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Accuracy of Otoacustic Emission in Comparison to Diagnostic Test of Auditory Brainstem Response in Hearing Screening for Children in Vietnam

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ABSTRACT
This study aimed to assess the accuracy of Otoacoustic Emissions (OAE) compared with Auditory Brainstem Response (ABR), the gold standard method, in a hearing screening program for children aged 2-5 years old in Hanoi, Vietnam. From 2011 to early 2012, 7191 preschool children were evaluated with OAE. OAE and ABR were the two methods were applied to examine the hearing loss status of the children. Children with OAE (-), meaning as *"refer"* in the community, were re-assessed using ABR in the sound rooms at the Vietnam National Hospital of Pediatrics, Hanoi, Vietnam. The results showed that the overall accuracy percentage of OAE compared with ABR 93.2%. The OAE method demonstrated highest accuracy of 97.9% in the oldest children of 5 years, lowest accuracy among 3-year children (90.0%), and similar for boys and girls. The study demonstrated that the OAE method is a convenient and precise method for universal hearing loss screening for preschool children in Vietnam, especially in the hard-to-reach and limited resource areas. However, further confirmed method like ABR is still needed to confirm the hearing loss status among those be classified as hearing impairment in the OAE step.

Keywords: hearing loss, OAE, ABR, children, Hanoi, accuracy

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INTRODUCTION

Hearing loss among children is now a significant public health problem in many countries globally. The World Health Organization (WHO) estimates that almost 500 million people living with hearing loss, of them, more than one-third million are children [1]. Those figures are projected doubled by 2050 [1].

In Vietnam, no universal hearing loss screening for newborn and children has been set up yet [2]. Hearing loss screening for children just have been performed in few big hospitals and major cities, provinces in the countries. It is, therefore, data on hearing loss among children in Vietnam is limited. Although few studies on hearing loss among children were conducted, the results showed that it is a public health problem in Vietnam. Recent studies reported that the hearing loss among preschool children aged 2-5 years in Hanoi was found in 4.4% [3], and was 4.7% in Hai Phong City [4]. Improving capacity for staff working in the field as well as provision the service delivery facilities for children with hearing loss are needed to guarantee early detection and appropriate treatment for children with hearing impairment in Vietnam [5]. Early diagnosis and immediate intervention play important role in the development of the children in many aspects, including social, emotional, intellectual and linguistic development [6].

The Joint Committee on Infant Hearing (JCIH) has recommended newborns and less than 3 month children need to be audiological assed for hearing impairment and appropriate interventions may be provided for needed children [7]. Otoacoustic emissions (OAE) and automated auditory brainstem response (ABR) are the two methods that been suggested by WHO [8]. They are also the two most-used methods in hearing screening programs globally [7, 9]. OAEs are the waves recorded in the cochlea when naturally functioning. These waves do not directly measure hearing sensitivity, but are directly associated with natural cochlear performance. The ABR device can show hearing sensitivity through examining the performance of the 8th central nerve and/or the brainstem auditory pathway [10]. Basically, OAE is an easy method for administration. It is not required high technical and experience staff as well as standard facilities to perform. It, therefore, can be used for screening in the community or in the areas with limited resources. In addition, in comparison with ABR test the average time to perform the OAE test is shorter, taking 2 to more than 10 minutes compared to 8-15 minutes of the ABR test.

Different studies have reported different values for the diagnostic accuracy of OAE compared to the ABR in hearing screening programs according to separated studies. To date, no single value has been reported for either sensitivity or specificity of these methods based on the acceptable scientific methods [11]. The aim of this study was to assess the accuracy of the OAE test as opposed to the ABR, a gold standard, method for hearing loss identification for children in Hanoi, Vietnam. Results of the study may provide scientific evidence for policy - making in hearing screening program for children in the country.

METHODS

2.1. Participants and study design

The participants of this cross-sectional study was children aged 2-5 years in Hanoi, the capital city of Vietnam, from June 2011 to February 2012.

The hearing screening procedure based on the from the Joint Committee on Infant Hearing [7]:

- Detection of bilateral OAE.
- For children which the test was positive in one or both ears, children were referred to the Audiological Center at the National Hospital of Pediatrics, Hanoi for ABR performance within 4 weeks.

OAE test were performed during children' natural sleep. For presence of OAE the response was PASS, and FLACK when

absent. ABR was took place within the audiology laboratory of the National Hospital of Pediatrics in Hanoi [12]. All tests were performed by qualified biomedical staff in the Department of Ear-Nose-Throat, National Hospital of Pediatrics, Hanoi.

2.2. Data analysis

Collected data were entered and managed by Epi-data software and was analyzed using SPSS 20.0.

2.3. Ethical issue

The research protocol was approved by the scientific committee of the Vietnam National Hospital of Children The mothers/guardians of those children agreed to take part in the study voluntarily.

RESULTS

3.1 General information of the study population

Table 1: Characteristics of the study participants classified by age and gender (n=7191)

Age (years)	Boys		Girls		Total	
	n	%	n	%	n	%
2 years	379	5.3	321	4.5	700	9.7
3 years	872	12.1	809	11.3	1681	23.4
4 years	1249	17.4	1138	15.8	2387	33.2
5 years	1265	17.6	1158	16.1	2423	33.7
Total	3765	52.4	3426	47.6	7191	100

The children in the study increased by age, 2 year children accounted for less than 10%, and 5 year children took more than one-third. More boys (52.4%) than girls (47.6%) took part in the study.

Table 2: Results of OAE (-) for children 2-5 years in Hanoi according age and gender (n=7191)

Age/Gender	OAE (-)	
	n	%
2 years	57	8.1
3 years	101	6.0
4 years	82	3.4
5 years	97	4.0
Boys	189	5.0
Girls	148	4.3
Total	337	4.7

3.2 Accuracy of the OAE compared to the ABR in the screening program

Table 3: The accuracy of the OAE compared to the ABR in the hearing screening for children in Hanoi, Vietnam (n=7191)

Age/Gender	OAE	ABR	Accuracy (%)
	OAE (-)	True hearing loss	
2 years	57	55	55:57 = 96.5
3 years	101	91	91:101 = 90.0
4 years	82	74	74:82 = 90.2
5 years	97	95	95:97 = 97.9
Boys	189	176	176:189 = 93.1
Girls	148	138	138:148 = 93.2
Total	337	314	314:337 = 93.2

Table 3 showed that among 337 children classified as negative results with the OAE method, 314 children were confirmed with true hearing loss in the sound room with the ABR method. It means that the accuracy of the OAE method in terms of correctly classified true hearing loss was 93.2%. The OAE method demonstrated highest accuracy in the oldest children of 5 years accounted for 97.9%, and lowest accuracy among 3-year children (90.0%). For gender, the method showed similar accuracy rate for boys and girls.

DISCUSSION

Based on our comprehensive search, this is the first research investigating the accuracy of a hearing screening method in the community in Vietnam. The results showed high accuracy percentage of the OAE in comparison with ABR in hearing impairment screening among children in Vietnam (93.2%). The study also suggested that higher accuracy percentage might be observed among older preschool children in our studied population. Results of this study

supports previous reports that high sensitivity of the OAE was observed. The study conducted in Iran showed that in comparison with the ABR, the sensitivity of OAE test was 99.7% [13]. Recent reviews have also reported the high accuracy of the test compared to the ABR, gold standard test [11].

The OAE is a simple and quick test with acceptable accuracy. It has been used in hearing screening programs in some provinces in Vietnam. But, the variety sensitivity reported are the main challenges of this test, ranging between 0.50 to 1.0 [14, 15]. Therefore, the OAE cannot completely replace ABR as screening modality for hearing impairment in neonates, but can complement it.

In addition, due to the nature of the diagnostic accuracy, many issues can lead to the bias or variation of the results [16]. In this case, the OAE results may be influenced by the level of noise in the testing environment [17]. Many recommendations have been made to improve the accuracy of the OAE test [16]. In this study, all the children were examined for ear infection before performing the measure. The OAE was conducted in a non-sound proof room. It, therefore, may influence to the OAE test. The way of recording OAE in the non-sound proof room so that OAE could be truly evaluated as a screening modality of hearing loss in the children.

ABR is a standard and very precise test in hearing loss confirmation, however, this test is complicated, time consuming, and costly [18]. Due to high technical staff and complex facility required, ABR cannot be applied widely in the situation of Vietnam. However, the OAE screening added significant value in hearing screening in the real-setting, especially in a low-middle income country like Vietnam. The high accuracy found in this research will support the idea of setting up a universal hearing screening in Vietnam.

CONCLUSIONS

OAE method is a reliable screening test for hearing loss among children in Vietnam. The test showed accuracy results in comparison with the ABR, the gold standard for hearing loss screening. In addition, due to the convenience, and simple technique required, this method can be used widely for universal hearing loss screening for children in Vietnam, especially in the hard-to-reach and limited resource areas. However, further confirmed method like ABR is still needed to confirm the hearing loss status.

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