR: 65 daPa  -85 daPa

Range of Normals
Ear Canal Volume 0.2 to 2.0
Compliance Peak 0.2 to 1.4
Pressure Peak -150 to +100
Gradient 60 to 150 Child
50 to 110 Adult
Acoustic Reflex Yes
Tympanometry - Steps

- Calibrate
- Place ear cuff on tip
- Select appropriate buttons
- Insert probe; obtain proper seal
- Read feedback from machine
- Remove probe
- Label tympanogram as Left or Right
- Save or print tympanograms
Diagnosis of Acute Otitis Media (AOM)

Diagnosis of AOM requires:
• History of acute onset of signs and symptoms
• Presence of MEE (middle ear effusion)
  – Bulging of the tympanic membrane
  – Limited or absent mobility of the tympanic membrane
  – Air-fluid level behind the tympanic membrane
  – Otorrhea
• Signs or symptoms of middle ear inflammation
  – Distinct erythema of the tympanic membrane
  – Distinct otalgia (discomfort clearly referable to the ears that results in interference with or precludes normal activity or sleep)
The AAP/AAFP/AHRQ guidelines for AOM require the documentation of middle ear effusion for the diagnosis of AOM by tympanometry, pneumatic otoscopy, acoustic reflectometry, tympanocentesis, or the visualization of fluid in the external ear canal with tympanic membrane perforation. However, for OME and AOM, pneumatic otoscopy is recommended as the primary tool for diagnosis of middle ear effusion.

Pneumatic Otoscopy and Tympanometry

The two tests are complementary...

• **Pneumatic otoscopy** provides a qualitative measure of tympanic membrane mobility (i.e., does the TM move with insufflation?)

• **Tympanometry** produces more quantitative information (e.g., numeric and graphic data about generated positive and negative pressures, absorption of acoustic energy by the middle ear system, ear canal volume).

Clinical Indications

• Nonspecific ear complaints
• Hearing Loss
• Ear pain without observed problems
• Subtle TM changes
• Middle ear effusion; Serous Otitis
• Resolved Otitis Media
• Ear Tubes
Normal Ear
Normal
Otitis Media
Flat TM: Serous Otitis
Flat TM: Patent Tube

GSI 37 AUTO TYMP

NAME__________________________

DATE__________________________

ECV: 3.5 cm³  PEAK: NP cm³
GR: daPa  NP daPa L

1.5 cm³

-400 -200 0 +200
daPa
Tympanostomy Tube - Functional
Abnormal: Negative Pressure
Compliance of the TM & Ossicles

![Graph showing compliance in ml vs pressure in decaPascals for Hyperflaccid, Normal Ear, and Stiff Ear conditions.](image)
Abnormal: Hyperflaccid TM

GSI 37 AUTO TYMP

NAME ____________________________
DATE ____________________________

ECV: 1.2 cm³  PEAK: 1.8 cm³
GR: 50 daPa  -30 daPa R

1.5 cm³

-400 -200 0 +200
daPa
Possible Future Developments

- A new method measuring the pressure–volume relationship of the middle ear system (MES) that express the dynamic mechanical properties of the MES.
- Compared with tympanometry the method is more detailed and has several advantages, which are discussed, and it has been found valuable for future mechanical studies of the MES.

GSI 39 Auto Tymp
(Grason Stadler)
MicroTymp 3 (Welch Allyn)
Handheld Unit

GSI 39 Auto Tymp

MT 10

EasyTymp

MicroTymp 3
Docking station - Cradle
EasyTymp

GSI 39
Auto
Tymp

MT 10

MicroTymp 3
Connector pins of MT 10
Connections

GSI 39 Auto Tymp

EasyTymp

MT 10

MicroTymp 3
Data Transfer

GSI 39
• Test results may be transferred to an external computer for data storage via the second built in USB port. This data is made NOAH compatible.

Easy Tymp
• The handheld unit enables the transfer of data to a PC via USB-connection. The unit is compatible with NOAH 3 software.
Data Transfer

MT 10
• Data may be transferred to the Interacoustics database program OtoAccess™ for Windows® and printed together with other patient data. Data transfer to NOAH is also possible.

MicroTymp 3
• Has an infrared data transfer to docking station and station can connect via port for data transfer. Micro-USB port at the bottom of the handheld unit can be used for transfer of data to computer via WA software.
Integration into telemedicine software

AFHCAN tConsult Software & Earscan Tympanometer
The Probe Tip – Ear Seal is Most Important

Earscan Probe and Tip
(Microaudiometrics)
Ear Tips

GSI 39 Auto Tymp

MT 10

EasyTymp

MicroTymp 3
Probe tip in ear and the view.

GSI 39 Auto Tymp

EasyTymp

MT 10

MicroTymp 3

Note it is difficult to visualize the tip-ear seal.
Probe angle and head piece
View of tip from user perspective.
## Overall Ease of Use

<table>
<thead>
<tr>
<th></th>
<th>GSI 39</th>
<th>Easy Tymp</th>
<th>MT 10</th>
<th>Micro Tymp 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>This device is intuitive.</td>
<td>4</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Easy to use on adult.</td>
<td>5</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Easy to use on a child</td>
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<td>4</td>
<td>4</td>
<td>3</td>
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<tr>
<td>Comfortable &amp; Non-invasive</td>
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<td>4</td>
<td>4</td>
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<tr>
<td>Simple to obtain a good seal of the tip</td>
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<td>4</td>
<td>4</td>
<td>3</td>
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</table>

Based on this reviewer’s evaluation/opinion using a Likert scale of 1 to 5 where…

5 is Very Good,
4 is Good,
3 is O.K,
2 is Poor and
1 is Very Poor
# LCD Screen - Monitor

<table>
<thead>
<tr>
<th>Feature</th>
<th>GSI 39</th>
<th>Easy Tymp</th>
<th>MT 10</th>
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<tbody>
<tr>
<td>Size</td>
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<tr>
<td>Brightness</td>
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<td>Glare Free</td>
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<td>Color</td>
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<td>3</td>
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<td>Text Clarity</td>
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<td>3</td>
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<td>Viewing Angle</td>
<td>90 deg</td>
<td>120 deg</td>
<td>60 deg</td>
<td>90 deg</td>
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</tbody>
</table>

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## Screen Information Layout

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<th>MicroTymp 3</th>
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<td>L/R Designation</td>
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<td>3</td>
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<td>Compliance &amp; Pressure Values Visible</td>
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<td>5</td>
<td>3</td>
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<tr>
<td>Status: Open, Blocked, Leak</td>
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<td>5</td>
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</tbody>
</table>

Based on this reviewer’s evaluation/opinion using a Likert scale of 1 to 5 where…

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3 is O.K,
2 is Poor and
1 is Very Poor
Power Cord

GSI 39 Auto Tymp

EasyTymp

MT 10

MicroTymp 3
Power Cord and Transformer Brick

GSI 39 Auto Tymp  
MT 10

EasyTymp
MicroTymp 3
Changing Battery

GSI 39 Auto Tymp

MT 10

EasyTymp

MicroTymp 3
Batteries

GSI 39 Auto Tymp

EasyTymp

MT 10

MicroTymp 3
## Print

<table>
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<th>Easy Tymp</th>
<th>MT 10</th>
<th>MicroTymp 3</th>
</tr>
</thead>
<tbody>
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<td>Data Layout of Print</td>
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<td>Speed of Printer</td>
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<td>15 sec</td>
<td>4.5</td>
</tr>
</tbody>
</table>

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- 3 is O.K,
- 2 is Poor and
- 1 is Very Poor
Print Outs

GSI 39 Auto Tymp

MT 10

EasyTymp

MicroTymp 3
In Summary

Four good choices for Tympanometers

• Form Factors… Pros and Cons
• Ease-of-Use… Pluses and Minuses
• Data Transfer… compatible, additional cost
• Will see more integration into EHRs and telemedicine software in the future