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High frequency and low frequency probe tone tympanometry in diagnosis of middle ear diseases in infants: Comparative study

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Abstract
Objectives: To evaluate diagnostic value of high frequency single prop tone tympanometry (1000 Hz) in otitis media with effusion in infants.
Method: We selected 90 infants patients aged 4 to 8 months with long standing or recurrent attacks of otitis media with effusion at the outpatient clinic of ENT Department, Aljumhory teaching hospital, Mosul, Iraq, May 2018 to June 2019. Immittancemetry included single low probe tone (226Hz) and high probe tone (1000Hz) frequency tympanometry at same setting were conducted. Tympanometric pattern occurrence, acoustic reflex thresholds and peak compensated static acoustic admittance for each tested frequency were estimated and analyzed.
Result: At 226 Hz frequency 25 patients were single peak tympanogram and 65 patients were flat curve, while at 1000 Hz frequency 51 patients were single peak and 39 patients had flat curve. Acoustic reflex threshold were present in 45 patients and absent in the other 45 at 226 Hz frequency, but it was present in 60 infants and absent in 30 infants at the 1000 Hz. Mean static peak acoustic admittance at 226 Hz was 0.69, while at 1000 Hz the mean was 4.52. Peak not founded in 31 patients at 226 Hz & in 19 patients at 1000 Hz.
Conclusion: 1000 Hz probe tone tympanometry was more efficient in the diagnosis of otitis media with effusion.

Keywords: tympanometry, probe, tone, infants

Introduction

Acoustic immittance measurements are valuable tools for estimation of middle ear pathology. It measures the acoustic energy transfer that occurs when sound pressure is delivered to the tympanic membrane, which causes its movement. This mode of investigation assess the ease or opposition to this sound energy within the auditory pathway. High frequency tympanometry founded as a promising new method for the detection of middle ear conditions because it is fast, objective, noninvasive, and more sensitive than conventional one (performed at 226 Hz). Tympanometry has become a routine in Audiological evaluation and has been used widely in assessment of middle ear diseases by the measurements of the aural acoustic immittance at the tympanic membrane as a function of the ear canal pressure within the external auditory meatus. Most of the commercial instruments have a single low probe tone (226 Hz) for measuring the acoustic immittance of the ear as the compliance or stiffness elements are the main contributors to the admittance measured in the ear canal.Many studies states that low frequency tympanometry could provide a useful diagnostic data for patients with disorders of the tympanic cavity (effusion), disorders of the tympanic membrane (tympanosclerosis) and for those with Eustachian tube dysfunction. However, it is relatively insensitive to many lesions that affect the tympano-ossicular system. It may shows the same Tympanometric pattern for many pathologies. Middle ear effusion, malleus fixation, and tympanic membrane perforation sealed with cholstuatoma give identical flat tympanograms. Conversely, one middle ear pathology may show different Tympanometric patterns. For example, middle ear effusion demonstrates a flat curve, but it May show a notched tympanogram. To overcome this problem, several studies have discussed the possible advantage of using probe tone frequencies closer to the resonance of the tympanic membrane and middle ear.

Shanks and Shelton stated that the higher frequency probe tone, the higher sensitivity in the detection of middle ear pathologies and therefore it might be more beneficial than the conventional (226 Hz) probe tone in evaluating the middle ear acoustic transmission system. Colletti was the first who reported that the high frequency tympanometry is superior to low frequency tympanometry in eliciting small changes in the transmission mechanism of the tympano-ossicular system. Margolis and Goycoolea We considered that the most potentially useful measure that could be gained from high frequency tympanometry is the resonant frequency of the middle ear were stiffness and mass elements of the ear are in balance. Some authors recommend the combination of conventional and high frequency tympanometry in neonates and children. The tympanic-Ossicular system behaves differently in children up to 2 years of age, in which mass is the dominant feature and can be assessed more accurately at high frequencies (probe tone 1000 Hz). After this age, there is a change in behavior toward the adult stage in which stiffness is dominated and is better evaluated by 226 Hz frequency probe tone. Acoustic immittance methods using high frequencies help to detect the false-positive screening data that occur due to pathology in the middle ear and result in inappropriate medical and Audiological referrals and may improve the efficiency of newborn hearing screening programs. The purpose of this study was to characterize acoustic immittance measurements in infants using 2 probe tones types.

Material and Methods

90 infants' patients aged 4 to 8 months with long standing or recurrent attacks of otitis media with effusion were selected from the outpatient clinic of ENT Department, Aljumhory teaching hospital Mosul Iraq, between May 2018 and June 2019. Their parents were informed and gave their consent to the procedures that were performed. A full medical history was taken from all patients included trauma to the ear (physical or acoustic), no history of aural discharge, nor intake of ototoxic drugs, or ear operations, and no family history of hearing loss. A full ENT examination was carried out with emphasis in Otological examination. Equipment used were Otoscopic, sound-treated room, digital impedance meter virtual model, Amplivox Otowave 202-H (single low 226Hz and high frequency prop tone 1000 Hz tympanometry).. Full Audiological investigations were conducted in the form of OAE&ABR and as it is required. Immittancemetry included low probe tone (226Hz) and high probe tone (1000Hz) frequency tympanometry at same setting. The low probe tone frequency of 226 Hz was performed with Sweep pressure from to positive to negative (+200 to -300 dapa) with sweeping rate of 50dapa-1. 1000Hz frequency tympanograms was performed similarly. All tests parameters checked and set appropriately prior to testing. Tympanometric shape occurrence, acoustic reflex thresholds and peak compensated static acoustic admittance for each tested frequency were estimated and analyzed. If there were artifacts or inadequate sealing of the probe, the test was repeated.

Results

In our study, the right and left ears were grouped together to help better analysis of the results, since no differences were found between ears in many studies. In many literatures, single-peaked and double-peaked tympanograms are considered normal, while asymmetric, inverted, and flat tympanograms are considered abnormal. 90 children below age of 1year with OME were examined by conventional (226hz) and 1000hz probe tone frequency at same set. Tympanogram pattern, acoustic reflex threshold and static peak acoustic admittance were collected and evaluated. At 226Hz probe tone frequency 25 patients (27.7%) were single peak tympanogram and 65 patients (72.2%) were flat curve, while at 1000Hz frequency 51 patients (56.6%) were single peak and 39 patients (43.3%) had flat curve.

Acoustic reflex threshold were present in 45 patients (50%) and absent in the other 50% at 226 Hz frequency, but it was present in 60 infants (66.6%) and absent in 30 infants (33.3%) at the 1000Hz probe tone. Mean static peak acoustic admittance(Y mt) at 226 hz (ml) was 0.69 with maximum admittance of 1.8, while at 1000hz the mean (mmho) was 4.52 with maximum admittance of 12.2.Minimum Ymt at 226Hz was 0.1 and at 1000Hz was 1.4. Peak not founded in 31 patients (27.9%) at 226 Hz and in 19 patients (17.1%) at 1000 Hz.

Table 1: Date collected & tabulated Table 1

Findings	Type	226 Hz ml	1000 Hz mmho
Tympanometric shape	Single peak	25 (27.7%)	51 (56.6%)
False +ve 26(23.4%)	Flat	65 (72.2%)	39 (43.3%)
Acoustic reflex threshold (ART)	present	45 (50%)	60 (66.6%)
False +ve 15(13.5%)	Absent	45 (50%)	30 (33.3%)
Static peak acoustic	Mean	0.69	4.52
Admittance (Ymt)	maximum(Ymt)	1.8	12.2
False +ve 12(10.8%)	peak not found	31(27.9%)	19(17.1%)

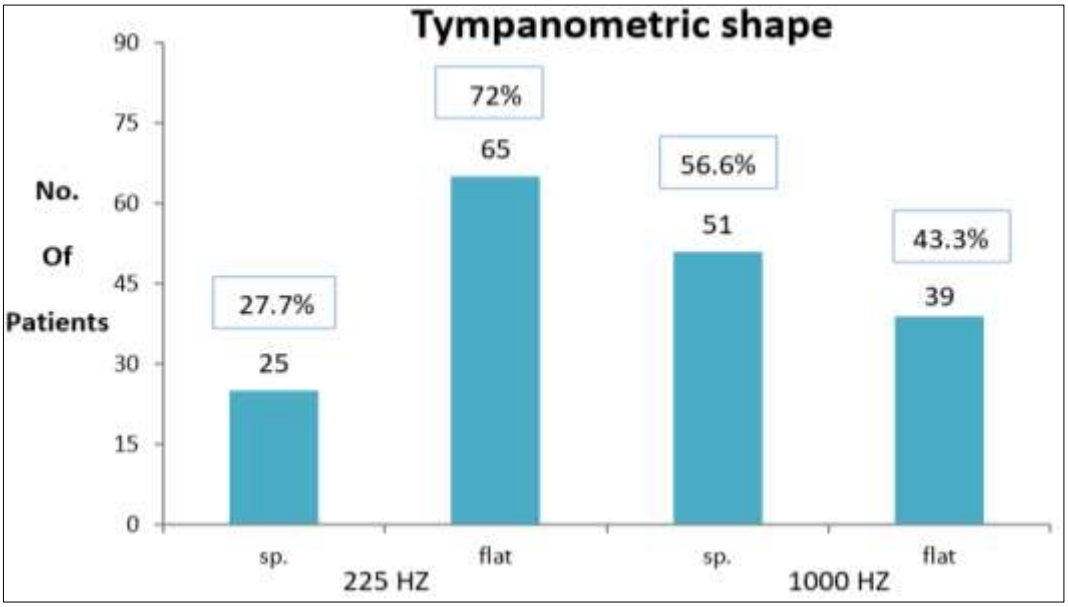

Fig 1: Tympanometric Shape according to frequency

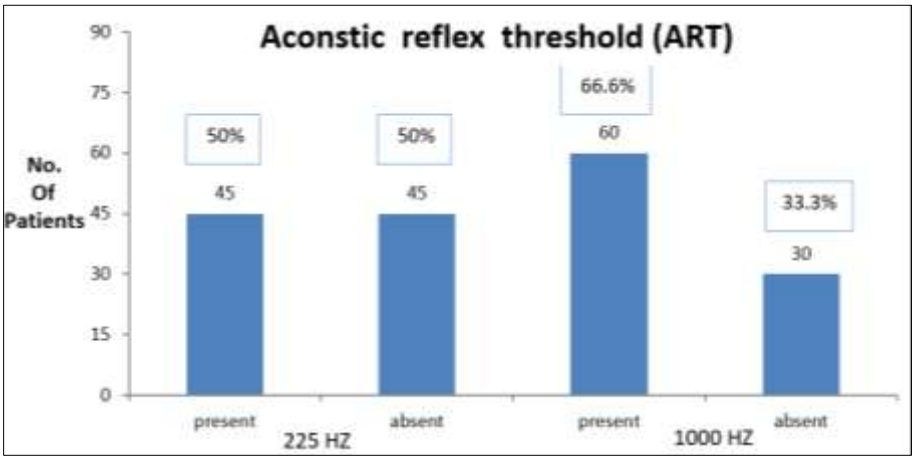

Fig 2: ART according to frequency

Discussion

Tympanometry is used routinely in audiology evaluation of middle ear pathology. Most of Tympanometric machines measure immittance at single low frequency probe tone (226 Hz). This instrument is occasionally insensitive to many lesions that affect the tympano-ossicular system. The first experimental data on multi-frequency tympanometry were collected in the 1960s. Colletti reported changes in the shape of the Tympanometric curve as the frequency of the probe tone increased from 200 to 2,000 Hz. High frequency tympanometry at 1000Hz founded between the sixties and eighties and become clinical practice in 2000. Research seems to prove greater validity of HFT than low frequency tympanometry (226Hz) in diagnosing OME in babies under 9 months. Hoffman *et al*. consider it wise to use 1 kHz tympanometry up to the age of 9 months. Alaerts *et al*. discovered that 1 kHz probe tone should be used at age less than 3 months; 226Hz probe tone at more than 9 months, and both at age 3 – 9 months. Vlachou *et al*. 13 founded different values of high frequency tympanogram despite the normal data of 226Hz tympanogram. A normal-appearing tympanic membrane does not exclude the possibility of middle ear pathology and HFT can help in these cases. High-frequency tympanometry can identify some middle ear pathologies that are not detectable by classic 226 Hz tympanometry. We conduct this study to determine the high sensitivity of high frequency tympanometry in adding a more information's about the nature of the pathology of the middle ear in patients with conductive hearing loss. Paradise *et al* founded that a major number of babies under 7 months having OME (confirmed by myringotomy) presented false normal tympanograms. It was confirmed that a tone of 226Hz in this age can produce flat tympanograms (false positives) in children with normal ears, in approximatley 40% - 90%. These finding may demonstrate the inefficacy of conventional tympanometry in few month-old infants. In infants under 3 months false positives increase with 226Hz probe tone tympanometry and decrease when 1 kHz is used. Despite this, 1 kHz tympanometry is still not widely used clinically, probably due to the difficulties interpreting these tympanograms and doubt of the age in which they are used. In our study 1000hz tympanometry was found to be more accurate in defining Tympanometric pattern and detecting normal ME system that have been filled with fluid at 226hz probe tone testing with significant false +ve ratio. This was noted by Colletti & Zhigi *et al*. The use of the 1,000-Hz tone decreased the prevalence of flat tympanograms and increased normal curves in a group of infants. In many studies, the assessment of ASRTs revealed absence of response when performed with the 226 Hz probe, and the positive response at 1,000 Hz probe. In this study the analysis of the stapedius acoustic reflex in newborns was more efficient with the 1,000 Hz probe tone. The occurrence of acoustic reflex in infants was higher (thresholds were lower) when the assessment was performed with the 1,000 Hz probe in comparison to the 226 Hz probe. Lilian &colleagues2015 in their study showed that the analysis of the stapedius acoustic reflex in newborns was more efficient with the 1,000 Hz. Recent studies showed high frequency tympanometry measurements have a higher success rate than classic tympanometry in detecting the middle ear effusions in infants (Zhigi *et al*.). Different admittance values are expected to be present in Tympanometric measurements since different audio frequencies are used. In our study, when the mean acoustic admittance values were compared with the general study group, statistically significant differences were found between 1,000 Hz tympanometry and 226 Hz tympanometry. Mean values of the acoustic admittance were found to be significantly different at 226 and 1,000 Hz; and increased at 1,000 Hz. This suggests that the admittance values are better at 1,000 Hz and that it could be significant in detecting other middle ear pathologies.

Conclusion

This study established that 1,000 Hz tympanometry seems more accurate for the diagnosis and treatment of OME with variable pressure differences and compliance values in infants compared to 226 Hz tympanometry.

References

1. Kei J, Allison-Levick J, Dockray J. *et al*. High-frequency (1000 Hz) tympanometry in normal neonates. J Am Acad Audiol. 2003; 14(1):20-28. [PubMed] [Google Scholar]
2. Margolis RH, Bass-Ringdahl S, Hanks WD, Holte L, Zapala D A. Tympanometry in newborn infants—1 kHz norms. J Am Acad Audiol. 2003; 14(7):383-392. [PubMed] [Google Scholar]
3. Carvallo RM. Rio de Janeiro, Brazil: Guanabara Koogan; Medidas eletroacústicas imitância acústica, 2003, 1-22. [Google Scholar]
4. Margolis RH, Hunter LL. São Paulo, Brazil: Manole. Timpanometria: princípios básicos e aplicações clínicas, 2001, pp. 85-126. [Google Scholar]

5. Sininger YS. Audiologic assessment in infants. Curr Opin Otolaryngol Head Neck Surg. 2003; 11(5):378-382. [PubMed] [Google Scholar]
6. Shahnaz N, Miranda T, Polka L. Multifrequency tympanometry in neonatal intensive care unit and well babies. J Am Acad Audiol. 2008; 19(5):392-418. [PubMed] [Google Scholar]
7. Baldwin M. Choice of probe tone and classification of trace patterns in tympanometry undertaken in early infancy. Int J Audiol. 2006; 45(7):417-27. [PubMed] [Google Scholar]
8. Swanepoel W, Werner S, Hugo R, Louw B, Owen R, Swanepoel A. High frequenc
9. Int Tamyne Ferreira Duarte de Moraes, Camila de Cássia Macedo, and Mariza Ribeiro Feniman Arch Otorhinolaryngol, 2012.
10. Rogers DJ, Boseley ME, Adams MT, Makowski RL, Hohman MH. Prospective comparison of handheld pneumatic otoscopy, binocular microscopy, and tympanometry in identifying middle ear effusions in children. Int J Pediatr Otorhinolaryngol. 2010; 74:1140-1143.
11. Michele Picanço Carmo, Nayara Thais de Oliveira Costa, and Teresa Maria Momensohn-Santos Tympanometry in Infants: A Study of the Sensitivity and Specificity of 226-Hz and 1,000-Hz Probe Tones, 2013.
12. Lilian Cássia Bórnia Jacob-Corteletti. Acoustic reflex on newborns: the influence of the 226 and 1,000 Hz probes CoDAS vol.27 no.3 São Paulo May/June, 2015.
13. Johannes Lantz, Michelle Petrak, Laura Prigge. Using the 1000-Hz probe tone for immittance measurements in infants High-frequency immittance.