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ORIGINAL ARTICLE

Effect of Different Stimulus Polarities on Wave V of Auditory Brainstem Response in Evaluation of Hearing

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ABSTRACT

Objectives: To evaluate the effect of stimulus polarity on latency and amplitude of wave V by click generated auditory brainstem response and to evaluate the effect of rarefaction and condensation on wave V latency and amplitude

Methodology: This interventional study was conducted at Al-Nafees Teaching Hospital Islamabad and Bahwal Victoria Hospital Bahawalpur from January 2019 to June 2019. Sixty patients with the complaint of hearing loss were enrolled.

Results: There were 26 (43.3%) males and 34 (56.7%) were females. The mean amplitude of wave V of 358.33 nV when rarefaction was applied and 336.33 nV when condensation was used. There was a significant (P<0.05) difference in mean value of amplitude and latency varying stimulus polarity.

Conclusion: The latency and amplitude of wave V are affected by changing stimulus polarity

Keywords: Effect, Stimulus polarities, Wave V, Auditory brainstem response, Hearing

INTRODUCTION

Ear is a sense organ for hearing and balance. Hearing loss occurs if there is an anomaly in any anatomical part of ear and pathway of sound. Hearing loss, also known as hearing impairment, is a partial or total inability to hear.[1]

Hearing loss has many types depending on the type of classifications. The main classifications are currently in clinical use are based on the severity of hearing impairment, topographic and functional distinction. On the basis of severity it is divided into mild, moderate, moderately severe, severe and profound degrees. On the basis of topographic and functional distinctions main types are conductive, sensorineural, mixed and central deafness.[2]

One of the six most significant contributors to the global burden of disease, according to the World Health Organization, is hearing loss. Hearing impairment is the most frequent sensory deficit in human populations, affecting more than 250 million people in the world. Consequences of hearing impairment include inability to interpret speech, reduced ability to communicate, delay in language acquisition, economic and educational disadvantage, social isolation and stigmatization.[3] Worldwide, 9% of people living with hearing loss are children younger than 15 years, and the prevalence of disabling hearing loss in children varies according to socioeconomic status. The effect of hearing loss on a developing child is quite different from the effects of hearing loss that occurs in adulthood, with substantial negative influences on children's development and educational achievement. However, hearing loss in children can be minimized through public health measures, and early identification and intervention for acute and chronic ear conditions.[4]

Hearing loss is generally measured by playing generated or recorded sounds, and determining whether the person can hear them. Hearing sensitivity varies according to the frequency of sounds.[5] Auditory brainstem response (ABR) testing is an electrophysiological test used to test hearing deficits caused by pathology within the ear, the cochlear nerve and also within the brainstem. This test can be used to identify delay in the conduction of neural impulses due to tumours or inflammation but can also be an objective test of hearing thresholds and is also known as brainstem evoked response (BERA) and brainstem auditory evoked potential (BAEP). The brainstem auditory evoked response is a complex response to external stimulation that represents the neural electrophysiological activity of the auditory system at the level of the brainstem, mapping the synapses of the auditory pathways from the cochlear nerve, cochlear nucleus and superior olivary brainstem complex to the inferior colliculus midbrain.[6]

Auditory brainstem response is recorded by placing electrodes on skull. The seven waves are collected in ABR in response to sound stimuli and numbered from I to VII. Among them the top five are of most interest, the waves I, III and V are those that offer the most important parameters for interpretation of BAEP.[7] Auditory brainstem response allows different computer base parameters to get proper waveform of the response. These parameters include electrode montage, (most performed with a vertical montage (high forehead [active or positive], earlobes or mastoids [reference right and left or negative], low forehead [ground]), Impedance: 5 k Ω or less (also equal between electrodes), Filter settings: 30-1500 Hz bandwidth, Time window: 10ms (minimum), Sampling rate: usually high sampling rate of 20 kHz, Intensity: usually start at 70 dBnHL, Stimulus type: click (100us long), chirportone burst, Transducer type: insert, bone vibrator, sound field, headphones, Stimulation or repetition rate: 21.1, amplification: 100-150K, no of averages/sweeps: 1000 minimum (1500 recommended) and stimulus polarity: rarefaction, condensation or alternating.[8] The BAEP are considered exogenous potentials, i.e. the characteristics of the stimulus used directly influence the response. The type of stimulus, its intensity, the rate at which it is presented, and its polarity are examples of these characteristics.[9] There are three types of polarity for the stimuli: rarefaction (negative polarity), condensation (positive polarity), and alternating (negative/positive polarity). The way in which the auditory system responds to stimuli differs according to type, rarefaction is observed usually during outward movement of the stapes and during upward movement in the structures of the organ of Corti. In the condensation, the initial movement of the stapes occurs inside, followed by an inverse movement to that described above. During alternating polarity there is a combination between the polarities of condensation and rarefaction in subsequent presentations.[10,11]

The wave form of ABR is strongly influenced by variations in parameters like the type of stimulus and presentation rate, for instance; when presentation rate is higher, wave reproducibility is lower and the test is also made to run faster.[12] The effects of stimulus phase on components of the auditory brainstem response (ABR) have been studied frequently with varying results. The purpose was to investigate the effect caused by variation of polarity on latency and amplitude of wave V of ABR waveform. It is highly anticipated that this study emphasized knowledge of stimulus polarity variation. It also assisted in the diagnosis of hearing loss and the standardization of clinical procedures. Moreover in our population no such work has been done in past. It was help us to collect data pertinent to our local population and help not only in standardization of this diagnostic audiological procedure was also provided for further research.

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METHODOLOGY

This interventional study was conducted at Al-Nafees Teaching Hospital Islamabad and Bahawal Victoria Hospital Bahawalpur from January 2019 to June 2019. A total of 60 patients with the complaint of hearing loss were enrolledwith non-probability convenient sampling technique. Children upto 12 years of age, suspicion of hearing loss and both male and female children were included. All children who have ear infection and congenital malformations of external and middle ear, hearing can be assessed by any subjective procedure and tympanometry is abnormal were excluded. Data was collected by taking targeted history, clinical examination no fears, otoscopy and tympanometry with consent from parents in all cases.To collect wave VBERA was performed as PATH medical, sentiero advanced, click, stimulusrate30.7, stimulus polarity condensation, rarefaction, signal averaging 2000, noise stop criterion 20nv, electrode montage vertical, evaluation binaural and single channel. Data was analyzed through SPSS-23. P-value less than 0.05 was considered significant.

RESULTS

There were 26 (43.3%) males and 34 (56.7%) were females. Thirty eight (63%) patients were between 2 months to 4.11 years, 16 (26.7%) patients were between 5 to 7.11 years and 6 (10%) patients were between 8 to 12 years (Table 1).

Thresholds of hearing for left ear were from 20dB to 90dB with the mean value of 63.42. Amplitude of wave v from 93 nv to 689 nV with the mean value of 358.33 nV when rarefaction was applied. However amplitude of wave V was from 103n V to 671 nV with the mean value of 336.33 nV when condensation was used. Latency of wave V for left ear was from 5.1 to 9.4 ms with the mean value of 6.283 ms when rarefaction was used. However latency of wave V was from 5.2 to 9.8ms with the mean value of 6.45ms when condensation was used (Table 2).

Table 1: Demographic information of the patients (n=60)

Variable	No.	%
Gender		
Male	26	43.3
Female	34	56.7
Age		
2 months – 4.11 years	38	63.3
5 – 7.11 years	16	26.7
8 – 12 years	6	10.0

Table 2: Descriptive statistics of the patients (n=60)

Variable	Mean±SD
Threshold of Hearing	
Right Ear	60.92±16/93
Left Ear	63.42±15.98
Amplitude (nV)	
Rarefaction	358.33±161.52
Condensation	336.33±150.91
Latency (msec)	
Rarefaction	6.28±0.68
Condensation	6.45±0.71

There was a significant (P<0.05) difference in mean value of amplitude and latency varying stimulus polarity (Table 3).

Table 3: Comparison of amplitude and latency on varying stimulus polarity

Variable	t	df	Sig. (2-tailed)	Mean difference	95% Confidence interval of the difference	
					Lower	Upper
Amplitude (n volts)						
Rarefaction	17.184	59	.000	358.333	316.61	400.06
Condensation	17.263	59	.000	336.333	297.35	375.32
Latency (msec)						
Rarefaction	71.415	59	.000	6.2833	6.107	6.459
Condensation	70.095	59	.000	6.4517	6.267	6.636

DISCUSSION

Auditory brainstem audiometry is an objective tool of hearing assessment especially used for children. Assessment of hearing is very crucial to better manage it because delay in hearing assessment will probably cause delay in its management which ultimately leads to delay in speech development. Thus for efficient hearing and neurological assessment evoked potentials should be checked for all affecting parameters. Auditory brainstem response gives a number of stimulus parameters, from which stimulus polarity is of main concern for this study. The objective of my study is to check either wave v is affected by variation in stimulus polarity by latency and amplitude. Dzulkarnain et al[13] found that the interaural peak latencies (IPL) were shorter for rarefaction clicks. In the present study latency was also shorter when rarefaction was used and correlated well with the literature.

In another study conducted by Gução et al[14] found that the average values of absolute latencies were lower in general regarding the rarefaction polarity compared to the polarities of condensation. This finding correlated well with the findings of present study. In a separate study, Kumar et al.[15] demonstrated that the signal's amplitude varied significantly with the polarity of the stimulus. According to this study, there is a difference in amplitude when the polarity of the stimulus changes. When rarefaction is used, the difference is greater, and when condensation is used, it is shorter. The sensitivity of brainstem auditory evoked potential (BAEP) to auditory disorders may vary according to the polarity of the click used, in addition to significantly influence the absolute latencies and inter peak latencies of waves I, III and V16 when rarefaction is used absolute latencies and IPL are shorter while for condensation it is greater. Similarly amplitude of waves of BAEP is greater on rarefaction stimuli. The way in which the auditory system responds to stimuli differs according to type, rarefaction is observed usually during outward movement of the stapes and during upward movement in the structures of the organ of Corti. In the condensation, the initial movement of the stapes occurs inside, followed by an inverse movement to that described above. In subsequent presentations, the polarities of condensation and rarefaction are combined during alternating polarity.[16,17] These polarities differ in the direction in which the headset's diaphragm first moves on the tympanic membrane.

CONCLUSION

The latency and amplitude of wave V are affected by changing stimulus polarity. Brainstem auditory evoked potential is effective test in various parameters of auditory brainstem response and to get normative data across age (paediatrics/geriatics).

REFERENCES

1. Britannica E. Encyclopaedia Britannica. London: WB Saunders, 2011.
2. Smith RJ, Shearer AE, Hildebrand MS, Van Camp G. Deafness and hereditary hearing loss overview. Gene Reviews (R). Seattle, WA: University of Washington, 2016.
3. Mathers C, Smith A, Concha M. Global burden of hearing loss in the year 2000. Global Burden Dis 2000; 18(4):1-30.
4. Editorial. Hearing loss: an important global health concern. Lancet 2016; 387(1036): 2351.
5. Shojaeemend H, Ayatollahi H. Automated audiometry: a review of the implementation and evaluation methods. Healthcare Informatics Res 2018;24(4): 263-75.
6. Hall JW. New handbook of auditory evoked responses. Boston: Pearson, 2007.
7. Beck DL, Speidel DP, Petrak M. Auditory steady-state response (ASSR): a beginner's guide. Hearing Rev 2007;14(12):34.

8. Burkard RF, Eggermont JJ, Don M. Auditory evoked potentials: Basic principles and clinical application. Philadelphia: Lippincott Williams & Wilkins; 2007.
9. Moore EJ. Bases of auditory brain-stem evoked responses. New York: Grune & Stratton; 1983.
10. deLima JP, deFreitas Alvarenga K, Foelkel TP, Monteiro CZ, Agostinho RS. Osefeitosda polaridadedo estímulo nos Potenciais Evocados Auditivos deTroncoEncefálico. Brazilian J Otorhinolaryngol 2008;74(5):725-30.
11. Türkman T, Kaygusuz İ, Başar F, Karlıdağ T, Keleş E, Birkent ÖF, Yalçın Ş. Normalization of bone conduction auditory brainstem evoked responses in normal hearing individuals. J Int Adv Otol 2018;14(3):418-25.
12. Konrad-Martin D, Dille MF, McMillan G, Griest S, McDermott D, Fausti SA, et al. Age-related changes in the auditory brainstem response. J Am Acad Audiol 2012;23(1):18-35;
13. Dzulkarnain AAA, Salamat S, Shahrudin FA, Jamal FN, Zakaria MN. Influence of Stimulus Polarity on the Auditory Brainstem Response From Level-Specific Chirp. J Audiol Otol 2021;25(4):199-208.
14. Gução AC, Romero AC, Lemes FL, Regaçone SF, Valenti VE, Frizzo AC. Auditory brainstem responses: stimulus variations. J Human Growth Develop 2015;25(3):292-6.
15. Kumar K, Bhat JS, D'Costa PE, Srivastava M, Kalaiah MK. Effect of stimulus polarity on speech evoked auditory brainstem response. Audiol Res 2013; 2:3.
16. Fowler CG, Bauch CD, Olsen WO. Diagnostic implications of stimulus polarity effects on the auditory brainstem response. J Am Acad Audiol 2002; 13(2): 72-82.
17. Wang X, Zhu M, Samuel OW, Wang X, Zhang H, Yao J, et al. The effects of random stimulation rate on measurements of auditory brainstem response. Front Hum Neurosci 2020;14:78.

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