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Original Article

The role of hearing capability test as a screening test for the possibility of hearing disorder in children with speech delay

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ABSTRACT

Background Hearing disorder may cause speech delay so that every child with speech delay should undergo hearing test. The gold standard for audiometric test is otoacustic emission (OAE) and brainstem evoked response audiometry (BERA). They have high sensitivity and specificity, but the availability is limited and expensive. Hence, both tests are not available at the primary health care centers. In 1997, the Department of Health, Republic of Indonesia, established a simple subjective test instrument, i.e. the hearing capability test (HCT).

Objective To asses the accuracy of HCT compared to the gold standard hearing tests (OAE and/or BERA).

Methods This study was a cross sectional study on 89 children aged less than 5 years who had speech delay and came to the Growth and Development Outpatient Clinic or the General Outpatient Clinic, Pediatric Neurology Clinic of the Department of Child Health, Cipto Mangunkusumo (CM) Hospital; and Center for Ear Care and Communicative Disorders (CECCD), Department of ENT, CM Hospital, during March to August 2005.

Results HCT sensitivity and specificity were 92.9% and 27.7%, respectively. Positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (PLR), and negative likehood ratio (NLR) were 84%, 50%, 1.9, and 0.7, respectively.

Conclusion The sensitivity and specificity of HCT as a screening test of hearing disorder in children with speech delay were 93% and 28%, respectively. Based on this result, HCT should only be used as screening test and not as a diagnostic test **[Paediatr Indones 2006;46:255-259]**.

Keywords: *hearing capability test, otoacustic emission, brainstem evoked response audiometry*

Good speech development in childhood is an important sign to determine the future learning-capacity of the child.[1] Speech delay may present as a symptom of various disorders, one of them is hearing disorder. Hearing disorder is the most frequent congenital disorders. In the United States, the prevalence of neonatal hearing disorder is 1 to 3 cases of 1000 live birth.[2,3] In Indonesia, based on Hearing Health Survey in 7 provinces (1993-1996), there were 0.1% of population having congenital hearing loss.[4] Every child with speech delay should undergo hearing test to prove whether there is any hearing disorder or not.[5]

The gold standard hearing tests are otoacustic emission (OAE) and brainstem evoked response audiometry (BERA). These objective tests have high sensitivity and specificity in detecting the presence of

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hearing loss in children, but expensive. Hence, they are not readily available at primary health care centers *(Puskesmas)* or isolated areas.

Hearing capability test (HCT) is one of various instruments which were established by the General Directorate of Public Health, Department of Health, Republic of Indonesia, in 1997. This test is aimed as a subjective early screening instrument test for hearing disorders. Until now, this instrument had not been validated, therefore its sensitivity and specificity in detecting hearing disorders is still unknown. The purpose of this study was to asses the accuracy of HCT compared to the gold standard hearing tests (OAE and/or BERA).

Methods

This study was a cross sectional diagnostic test on 89 children aged less than 5 years who had speech delay and came to the Growth and Development Outpatient Clinic, or the General Outpatient Clinic, or the Pediatric Neurology Clinic, Department of Child Health, Cipto Mangunkusumo (CM) Hospital; and Center for Ear Care and Communicative Disorders (CECCD), Department of ENT, CM Hospital, during March to August 2005.

The proportion of patients with positive hearing disorder resulting in speech delay was 50%.[6] This percentage was considered as a representative proportion of children with speech delay caused by hearing disorder at outpatient clinic in the Department of Child Health, CM Hospital. The proportion of positive hearing disorder resulting in speech delay patient at CECCD, Department of ENT, CM Hospital was 82.79%.[7] Most of the subjects (72 children) was from CECCD, Department of ENT, CM Hospital, therefore we needed minimal sample size of 81 children with speech delay.

Patients were excluded if they were not cooperative or had anatomical disorders in their head and neck, any syndrome related to sensori-neural hearing loss, mental retardation, cerebral palsy, or autism. This study was approved by the Ethics Committee of CM Hospital, Jakarta.

All patients who had fulfilled the inclusion criteria underwent medical history, physical examination, Denver II development screening test, speech development test using early language milestones scale (ELMS) continued by hearing test of HCT, OAE, and BERA. HCT was conducted by the researcher without knowing the results of OAE and BERA. HCT might be conducted before or after OAE and BERA test. OAE was conducted at CECCD, Department of ENT, CM Hospital, while BERA was conducted at the same place and at the Division of Neurology, Department of Child Health, CM Hospital. We used distortion product otoacustic emission (DPOAE) and BERA. The results of DPOAE and BERA click test were interpreted by an otolaryngologist or by a pediatric neurologist. Finally the results of HCT, DPOAE, and BERA click test were compared.

The result of HCT was categorized into "yes" and "no" criteria. "Yes" means there was no hearing disorder and "no" means there was hearing disorder. There was no more detailed criteria mentioned about "yes" or "no" answer. In this study, "yes" criteria was given if the child could perform all of the instructions on the question column according to his/her age (no hearing disorder), and "no" was given if the child could not perform all of the items in the question column (positive hearing disorder), and "doubtful" was determined if the child could only perform several part of the items.

Results

The total number of subjects was 109 patients. Twenty children were excluded from the study because of several reasons: certain syndromes (3), anatomical disorders in head and neck (4), cerebral palsy (8), and autism or mental retardation (5). Thus, 89 children were available for further analysis.

TABLE 1. CHARACTERISTICS OF PATIENTS WITH SPEECH DELAY

Patient characteristics	Number of patients	(%)
Sex		
Male	56	63
Female	33	37
Age (month)		
<6	3	3
6-<9	2	2
9-<12	1	1
12-<24	21	26
24-<36	15	17
≥36-60	47	53

TABLE 2. RESULTS OF HEARING CAPABILITY TEST (HCT)

HCT	Number of patients	(%)
Hearing loss		
Positive	59	67
Doubtful	20	22
Negative	10	11
Total	89	100

There were 56 males (63%) and 33 females (37%). Most of them were more than 3 years old, followed by the range between 1 and 2 years old. Risk factors of hearing disorder were only found in 16 patients.

The results of HCT were compared to gold standard of BERA click and DPOAE. Hence, if one or both gold-standard revealed "refer" or failed, then a child was considered to suffer from hearing disorder; a child will be considered as normal/not having any hearing disorder if both of gold standards revealed "pass".

We plotted the study results into 2X2 table. The doubtful results were merged into hearing disorder category and a high sensitivity value was found (92.9%), with a low specificity (27.7%) **(Table 3)**.

Discussion

In this study, there were 56 males and 33 females **(Tabel 1)**. This was rather different from the study of Leung *et al*[5] which revealed that the rate of speech delay in boys is four times greater than that in girls. The results of 71 children with abnormal DPOAE and/or BERA click and with hearing disorder consisted of 42 males and 29 females. This result was different from literature which mentioned that the rate of hearing disorder is equal between sexes.[8]

The percentage of children with speech delay and hearing disorder was 79% (71 of 89 children). This result was greater than that in the literature in which hearing disorder was assumed as the cause of speech delay in more than 50% children.[6] This difference might be caused by different samples. The samples in the literature were taken from the general population, while our study obtained samples from selected patients.

The ages of most of our subjects were more than 36 months, which were 47 out of 89 children (53%). This was very apprehensive because age of 6 months to 2 years is the critical period for the development of speech and hearing system, and the age of 2–3 years is the golden period for speech development.[3,9]

From 71 patients with hearing disorders, we found 47 children who were diagnosed at the age of more than 3 year; and only 3 children were diagnosed at the age of less than 6 months. In this study, almost all patients with hearing disorders were diagnosed at the age of more than 6 months (96%), which was very late. According to Christine Yoshinago-Itano *et al*[10] in 1998, the speech ability of infants with hearing disorder who had intervention before 6 months of age would be better compared to those with late intervention. CECCD, Department of ENT, CM Hospital evaluated 830 children who had complaint of hearing impairment and were treated. They found that 42.9% of children had the impairment at the age of less than 3 years, 25.4% at the age 3-5 years, and 31.7% at the age of more than 5 years. Unfortunately, there were no data concerning the number of patients who had the impairment detected at the age of less than 6 months.[11]

There were 16 patients with speech delay who had risk factors of hearing disorder. Fifteen patients had one risk factor and one patient had 3 risk factors. Risk factor mostly found was history of TORCH infections, which was positive in 11 patients. Others were asphyxia which was found in 3 patients, followed by hyperbilirubinemia, family history of con-

TABLE 3. THE COMPARISON OF HCT RESULTS WITH BERA CLICK AND/OR DPOAE (GOLD STANDARD) RESULTS

			BERA click and/or DPOAE		
			Hearing loss		Number of patients
			Positive	Negative	
HCT	Hearing loss	Positive	66	13	79
		Negative	5	5	10
	Total		71	18	89

genital hearing loss, birth weight of <1500 grams and severe illness warranting ventilatory support each found in 1 patient. There was no patient had risk factors of dyspnea and severe infection (bacterial meningitis). Of the 16 patients, 12 patients had hearing disorders. This finding was different from other studies, which may be caused by different risk factors.

There were 59 of 71 children with hearing disorders who had no risk factor. This finding was greater than that stated in the literature.[13-16] There was only 1 patient who had more than 1 risk factors which were birth weight of 1000 grams, asphyxia, and history of 1 month ventilator usage.

The results of sensitivity and specificity of HCT were 92.9% and 27.7%, respectively. This finding supports the use of the test as a screening test.

In this study, the confounding variables such as anatomical disorders, certain syndrome, cerebral palsy, mental retardation, and autism had been excluded through examination which was previously performed. Some questions that might be used to exclude the confounding variable above should be added to HCT, if this test would be consistently used.

The value of PPV and NPV was really influenced by the prevalence of illness during the study. The study, which was conducted in a hospital would have higher result than epidemiological study. The prevalence of hearing disorders of our subjects was high; therefore there was high PPV and low NPV, i.e. 83.7% and 50%. In general population, the value of this PPV will decrease and NPV will increase, because the prevalence of hearing disorder in children with speech delay was only 50%. The value of PLR in this study was moderate, because it was about range 1. The value of this PLR was considered as not significant because it was less than 10.

As the instrument of screening test, HCT has some advantages and disadvantages. The advantages include less expensive, practical, and understandable. It is less expensive because the examiner only used questionnaire and some helping instrument such as drawing book, a spoon, and a cup to examine the child. It is practical because it is simple; it takes only a few minutes and easy to perform. It is also understandable because this screening test is easy to understand and easy to be performed by health care personnel.

There are 2 disadvantages of HCT, i.e. the validity and the content. The disadvantage of validity has been explained earlier. HCT had lack of content including written content in questionnaire and the content inside. On written content, the division of age group was not clearly detailed and the evaluation method was also not in detail. The evaluation of HCT was not in detail, because the test result could be only taken if there was yes or no answer. It was not explained whether the answer should be given for half or all of questions in one age group. So, there were no certain criteria if the child could only answer half of the question item.

The content of HCT could not examine all of the child's language ability, which included expressive, receptive, and visual language. For example, question in the age group of <6 months, >6 months, and >9 months only examined the receptive ability; whereas for the age group >12 months only examined the receptive and expressive ability. The question for age group >24 months should be able to indicate better expressive ability, such as by asking whether the child was able to say two combined words.

Another point was HCT can not perform screening function if there were confounding variables such as autism or behavior disorder, mental retardation, various syndromes, and cerebral palsy. For example, a child with autism will not be able to answer all questions at the age group of >24 months and >36 months because the child was lacking contact, not because they can not hear. Therefore, this child can not be regarded as a child with hearing capacity disorder.

The sensitivity and specificity of HCT examination on children with speech delay due to hearing disorder compared to gold standard of hearing examination (BERA click and/or DPOAE) was 93% and 27%, respectively. From the point of view of this sensitivity and specificity determination, HCT may be used as screening test for hearing disorder, but it can not be used as diagnostic test. The PPV and NPV of HCT was 84% and 50%, respectively.

Based on various considerations above, the authors tried to make the proposal of hearing capability test modification. This modification at least can fulfill the needs of hearing disorder screening test instrument in primary health care unit, such as inte-

grated health services *(Posyandu)* and primary health care centers *(Puskesmas)*. The proposal of this modification was a simple adaptation of ELMS. Therefore, if we need a screening test with good accuracy, then we can directly use the ELMS.

References

1. Kelly DP. Neurodevelopmental dysfunction in the school aged child. In: Berhman RE, Kliegman RM, Jenson HB, editors. Nelson textbook of pediatrics. 17th edition. Philadelphia: WB Saunders, 2004. p. 100-7.
2. Kenna MA. Neonatal hearing screening. Pediatr Clin North Am 2003;50:301-13.
3. Sokol J, Hyde M. Hearing screening. Pediatric in review 2002;23:155-62.
4. Sirlan F, Suwento R. Hasil survei kesehatan indera penglihatan dan pendengaran 1993-1996. Depkes RI, 1998.
5. Leung AKC, Pion Kao C. Evaluation and management of child with speech delay. American Family Physician 1999;59:3121-8;3135.
6. Kelly DP, Sally JI. Disorders of speech and language. In: Carey WB, Crocker AC, editor. Developmental behavioral pediatrics. Philadelphia: WB Saunders, 1999. p. 621-31.
7. Suwento R. Anak belum dapat berbicara, apakah dikarenakan tuli? Medicinal 2003;4: 16-8.
8. Lotke M. Hearing impairment. Citated from: hhtp:// www.emedicine.com. July 31st 2004.
9. Suwento R. Skrining pendengaran bayi baru lahir. Jakarta: Buletin IDAI, 2004. p. 35-7.
10. Yoshinaga-Itano C, Sedey AL, Coulter DK, Mehl AL. Language of early and later identified children with hearing loss. Pediatrics 1998;102:1161-71.
11. Suwento R, Hendarmin H. Evaluasi kemungkinan penyebab tuli saraf berat pada anak di Pusat Kesehatan Telinga dan Gangguan Komunikasi, Department of ENT, Medical School, University of Indonesia, Cipto Mangunkusumo General Hospital. Konas Perhati. Yogyakarta, 1999.
12. Thompson DC, McPhillips H, Davis RL, Lieu TL, Homer CJ, Helfand Ml. Universal newborn hearing screening. Summary of evidence. JAMA 2001;286: 2000-10.
13. Northern JL, Downs MP. Screening for hearing disorders. In: Hearing in children. Philadelphia: Williams and Wilkins, 1991. p. 231-83.
14. Richards IDG, Robert CJ. The risk at infant. The Lancet 1967:2:711-4.
15. Northern JL, Downs MP. Physiologic hearing tests. In: Hearing in children. Philadelphia: Williams and Wilkins, 2002. p. 209-57.