



Tympanometry and Clinical Findings: Bridging Objective Assessment with Clinical Insight

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Tympanometry has become an indispensable component in the evaluation of middle ear function. As an objective, non-invasive, and rapid diagnostic tool, it complements clinical otoscopy and audiometric findings, providing valuable information about middle ear compliance, pressure, and Eustachian tube function. In contemporary otological practice, tympanometry not only enhances diagnostic accuracy but also aids in treatment planning and outcome assessment, particularly in disorders involving the tympanic membrane and middle ear cleft. However, there has been incidences where the clinical picture and tympanometry does not match with each other. For example a patient coming with simple blockage with grade II retraction of tympanic membrane might have Type A impedance graph or patient with no complaint might have a Type C or Type C1 (pressure -100 to -199).

Understanding the principles of tympanometry

Tympanometry is based on the principle of varying air pressure within the external auditory canal and measuring the corresponding movement (compliance) of the tympanic membrane and ossicular chain. The test employs a probe tone, typically 226 Hz for adults and higher frequencies such as 1000 Hz for infants, to assess the admittance of sound energy through the middle ear system. By altering the air pressure from positive to negative relative to atmospheric pressure, the instrument generates a tympanogram—a graphical representation of compliance versus pressure.

The resulting tympanogram reflects the status of the middle ear. The point of maximum compliance, or peak, corresponds to the pressure at which the tympanic membrane moves most freely, usually near ambient pressure in a normal ear. Deviations from this pattern indicate various pathological states such as fluid accumulation, negative pressure, or ossicular chain abnormalities.

Based on Jerger's classification tympanogram is classified into 3 distinct types that correlate with specific clinical conditions:

- **Type A:** Represents normal middle ear function
- **Type As (shallow):** Indicates reduced compliance, often due to stiffness in the ossicular chain or tympanic membrane thickening, as seen in otosclerosis or tympanosclerosis.
- **Type Ad (deep):** Shows hypercompliance, suggestive of ossicular discontinuity or a flaccid tympanic membrane.
- **Type B:** Characterized by a flat trace with no discernible peak, typically indicative of middle ear effusion or perforation. In such cases, the ear canal volume becomes a crucial parameter to differentiate between a fluid-filled middle ear and a large perforation.
- **Type C:** Displays a negative peak pressure beyond -100 daPa, signifying Eustachian tube dysfunction or resolving otitis media.

However, the normal pressure described in many text books from -200 to +200 daPa is not the one which matches with clinical findings.

Thus otoscopic examination remains the cornerstone of middle ear assessment, but subjective visualization can be limited by anatomical variations or patient cooperation. Tympanometry provides an objective quantification that can confirm or challenge clinical impressions.

For instance, in otitis media with effusion (OME), usually tympanometry typically reveals a Type B curve with normal ear canal volume, even when the tympanic membrane appears only mildly retracted on otoscopy. This helps in early detection of subclinical effusion, particularly in pediatric populations where clinical signs may be subtle. In contrast, a flat tympanogram with a large canal volume suggests a tympanic membrane perforation, directing the clinician toward appropriate management such as myringoplasty rather than medical therapy. However, one can find an almost normal or Type C1 graph in early effusion which do not synchronised with clinical finding of glue ear symptoms. Similarly, a Type As graph can be seen even in cases with intact or functioning ossicular chain but retracted tympanic membrane. Under normal circumstances the retracted tympanic membrane might show presence of Type C graph which with Type As graph is contradictory to the findings.

However, regular monitoring with tympanometry can track improvement or deterioration, guiding conservative measures like decongestants or surgical interventions such as balloon dilation, myringotomy etc based on the clinical diagnosis confirmed with impedance audiometry.

Tympanometry is particularly valuable in pediatric practice, where conventional audiometry may be unreliable due to poor cooperation. Middle ear effusion is a common cause of hearing loss in children, often leading to delayed speech and language development if undetected. Routine tympanometric screening in preschool and school-aged children enables early identification and timely referral for intervention.

In the elderly, tympanometry helps differentiate between sensorineural and conductive components of hearing loss, especially in patients with age-related ossicular or tympanic membrane changes. It also aids in preoperative and postoperative monitoring in tympanoplasty and ossiculoplasty procedures.

Despite its many advantages, tympanometry is not without limitations. The accuracy of the test depends on proper probe sealing, patient stillness, and absence of cerumen impaction. In infants below six months, the middle ear system is mass-dominated rather than stiffness-controlled, making low-frequency probe tones (226 Hz) less reliable. High-frequency tympanometry (1000 Hz) is therefore recommended in this group.

Recent advancements in acoustic immittance testing, such as wideband tympanometry (WBT) and multi-frequency tympanometry, are expanding the diagnostic horizon. These newer techniques assess middle ear function across a broad frequency range, providing more detailed information about energy absorbance and reflectance. They have shown promise in identifying subtle pathologies, monitoring postoperative recovery, and evaluating ears with ambiguous conventional tympanograms.

Moreover, tympanometry does not provide direct information about sensorineural hearing or the functional integrity of the cochlea and auditory nerve. It must always be interpreted in conjunction with pure-tone audiometry, acoustic reflex testing, and detailed clinical evaluation.

Tympanometry remains a cornerstone of otologic diagnostics, bridging the gap between subjective examination and objective assessment. Its simplicity, reliability, and diagnostic accuracy make it an invaluable complement to clinical findings in both routine and specialized ENT practice. When interpreted judiciously and in conjunction with otoscopic and audiometric evaluations, tympanometry enhances the clinician's ability to identify, monitor, and manage middle ear disorders with precision.

Though there have been many studies where a question is raised on the sensitivity of the tympanometry and it required a further research to validate whether tympanometry as a diagnostic tool is how accurate and sensitive in certain circumstances.