ABSOLUTE WAVE LATENCY OF AUDITORY BRAINSTEM RESPONSE (ABR) IN CHILDREN AT HASAN SADIKIN GENERAL HOSPITAL BANDUNG

Era Yulian Ineka, Wijana, Sally Mahdiani, Yanti Nurrokhmawati

Department of Otorhinolaryngology - Head and Neck Surgery, Faculty of Medicine Padjadjaran University / Hasan Sadikin General Hospital Bandung, Indonesia

ABSTRACT

Introduction: Children's hearing problem will influence development, especially speech and language. Early detection is essential,but Auditory Brainstem Response (ABR) reference for Indonesian hasn't been present yet. **Objective:** to determine absolute wave latency of ABR in children **Methods:** A retrospective descriptive study was conducted on children who underwent ABR examination at Hearing and Speech Clinic, Hasan Sadikin Hospital from 2018-2021. Inclusion criteria are type A tympanogram, pass outcome on OAE, wave V appearance on 20 dBnHL click stimulus in both ears. Exclusion criteria are incomplete medical record, tumors, abnormalities in head and neck, and presence of systemic and syndromic diseases. ABR wave were evaluated using the ABR bio-logic® System Corp and calculated in 60dBnHL **Results:** Subjects comprised of 64.1% boys and 35.9% girls, with the most in older than 2 year age group. Mean absolute latency of ABR waves, in 0-24 month age group, for the right ear are wave I: 2.230 (±0.425)ms; wave III: 4.506 (±0.421)ms; wave V: 6.324 (± 0.521)ms and left ear wave I: 2.131 (±0.416)ms ; wave III: 4.310 (±0.412)ms; wave V: 6.246 (± 0.326)ms. In older age group for the right ear are wave I: 2.120 (±0.468)ms; wave III: 4.343 (±0.472)ms; wave V: 6.182 (± 0.498)ms and left ear wave I: 2.111 (±0.421)ms ; wave III: 4.314 (±0.415)ms; wave V: 6.118 (± 0.407)ms. **Conclusion:** There was a new absolute wave latency of ABR values in children for the population in West Java.

Keywords: Auditory Brainstem Response (ABR), absolute latency, children.

Introduction

Children's speech and language disorders can negatively impact their social environment, personality, and academic performance. This has been a prominent concern within clinicians as an array of concerns may come along with the said disorder, significantly impacting the sufferer's quality of life.[1]

In addition to detecting hearing loss, subjective and objective exams also play a crucial role in identifying speech and language disorders in children. Speech and language disorders can encompass a range of difficulties, including articulation disorders, language delays, stuttering, and auditory processing disorders.

Subjective exams for hearing loss in children typically involve the use of audiometry, where the child responds to different sounds or tones presented through headphones or speakers. The results are recorded on an audiogram, which helps determine the severity and nature of the hearing loss.

Objective exams, on the other hand, provide an indirect assessment of hearing loss by measuring the physiological responses of the auditory system. Oto-acoustic emission (OAE) and auditory brainstem response (ABR) are two commonly used objective electrophysiological examinations.

OAE testing involves placing a small probe in the child's ear, which emits sounds and measures the echoes produced by the cochlea. This examination is particularly useful in screening for hearing loss in infants since it can be conducted shortly after birth. OAE has high sensitivity (ability to correctly identify hearing loss) and specificity (ability to correctly identify normal hearing), making it an ideal screening tool.

ABR testing, on the other hand, evaluates the electrical activity of the auditory nerve and brainstem in response to sound stimulation. Electrodes are placed on the child's scalp to record the neural responses, and the results provide information about the integrity of the auditory pathway and the type of hearing loss (conductive, sensorineural, or mixed). ABR testing can also estimate the threshold of hearing, which is the softest sound a person can detect.

Both OAE and ABR examinations are valuable in diagnosing hearing loss and determining the appropriate course of intervention. They can provide valuable information to audiologists, speech-language pathologists, and other healthcare professionals involved in the management of children with speech and language disorders.

Early detection of hearing loss and speech-language disorders is crucial for effective intervention and support. With the help of these subjective and objective exams, healthcare professionals can identify potential issues and provide appropriate interventions, such as hearing aids, cochlear implants, speech therapy, or a combination of approaches, tailored to the child's specific needs. By addressing these challenges early on, children can have better opportunities for speech and language development, academic success, and overall well-being.[2,3]

Jewett and Williston classified the waves into seven different types by assigning Roman numerals to each peak of the waves. Each wave represents neural integrity in a specific area along the auditory pathway. The amplitude component of ABR varies between each subject. Wave I show activity from the distal part of the Eighth Cranial Nerve, while wave III shows activity at the level of the cochlear nucleus. wave V shows activity from the lateral lemniscus and the inferior colliculus. The presence of a difference in the morphology of ABR waves may be related to an individual's development process. Over time, wave V becomes clearer compared to other waves. Wave V is described as the most stable wave that is easy to assess even

Y. A. Dewi et al. (eds.), *Proceedings of the 19th Otorhinolaryngology Head and Neck Surgery National Congress (PERHATIKL 2022)*,
Advances in Health Sciences Research 68,
https://doi.org/10.2991/978-94-6463-280-4_28

with a low-intensity, clinically significant sound stimulus. Therefore, the assessment of ABR is predominantly based on the absolute latency period of the wave.[4,5,6,7]

Several studies and references show that an ABR recording may be affected by several factors. [7,8,9] The internal factors include age, sex, race, body temperature, and abnormalities in the hearing system, whereas the external factors comprise of the type of transducer, stimulus, distance between stimuli, polarity, intensity, and the presence of artifacts in the environment. In addition, the results of the absolute wave latency on the ABR examination were said to be longer in infants under 24 months old than older.[6,8,9,10]

ABR parameters like absolute latencies, amplitudes, amplitude ratios, Inter-wave latencies and inter – aural latencies were assessed for their normative values which are required to establish a baseline data. Mean values of absolute latencies for ABR wave I were1.5 -1.6 ms; wave III were 3.57-3.7 ms and wave V were 5.6 ms on 75 dBnHL.[6]

Currently, there has been limited literatures conducted in Asia, specifically in Indonesia regarding ABR waves. The hallmark utilized for the morphological assessment of ABR waves in Indonesia is still taken from research conducted abroad, which has different demographics and population characteristics to Indonesian. Hence, a reference for Indonesian should be established.

Thus, the researchers are interested in conducting a study to observe the absolute latency of ABR wave in children at Hasan Sadikin General Hospital, Bandung, from 2018 to 2021. This study will provide data about the morphology of ABR waves, which may soon serve as a foundation for other researchers to conducting further research.

Methods

This is a descriptive retrospective study to observe the latency period of ABR wave in children. The sampling technique used is total sampling, taken from the medical records of children with speech delay in aged 1 to 5 who underwent ABR examination at Hearing and Speech clinic, Hasan Sadikin General Hospital, Bandung, from 2018 to 2021.

The inclusion criteria for this study includes Type A tympanogram bilaterally, otoacoustic emissions (OAE) with 'pass' bilaterally, and a wave V appearance on a 20dBnHL click stimulus.

Subjects were excluded from the study if their medical records are incomplete, history of tumors and head and neck abnormalities, and if they are suffering from systemic diseases, such as hyperbilirubinemia, genetic disorders, and syndromes.

The examination tools used to determine the hearing threshold are ABR Bio-Logic® System Corp, OAE, 580-NAVPR2 type, and tympanometry GSI 39 auto tymp type . The absolute latency and the inter-wave latency are determined through provision of a click stimulus of 60 dBnHL.

The subject divide into 2 age groups, under 2 years old and older than 2 years old.

Results

From 2018 to 2021, 758 children (425 boys and 333 girls) had a ABR examination at the Hearing and Speech clinic, Hasan Sadikin General Hospital, Bandung. From these patients, 232 children were excluded because 59 children had incomplete medical records, 115 children had genetic disorders and syndromic history, 38 children had systemic disease and hyperbilirubinemia, 18 children had a history of tumor, and two children had head and neck abnormalities.

Table 1. Characteristics of subject (N=526)

Characteristics	Total	%
Sex		
Boy	337	64.1
Girl	189	35.9
Age (months)		
0-24 months	224	42.6
>24-60 months	302	57.4

Table 2. Mean Absolute Latency and Inter-wave Latency of ABR Wave (milisecond)

Age (months)	Mean Left Ear (±SD)	Mean Right Ear (±SD)
Wave I		
0-24	2.131 (0.416)	2.230 (0.425)
>24-60	2.111 (0.421)	2.120 (0.468)

Wave III		
0-24	4.310 (0.412)	4.506 (0.421)
>24-60	4.314 (0.415)	4.343 (0.472)
Wave V		
0-24	6.246 (0.326)	6.324 (0.444)
>24-60	6.118 (0.407)	6.182 (0.498)

Table 3. Inter-wave Latency of ABR Wave (milisecond)

Age (months)	Mean Left Ear (±SD)	Mean Right Ear (±SD)
Wave I-III		
0-24	2.129 (0.512)	2.334 (0.945)
>24-60	2.216 (0.828)	2.232 (0.763)
Wave III-V		
0-24	1.848 (0.263)	1.824 (0.274)
>24-60	1.632 (0.283)	1.712 (0.336)
Wave I-V		
0-24	4.094 (0.515)	4.193 (0.595)
>24-60	3.010 (0.418)	3.887 (0.512)

Discussion

This study shows that the number of boys who had their hearing checked in the Hearing and Speech clinic was higher than girls, with a ratio of 1.8:1, indicating that speech problems are more common in boys than girls. A similar result was also seen in the research conducted by Dewi et al. in Bali that shows hearing and speech problems also more common in boys than girls (3,3:1). [10] Wijana et al. study , also shows the same result with a ratio of boys and girl are 1.5:1.[8]

This study also found that most of the samples were within the age group of >24-60 months. Through these results, we may conclude that the level of knowledge and awareness of parents, as well as the general society regarding the early detection of hearing problems is still poor and have yet to be adequate.

Mean absolute latency of ABR wave in this study were describe into 2 age groups (It is showed in table 2). In 0-24 month age groups, for the right ear are wave I: 2.230 (±0.425)ms; wave III: 4.506 (±0.421)ms; wave V: 6.324 (± 0.521)ms and left ear wave I: 2.131 (±0.416)ms ; wave III: 4.310 (±0.412)ms; wave V: 6.246 (± 0.326)ms. In older age groups for the right ear are wave I: 2.120 (±0.468)ms; wave III: 4.343 (±0.472)ms; wave V: 6.182 (± 0.498)ms and left ear wave I: 2.111 (±0.421)ms ; wave III: 4.314 (±0.415)ms; wave V: 6.118 (± 0.407)ms.

In this study show that the absolute latency for ABR waves in children under two year old is also found to be longer than in children over two year old. A study by Lotfi et al, also described the same result [11] Luana Araujo Cruz Rosa et al. also stated that the in the higher the age of the toddler, there was shorter of absolute latency and inter wave latency ABR wave.[12] This result is also similar with Kaeswiri et al study that stated that absolute latency have correlation with age of subject.[9] In younger subject, mean latency is longer than older children.[11,12] It is happens because there is a preexisting relationship with the process of maturity of the auditory pathways, with wave I having the shortest developmental period of about 2-3 months to reach the latency period of adults. Meanwhile, wave V has the longest development time, reaching the latency period identical to adults at about two years of life.[6,9,11,12]

Conclusion

Absolute latencies of ABR wave were assessed for their normative values which are required to establish a baseline data. There was a new absolute wave latency of ABR values in children for the population in West Java.

References

1. Rai Wiryadi IM, Wiranadha IM. Overview of examination results in patients with speech & language delays at the ENT-HNS polyclinic, Sanglah Hospital for the period January-December 2017. Medicina (B Aires). 2019;50(3):452–6.

2. Gunawan LM, Wijana, Pratiwi YS. Oto–Acoustic Emission and Auditory Brainstem Response Profile in Children with Speech Delay at Dr. Hasan Sadikin General Hospital Bandung. AMJ. 2016; 3(2):265–8.

3. Wijana. Auditory Brainstem Response. Bandung: Paramedia Komunikatama; 2018.

4. Robert B, McNerney K. Intoduction to auditory evoked potentials. In: Katz J, Editor. Handbook of clinical audiology Baltimore: Lippincott Williams & Wilkins; 2009: 222-41.

5. Pratiwi D. Profile of Brainstem Evoked Response Audiometry in People aged 19-21 years with normal hearing. Jakarta; 2012.

6. Hall J, Antonelli P. Assessment of peripheral and central auditory function. In: Bailey's Head and Neck Surgery Otolaryngology. 5th Editio. Baltimore: Lippincott Williams & Wilkins; 2014 : 2274–90.

7. Solanki JD, Joshi N, Mehta HB, Shah CJ. A study of gender, head circumference and BMI as a variable affecting BAEP results of late teenagers. Indian J Otol. 2012;18(1):3–6.

8. Wijana, Syamsuddin A, Dewi YA. Waves of Auditory Brainstem Response (ABR) in Children Under Five Years. MKB. 2014;46(3):183–8.

9. Kaewsiri SI, Waseenon V, Navacharoen N. Correlation between age and gender, and parameters of auditory brainstem evoked response. Chiang Mai Med J. 2015;54(4):163–9.

10. Dewi NMAW, Wiranadha IM. Brainstem Evoked Response Audiometry (BERA) waves in children under five years with speech and language delays accompanied by hearing loss at Sanglah Hospital, Bali, Indonesia. Medical Science Essence. 2021;12(2):563.

11. Lotfi Y, Abdollahi FZ. Age and gender effects on Auditory Brain Stem Response (ABR). Iran Rehabil J. 2012;10(16):30–6.

12. Rosa LAC, Suzuki MR, Angrisani RG, Azevedo MF. Auditory Brainstem Response: Reference-values for age. Codas. 2014;26(2):117–21.