

CASE REPORT

Hearing within the Normal Limit may not Indicate that the Middle Ear is Healthy

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ABSTRACT

In clinical settings, air conduction (AC) thresholds of pure tone audiometry (PTA) represent the severity of hearing loss. If the AC thresholds are within the normal limit (≤ 20 dB HL), bone conduction (BC) thresholds are not typically determined. In this case report, the importance of having BC thresholds is highlighted (even though AC thresholds are normal) to achieve an accurate diagnosis.

Keywords: Air-bone gap, Bone conduction, Conductive hearing loss, Otitis media, Pure tone audiometry.

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INTRODUCTION

Hearing loss has been recognized as one of the important health issues.^{1,2} It affects people of various age-groups including children.¹ There are three types of hearing losses, such as conductive hearing loss (CHL), sensorineural hearing loss (SNHL), and mixed hearing loss.³ Those who are diagnosed with hearing loss may have hearing levels ranging from mild to profound. While SNHL is a permanent disorder, CHL can be characterized as a temporary condition and hearing levels may fluctuate over time. One of the common causes of CHL among children is middle ear problems.² If not treated in a timely manner, more serious consequences would occur in those with middle ear problems.⁴ Comprehensive hearing assessments are therefore essential to determine the severity and type of hearing loss in individuals who are at risk to have hearing loss. As such, the hearing diagnosis must be accurate as different types of hearing losses require specific treatment options.²

In clinical settings, pure tone audiometry (PTA) has been regarded as the gold standard test of hearing among cooperative children and adult patients.² In this test, air conduction (AC) and bone conduction (BC) thresholds are determined. In this respect, AC and BC thresholds represent the severity and the type of hearing loss, respectively. Those with AC thresholds that are equal to or less than 20 dB HL are considered to have normal hearing.² Additionally, tympanometry and acoustic reflex tests may also be carried out to support the hearing diagnosis.^{5,6} It is worth noting that completing all these tests from uncooperative children can be challenging. In this regard, due to their short attention span or other "behavioral" problems, some clinicians may apply shortcuts (to ensure that valid and reliable results are obtained in a short time). That is, only AC thresholds are determined, especially when those are within the normal limit (≤ 20 dB HL). In this case report, the importance of having BC thresholds is highlighted, even though the AC thresholds are normal to achieve an accurate diagnosis.

CASE DESCRIPTION

This is a case of eight-year-old boy who was referred to Audiology Clinic, University Hospital, for hearing assessments by an otorhinolaryngology (ORL) doctor. According to the report, he was diagnosed with inactive chronic suppurative otitis media

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(CSOM) bilaterally. There was no concern about his hearing, and his communication skills were adequate. According to his mother, the child has history of recurrent ear discharge since 3 months of age (involving both of his ears) and has regular follow-ups with ORL doctors to manage his otological condition. His physical development was normal, and he is enrolled in a normal (mainstream) school.

Otoscopic examination showed the presence of minimal earwax with an intact tympanic membrane (TM) bilaterally. However, the cone of light was not visible from both TMs. Tympanometry revealed a type A tympanogram for the left ear (suggestive of reduced middle ear compliance) and a type B tympanogram for the right ear (indicative of the presence of fluid in the middle ear). The tympanometric testing was performed using a 226-Hz middle ear analyzer (Interacoustics AT235H, Denmark).

PTA was then performed using a calibrated two-channel audiometer (GSI 61, Grason-Stadler Inc. from USA). The TDH-39 headphone was used to obtain AC thresholds at 250 to 8000 Hz for both ears. The B71 bone vibrator was employed to determine BC thresholds (250–4000 Hz). Both AC and BC thresholds were determined using the standard threshold seeking procedure.² As the boy was restless during the BC procedure, the masked BC thresholds were only able to be obtained at two frequencies (250

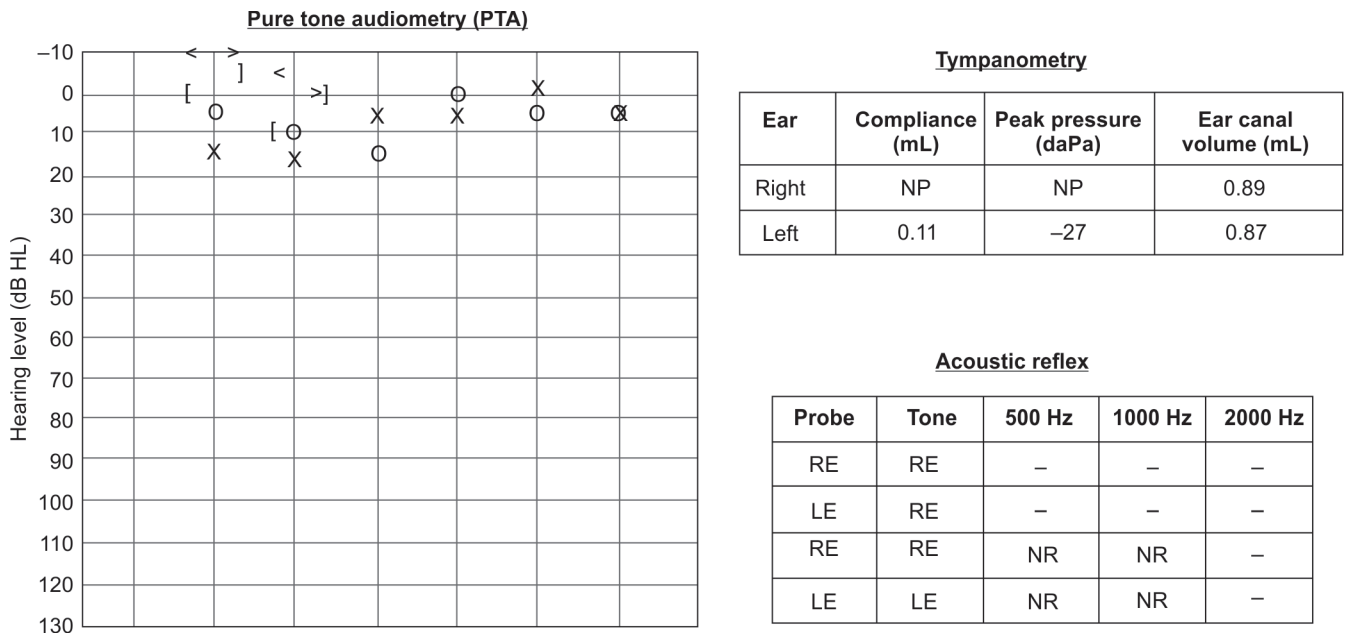


Fig. 1: Audiological results of the child

and 500 Hz) for the left ear. Figure 1 shows the results of PTA and tympanometry of the boy. As indicated, the AC thresholds were indeed within the normal limit across the tested frequencies bilaterally (≤ 15 dB HL). Nevertheless, for the left ear, a significant air-bone gap (ABG) was seen at 250 Hz (i.e., 20 dB) and 500 Hz (i.e., 15 dB), implying that the middle ear was not “healthy.” No significant ABG was seen for the right ear (even though the tympanogram was type B). At this point, the results of PTA and tympanometry were not consistent with each other, and a further assessment was warranted to conclude the hearing diagnosis.

Hence, the acoustic reflex test was performed ipsilaterally at 500 and 1000 Hz on both ears using the screening procedure. As shown in Figure 1, no reflex was observed at the maximum intensity levels (i.e., 100 dB at 500 Hz and 105 dB at 1000 Hz) for both ears. The acoustic reflex results were in fact consistent with those of tympanometry, indicative of the presence of conductive pathology in both ears (even though his hearing was well within the normal limit).

DISCUSSION

In clinical settings, getting an accurate result is very important in ensuring the best treatment option for patients. Integrating the results of several audiological tests is always the recommended practice in enhancing the accuracy of hearing diagnosis.² In this case report, the boy’s hearing was found to be within the normal limit bilaterally (by PTA). This result was rather unexpected given the history of middle ear problems and tympanometric results. In fact, for the right ear, a “significant” hearing loss would have been expected since the tympanogram was type B. It is indeed common to have the type B tympanogram in those with otitis media.^{2,5} Nevertheless, as shown in Figure 1, the AC thresholds were well within the normal limit (≤ 15 dB HL) with no significant ABGs. For the left ear, it was not surprising to have significant ABGs at low frequencies (even though the AC thresholds were normal) as the tympanogram was type As. That is, this type of tympanogram could

be associated with poor mobility of TM due to the presence of middle ear pathology.^{2,5} The presence of conductive pathology in both ears was then confirmed as no acoustic reflexes were observed at the maximum intensity levels.

It is worth stating that both tympanometry and acoustic reflex tests were repeated twice for each ear as an effort to obtain reliable results.

Collectively, this boy was found to have a bilateral conductive pathology even though his hearing was within the normal limit. This finding is rather sensible as the range of normal hearing (in PTA) is reasonably big, that is, 30 dB (from -10 to 20 dB HL).² Furthermore, since 15 dB is the minimum ABG to be considered as significant,² it is not surprising to have normal hearing results but with the presence of conductive pathology.

In this case report, the absence of acoustic reflex was likely due to the presence of conductive pathology (rather than sensory or neural pathology) for several reasons. Firstly, the presence of conductive pathology is more consistent with the boy’s history of middle ear problems and tympanometric results. Secondly, the AC thresholds were well within the normal limit (excluding the possibility of sensory or neural pathology, in which high-frequency hearing loss is typically observed). Thirdly, it has been consistently demonstrated that the acoustic reflexes would be absent in CHL cases with ABG as low as 5 dB.^{2,7}

Even though objective hearing assessments are available,^{8,9} getting accurate results for the behavioral audiological tests should be the primary aim in clinical sessions. Nevertheless, it can be challenging to perform all tests completely in one session when dealing with pediatric cases. In this case report, the boy was older enough to give reliable responses during the testing (even though he felt restless at the end of session). That is, the assessments began with otoscopy and then followed by tympanometry, PTA, and acoustic reflex test. During the PTA assessment, initially the boy refused to cooperate in the BC testing (after cooperating well in the AC testing). After some persuasion, he then agreed to proceed with the BC testing, and only 250 and 500 Hz were tested

(as these frequencies are more commonly affected in CHL). If the BC testing was not carried out (because the AC thresholds were normal and the boy was restless), the significant ABGs would have not been seen (leading to misdiagnosis). It would be even more challenging if younger children are tested. Due to their short attention span and other factors, some clinicians would prefer to start with the behavioral hearing test (rather than otoscopy or tympanometry). If the AC thresholds are found to be within the normal limit, BC thresholds are not typically determined (which may lead to misdiagnosis if the conductive pathology is present). This situation could become “worse” if tympanometry or acoustic reflex machine is faulty or not available during the session. Taken together, measuring the BC thresholds (at least at certain frequencies) is highly recommended, even though the AC thresholds are normal to avoid the misdiagnosis and inappropriate case management. In terms of case management, the boy’s hearing and otological condition will be closely monitored from time to time by the respective ORL doctor and audiologist.

CONCLUSION

Hearing within the normal limit does not exclude the possibility of having conductive pathology. Even though getting complete test results can be challenging when dealing with children, having BC thresholds is advantageous (even though AC thresholds are normal) to avoid misdiagnosis. Additionally, the test battery approach is always recommended to achieve an accurate diagnosis.

CLINICAL SIGNIFICANCE

Several useful points could be gathered from this case report as guidelines to hearing healthcare clinicians. Firstly, normal AC thresholds may not indicate that the middle ear is healthy, and having BC thresholds is useful (to rule out any ABGs). When testing children, clinicians may choose certain frequencies in the BC testing. This approach can be considered as a “safe” shortcut (rather than not doing the BC testing at all because AC thresholds are normal).

Secondly, it is also possible to see “perfectly” normal hearing results (normal AC and BC thresholds with no significant ABGs) in those with middle ear disorders. In this regard, the results of other routine audiological tests are required to conclude the hearing diagnosis.

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REFERENCES

1. Abdul Wahid SN, Md Daud MK, Sidek D, et al. The performance of distortion product otoacoustic emissions and automated auditory brainstem response in the same ear of the babies in neonatal unit. *Int J Pediatr Otorhinolaryngol* 2012;76(9):1366–1369. DOI: 10.1016/j.ijporl.2012.06.008.
2. Katz J, Marshall C, English K, et al., editors. *Handbook of clinical audiology*. Philadelphia: Lippincott Williams & Wilkins; 2015.
3. Romli M, Wan Mohamad WN, Awang MA, et al. The clinical value of bilateral bone conduction testing in hearing diagnosis. *Indian J Otol* 2020;26(3):182–185. DOI: 10.4103/indianjotol.INDIANJOTOL_106_20.
4. Choi HG, Min C, Lee CH, et al. The relation of sudden sensorineural hearing loss in pediatric patients with recurrent otitis media: a nested case-control study using a national sample cohort. *Otol Neurotol* 2020;41(7):e836–e841. DOI: 10.1097/MAO.0000000000002655.
5. Lih AC, Zakaria MN, Mohamad RA, et al. Effects of ethnicity and gender on the middle ear function in Asian adults. *Indian J Otol* 2017;23(2):94–97. DOI: 10.4103/indianjotol.INDIANJOTOL_27_17.
6. Awang MA, Zakaria MN. Acoustic reflex testing in clinical audiology: what is the next direction? *Int J Disabil Hum Dev* 2019;18(2):123–128.
7. Kazanas SG, Maw AR. Tympanometry, stapedius reflex and hearing impairment in children with otitis media with effusion. *Acta Otolaryngol* 1994;114(4):410–414. DOI: 10.3109/00016489409126079.
8. Zakaria MN, Jalaei B, Wahab NA. Gender and modulation frequency effects on auditory steady state response (ASSR) thresholds. *Eur Arch Otorhinolaryngol* 2016;273(2):349–354. DOI: 10.1007/s00405-015-3555-3.
9. Zakaria MN, Jalaei B, Aw CL, et al. Are speech-evoked auditory brainstem response (speech-ABR) outcomes influenced by ethnicity? *Neurol Sci* 2016;37(6):943–948. DOI: 10.1007/s10072-016-2522-0.