

Efficacy and feasibility of 226 Hz and 1000 Hz tympanometry in healthy pediatric patients

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ABSTRACT

Objectives: Tympanometric evaluation of middle ear with 226 Hertz (Hz) frequency probe has been widely used in patients with suspected middle ear and Eustachian tube disorders. However most of the recent studies were demonstrated that tympanometric examination with 1000 Hz frequency probe was superior to 226 Hz frequency probe examination to detect middle ear disorders affecting middle ear admittance especially for infants. The objective(s) of this study was to compare the reliability and feasibility of 226 Hz and 1000 Hz tympanometric results in normal hearing healthy pediatric group of patients.

Methods: In this study, we evaluated normal healthy pediatric patients with 226 and 1000 Hz frequency probe tympanometry for the aim of comparing efficacy and detecting the rate of false negative tympanometric findings in these subjects. Forty-nine (98 ears) healthy pediatric patients (25 males and 24 females) were enrolled in the study and all of the patients were younger than 18 years of age. Oto-microscopic examination was performed to all of the patients as a gold standard.

Results: The mean age was 9.3 ± 4.46 years old with a range from 3 to 17 years. The mean values of 226 Hz tympanometric measurement of right ears for ear volume, compliance, pressure and gradient were 74 ± 28.10 , 59 ± 38.96 , -46 ± 92.38 and 36 ± 3.22 , respectively; these values for the left ears were 84 ± 65.94 , 51 ± 31.00 , -57 ± 102.05 and 30 ± 23.35 , respectively. The mean values of 1000 Hz tympanometric measurement of right ears for ear volume, compliance and pressure were 78 ± 23.03 , 172 ± 85.04 and -22 ± 110.70 , respectively; these values for the left ears were 64 ± 32.05 , 147 ± 104.70 , and 0 ± 98.20 , respectively.

Conclusions: We found that there was no superiority of the usage of 1000 Hz tympanometry to 226 Hz tympanometry in normal hearing healthy pediatric patients who were equal or older than 3 years of age.

Keywords: 1000 Hz tympanometry, 226 Hz tympanometry, children, normal hearing

Tympanometry is a useful diagnostic tool to detect middle ear pathologies especially otitis media with effusion (OME). It reflects the middle ear elasticity, stiffness and compliance which are disrupted in some middle ear pathologies. The most common conventional method for tympanometric measurement is performed by using 226 Hertz (Hz) probe tone. The

other common, especially in infants, used 1000 Hz probe tone frequency have been found superior to 226 Hz probe tone in infants younger than 9 months [1, 2].

In recent years, 1000 Hz probe tone tympanometry in infants has been increasingly studied with the widely committed national hearing programs in more countries for the aim of early detection of hearing loss

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in neonates. Middle ear dysfunctions in which the most common reason is OME are the main reason for false-positive results in these screening programs, therefore it is crucial to detect clearly OME if it is present [3]. Tympanometry is an objective, useful, non-invasive and reusable clinical diagnostic tool to detect middle ear function, and also external ear as well.

Although studies regarding with comparing feasibility of 1000 Hz and 226 Hz probe tone tympanometries in children, especially in infants, have presented for patients with normal and middle ear pathologies in the literature, there are a few studies comparing the feasibility and usefulness of 1000 Hz and 226 Hz probe tone tympanometries in children older than 3 years of age with normal functioning middle ears. Therefore, it would be possible to detect false-positive results and compare with this method in the patients.

In this retrospective study, we aimed to compare the feasibility and usefulness of 1000 Hz and 226 Hz probe tone tympanometries in children older than 3 years of age with normal otomicroscopic examination and normal hearing detected with behavioral audiometry, transient-evoked otoacoustic emissions (OAE) and/or click-evoked auditory brainstem audiometry (ABR).

METHODS

In this retrospective study, we evaluated normal healthy pediatric cases with 226 and 1000 Hz frequency probe tympanometries for the aim of comparing efficacy and detecting the rate of false positive tympanometric findings in these subjects.

Forty-nine (98 ears) healthy pediatric subjects (25 males and 24 females) were enrolled in the study, and all of the cases were younger than 18 years of age. The mean age was 9.3 ± 4.46 years old with a range from 3 to 17 years. Oto-microscopic examination was performed to all of the children as a gold standard to detect pathologies in middle ear and external ear as well. All of the children had normal hearing that were detected by means of behavioral audiometry, Otoacoustic emission (OAE) and/or Auditory Brainstem Response (ABR).

All of the tympanometric tests were performed with both of the 226 Hz and 1000 Hz probe tones (Interacoustics AT 235 h tympanometer, Denmark) in each child. Tympanometry types for 226 Hz tone probe were noted as type A, type B, type C, type D and type Du; and for 1000 Hz tone probe as type 1, type 2, type 3, type 4 and type 4u as based on Lidén [4] and Jerger [5].

RESULTS

The mean values of 226 Hz tympanometric measurement of right ears for ear volume (EV), compliance (C), tympanometric peak pressure (TPP) and gradient (G) were 74 ± 28.10 ml, 59 ± 38.96 ml, -46 ± 92.38 daPa and 36 ± 33.22 ml, respectively; these values for the left ears were 84 ± 65.94 ml, 51 ± 31.00 ml, -57 ± 102.05 daPa and 30 ± 23.35 ml, respectively. The mean values of 1000 Hz tympanometric measurement of right ears for EV, C and TPP were 78 ± 23.03 ml, 172 ± 85.04 ml and -22 ± 110.70 daPa, respectively; these values for the left ears were 64 ± 32.05 , 147 ± 104.70 , 0 ± 98.20 , respectively. TPP

Table 1. 226 Hz and 1000 Hz tympanometry results of the patients

	226 Hz. Tympanometry		1000 Hz. Tympanometry	
	Right Ears	Left Ears	Right Ears	Left Ears
Normal tympanogram*	42	41	42	42
Anormal tympanogram**	7	8	7	7
Other anormal tympanograms [†]	None	None	None	None
Total	49	49	49	49

*Type A in 226 Hz probe tone tympanometry, and type 1 in 1000 Hz tympanometry.

**Type C in 226 Hz probe tone tympanometry, and type 3 in 1000 Hz tympanometry.

[†]Type B, D and Du in 226 Hz probe tone tympanometries, and type 2, 4 and 4u in 1000 Hz tympanometries.

around 0 daPa (between +100 daPa and -150 daPa) were classified as Type A or Type 1 in 226 Hz tone probe and 1000 Hz tone probe tympanometries, respectively. We detected 86% (42/49 patients) type A tympanometry for the right ears and 84% (41/49 patients) for the left ears in 226 Hz tympanometric measurements, and 86% (42/49 patients) type 1 tympanometry for the right ears and 86% (42/49 patients) for the left ears in 1000 Hz tympanometric measurements (Table 1). Additionally, we detected 14% (7/49 patients) type C tympanometry (TPP at lower than -150 daPa pressure) for the right ears and 16% (8/49 patients) for the left ears in 226 Hz tympanometric measurements, and 14% (7/49 patients) type 1 tympanometry (TPP at lower than -150 daPa pressure) for the right ears and 14% (7/49 patients) for the left ears in 1000 Hz tympanometric measurements. There were no type B, type D and type Du tympanometries in any patient with 226 Hz tympanometry and no type 2, type 4 and type 4u in any patient with 1000 Hz tympanometry.

DISCUSSION

In this study, we compared the 266 Hz tone probe tympanometry results with 1000 Hz tone probe tympanometry results that were performed in normal hearing and healthy pediatric patients older than 3 years of age. However, there is a study from Korea that recommends usage of 1000 Hz probe tone tympanometry for infants up to 12 months of age [6]. Type of tympanogram in the clinician perspective is the main objective to consider normality or abnormality of this objective measurement with regarding to external ear canal, tympanic membrane and middle ear function. Therefore we considered the type of tympanometry as normality standard.

Alaerts et al. [3] found that type 1 tympanogram were detected in 91% of infants younger than 3 months of age with 1000 Hz tone probe tympanometry; on the other hand, 75% of the cases had type A tympanometry with 226 Hz tympanometry in children between 9-32 months of age. We found that 86% (42/49 patients) type A tympanometry for the right ears and 84% (41/49 patients) for the left ears in 226 Hz tympanometric measurements, and 86% (42/49 patients) type 1 tympanometry for the right ears

and 86% (42/49 patients) for the left ears in 1000 Hz tympanometric measurements.

Park et al. [6] studied on Korean infants (up to 13 months of age) whether having OME or not by using 226 Hz and 1000 Hz tympanometry. They found that more than 90% of tympanometries with 226 Hz were normal in infants without OME as well as with 1000 Hz tympanometry. On the contrary, in infants with OME more than 90% of tympanometries with 226 Hz were normal but more than 90% of tympanometries with 1000 Hz were abnormal which means more reliable results. In normal functioning middle ears, the tympanometry results were similar with 226 Hz and 1000 Hz but in middle ear pathologies, such as OME, the results of 1000 Hz were more reliable and false-negative results were detected with 226 Hz tympanometry [6].

Other important tympanometric finding in first 6 weeks of life in neonates is DP (double peak curve) tympanogram which was compatible with rapid anatomical growth of ear structures during this period, and this tympanometric finding is decreased with increasing age [3, 7]. Also, we detected no DP tympanometric finding in normal hearing healthy pediatric patients who were equal or older than 3 years of age which is compatible with the literature.

In current study, nearly 85% of normal functioning ears had normal type A or type 1 tympanometry but remaining nearly 15% subject had abnormal tympanometry on both of 226 Hz and 1000 Hz tympanometry in normal hearing and normal functioning middle ear system (false-positive results) in healthy children with older than 3 years of age.

CONCLUSION

We found that there was no superiority of the usage of 1000 Hz tympanometry to 226 Hz tympanometry in normal hearing healthy pediatric patients who were equal or older than 3 years of age. It needs studies with large series of cases to assess the reliability of these results.

Authors' contribution

OİÖ = writing of the article, substantial contributions to conception and design, revising it critically for important intellectual content and final

approval of the article; GÖA = revising it critically for important intellectual content, substantial contributions to conception and design, and final approval of the article; EP = analysis and interpretation of data, performing of tympanometric measurements, data collection, drafting the article and final approval of the version; ÖE = analysis and interpretation of data, performing of tympanometric measurements, data collection, drafting the article and final approval of the version; ŞY = Analysis and interpretation of data, performing of tympanometric measurements, data collection, drafting the article and final approval of the version.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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