Diagnostic Agreement Study: Otoscopy vs Tympanometry in Otitis Media with Effusion

By
Khalid Salem Bayou, Salem A Farhat, Mohamed A. Shultami
Istishari Diagnostic Center

Resch article

ABSTRACT

Background: Otitis media with effusion is a common pediatric condition leading to hearing impairment. Accurate diagnosis is essential and relies primarily on otoscopy and tympanometry. Objective: To describe the diagnostic agreement between otoscopy and tympanometry in children with suspected otitis media with effusion. Methods: A prospective study was conducted on 45 children (90 Tympanic membranes) aged 3–11 years. Tympanic membranes over 15 days (1/9/2025–15/9/2025). Otoscopy was performed using an Omni 3000 otoscope and tympanometry with Interacoustics AT 235. Exclusion criteria were acute otitis media, tympanic membrane perforation, tympanic membrane perforation, ear discharge and children who are uncooperative. Findings were categorized and cross-tabulated descriptively. Results: out Of 90 Tympanic membranes, otoscopy identified normal (8), red (41), retracted (33), and air bubbles (8). Tympanometry showed Type A in 23 (25.6%), Type B in 55 (61.1%), and Type C in 15 (16.7%). Among normal Tympanic membranes, most showed Type A (6/8, 75%), while red Tympanic membranes showed predominantly Type B (25/41, 61%). Retracted Tympanic membranes correlated mainly with Type B (20/33, 60.6%), and air bubble Tympanic membranes were exclusively Type B (8/8, 100%). Conclusion: Tympanometry and otoscopy showed more than 60% agreement. Type B tympanograms correlated most strongly with abnormal otoscopic findings, particularly with presence of air bubbles behind tympanic membrane. However, some Tympanic membranes with red drum or retracted drum by otoscopy yielded Type A or Type C tympanograms, emphasizing the need for combined diagnostic use.

KEYWORDS: Otitis media with effusion, otoscopy, tympanometry, diagnostic agreement, pediatric ENT

INTRODUCTION

Otitis media with effusion (OME) is one of the most common conditions encountered in pediatric otolaryngology[1].

It is characterized by the accumulation of non-purulent fluid in the middle tympanic cavity space without the signs and symptoms of acute infection. The prevalence of OME is particularly high in children aged between 2 and 7 years .Tympanic membranes, with studies estimating that up to 80% of children will have experienced at least one episode by the age of 4 years[2]. This condition can have a significant impact on tympanic membrane thresholds compliance and hearing thresholds and, if persistent, may interfere with speech, language,

educational achievement, and quality of life[3].

The diagnosis of OME poses challenges in daily clinical practice. Otoscopy is gold standard for diagnosis, as it allows direct visualization of the tympanic membrane[4] . The Characteristic findings include opaque tympanic membrane, retraction, increased vascularity, or the presence of air-fluid levels and bubbles. However, otoscopy is inherently subjective and depends heavily on the examiner's experience and skill, which may lead to variability in accuracy across different clinicians[5].

Tympanometry provides an objective method to evaluate middle Tympanic membrane function by measuring the compliance of the tympanic membrane and ossicular chain in response to changes in air pressure[6].

Type A (normal curve) is usually interpreted as normal middle ear function. Type B tympanogram (flat curve) is often considered as diagnostic of middle ear effusion, while, Type C (negative peak) is associated with eustachian tube dysfunction or resolving effusion[7]. Despite its value, tympanometry is not infallible; some cases of OME may present with Type A or C curves, leading to false negatives or ambiguous results[8]. Furthermore, factors such as crying or improper probe seal may influence the test outcome.

The combination of otoscopy and tympanometry is therefore recommended in many clinical guidelines, including those of the American Academy of Pediatrics and the American Academy of Otolaryngology–Head and Neck Surgery[9]. Nevertheless, discrepancies between these two diagnostic tools remain common in clinical practice.

Understanding the degree of agreement between them is essential to improve diagnostic accuracy and guide management strategies.

This study was designed to evaluate the diagnostic agreement between otoscopy and tympanometry in children aged 3–11 years Tympanic membranes presenting with suspected OME. By examining both methods in a prospective clinical setting.

This research aims to highlight the strengths and limitations of each tool, and to emphasize the value of a combined diagnostic approach in improving the accuracy of OME detection and subsequent management.

METHODOLOGY

Prospective study is conducted in Istichari Diagnostic Center. All children aged between 3 - 11 years. in a period of 15 days from 1/ 9 /2025 to 15/ 9/2025, under-went full ENT examination. Out of them 45 child were included in the study. Including criteria were abnormal tympanic membrane and complain of hearing loss. All children were examined by the same consultant using the same otoscope and tympanometry. The otoscope used was Omni 3000 and tested by interacoustics tympanometry AT 235 [Automatic Tympanometry 235]. The children having acute otitis media or ear discharge or tympanic membrane perforation or uncooperative for otoscopy or tympanometry were excluded from the study. On otoscopic examination we categorized findings of tympanic membrane as normal, red, retracted, or air bubbles, tympanometry finding are categorized as: type A which is normal, type B which indicates fluid collection behind the tympanic membrane, and type C which indicates a negative pressure in the middle ear.

Corresponding author: Khalid Salem Bayou   Email: baiy7@hotmail.com
ORCD: "https://orcid.org/0009-0000-6861-7988

Each ear was examined and analyzed separately.

RESULTS
Gender Distribution
The number of boys found to be 25 and the girls were 20. The total number of Tympanic membranes examined was 90, with 50 from males and 40 from females. The study included 45 child, with a slightly higher proportion of males (25/45; 55.6%) compared to females (20/45; 44.4%).

Red tympanic membranes were the predominant finding in both genders, affecting 20/50 male Tympanic membranes (40%) and 21/40 female Tympanic membranes (52.5%). Retraction was the next most common, present in 18/50 males (36%) and 15/40 females (37.5%). Normal otoscopy findings were equally distributed (10% in both groups). Air bubbles were more common among males (16%) and absent in females (Table 1).

Table 1. Otoscopy findings by gender (n=90 Tympanic membranes)

Gender	Normal	Red	Retracted	Air bubbles	Total
Male	4	20	18	8	50
Female	4	21	15	0	40
Total	8	41	33	8	90

Tympanometry results by gender shows:
- Normal Tympanic membranes: Majority had Type A (6/8, 75%), with 2 showing Type C. None had Type B.
- Red Tympanic membranes: Predominantly Type B (25/41, 61%).

- Retracted Tympanic membranes: Mostly Type B (20/33, 60.6%), with some Type A and Type C.
- Air bubble Tympanic membranes: Exclusively Type B (8/8, 100%).
Overall, Type B tympanograms correlated most strongly with abnormal otoscopy (Table 2).

Table 2. Tympanometry results by gender (n=90 Tympanic membranes)

Gender	Type A	Type B	Type C	Total
Male	12	30	8	50
Female	11	25	7	43
Total	23	55	15	90

By comparing otoscopy finding by tympanogram results: normal Tympanic membranes were mostly associated with Type A tympanograms (6/8, 75%), with a minority showing Type C (25%). No normal Tympanic membrane showed a Type B curve. Red Tympanic membranes were predominantly linked with Type B (25/41, 61%), while retracted Tympanic membranes were also strongly associated with Type B (20/33, 60.6%) but with some variability (Type A and C also present). Air bubbles were exclusively correlated with Type B tympanograms (8/8, 100%) (Table 3).

Corresponding author: Khalid Salem Bayou   Email: baiy7@hotmail.com
ORCD: "https://orcid.org/0009-0000-6861-7988

Table 3. Cross-tabulation of Otoscopy findings and Tympanometry results (n=90 Tympanic membranes)

Otoscopic Finding	Type A	Type B	Type C	Total
Normal	6	0	2	8
Red	9	25	7	41
Retracted	7	20	6	33
Air bubbles	0	8	0	8
Total	23	55	15	90

DISCUSSION

Our findings demonstrate that Type B tympanograms are the most reliable indicator of OME, strongly correlating with abnormal otoscopic findings such as redness, retraction, and especially air bubbles (100% correlation). Interestingly, in this dataset, none of the normal tympanic membranes showed a Type B curve, but some still presented Type C patterns (25%), consistent with eustachian tube dysfunction rather than effusion (Williamson, 1994; Rosenfeld et al., 2016)[10,11].

The increase in Type C tympanograms (15/90, 16.7%) highlights its intermediate role: it was frequently observed in both red and retracted Tympanic membranes, suggesting compromised middle Tympanic membrane ventilation but not always effusion[12,13]. This aligns with Paradise et al. (1997) and Marchant et al. (1986), who noted that tympanometry may underestimate effusion if only Type B curves are considered diagnostic. As in Tympanic membranelier studies (MRC Trial 2001; Roush & Bryant, 2018), tympanometry alone would miss some cases: about 25% of normal Tympanic membranes and 18% of retracted Tympanic membranes showed Type C curves despite otoscopic suspicion [14,15]. This reinforces the value of combined diagnostic assessment.

CONCLUSION

Tympanometry and otoscopy showed a strong clinical agreement. Type B tympanograms strongly correlated with effusion on otoscopy, especially with visible air bubbles. However, the presence of Type C tympanograms in both normal and abnormal Tympanic membranes demonstrates that it should be interpreted cautiously as a marker of eustachian tube dysfunction rather than definite OME.

Clinical implication: Tympanometry is valuable but should complement, not replace, otoscopy. A combined diagnostic approach ensures the most accurate identification of OME in children.

REFERENCES

1. American Academy of Pediatrics. (2004). Otitis media with effusion. Pediatrics, 113(5), 1412–1429. https://doi.org/10.1542/peds.113.5.1412

2. Rosenfeld, R. M., Shin, J. J., Schwartz, S. R., et al. (2016). Clinical practice guideline: Otitis media with effusion (update). *Otolaryngology–Head and Neck Surgery*, *154*(1_suppl), S1–S41.

3. Roush, J., & Bryant, K. (2018). Tympanometry in clinical

practice. *Seminars in Hearing*, *39*(01), 010–021.

4. Bluestone, C. D., & Klein, J. O. (2018). *Otitis media in infants and children* (6th ed.). BC Decker.

5. Tos, M. (1997). Epidemiology and natural history of secretory otitis. In C. D. Bluestone & J. O. Klein (Eds.), *Otitis media in infants and children* (pp. 47–86). WB Saunders.

6. Zielhuis, G. A., Rach, G. H., van den Bosch, A., & van den Broek, P. (1990). The prevalence of otitis media with effusion: A critical review of the literature. *Clinical Otolaryngology*, *15*(3), 283–288.

7. Stool, S. E., & Berg, A. O. (2002). *Otitis media with effusion in young children: Clinical practice guideline*. Agency for Healthcare Research and Quality.

8. Saunsbury, J. E., & Berman, S. (1995). Interpretation of tympanograms in infants and young children. *Annals of Otology, Rhinology & Laryngology*, *104*(10), 830–836.

9. Marchant, C. D., McMillan, P. M., Shurin, P. A., Johnson, C. E., Turczyk, V. A., Feinstein, J. C., & Carlin, S. A. (1986). Objective diagnosis of otitis media in early infancy by tympanometry and ipsilateral acoustic reflex thresholds. *Journal of Pediatrics*, *109*(4), 590–595.

10. Paradise, J. L., Smith, C. G., & Bluestone, C. D. (1997). Tympanometric detection of middle-ear effusion in infants and young children. *Pediatrics*, *99*(3), 318–323.

11. Williamson, I. (1994). Otitis media with effusion. *Clinical Evidence*, *1*, 291–298.

12. MRC Multicentre Otitis Media Study Group. (2001). Surgery for persistent otitis media with effusion: generalisable results from the UK trial. *Lancet*, *357*(9251), 1903–1909.

13. Finitzo, T., Friel-Patti, S., Chinn, K., & Brown, O. (1992). Tympanometry and otoscopy prior to myringotomy: issues in diagnosis of otitis media. *International Journal of Pediatric Otorhinolaryngology*, *24*(2), 101–110.

14. Paradise, J. L., Rockette, H. E., Colborn, D. K., et al. (1997). Otitis media in 2253 Pittsburgh-area infants: prevalence and risk factors during the first two years of life. *Pediatrics*, *99*(3), 318–323.

15. Fiellau-Nikolajsen, M. (1983). Tympanometry and secretory otitis media: observations on diagnosis, epidemiology, treatment, and prevention in prospective cohort studies of three-year-old children. *Acta Oto-Laryngologica*, *96*(sup398), 1–73.

Corresponding author: Khalid Salem Bayou   Email: baiy7@hotmail.com
ORCD: "https://orcid.org/0009-0000-6861-7988