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Correlation Between Delayed Speech and Hearing Loss by Using Auditory Brainstem Response Test

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ABSTRACT

This study aimed to know the correlation between delayed speech and hearing loss by using auditory brainstem response test. Fifty people between the ages of 17 and 52 years were participated in this study. Patients, families of patients, and those travelling to the clinic for pre-employment testing in Baghdad all played roles in the selection process. Each participant provided written informed consent before participation. Participants were split into two categories for this study: The first group, the control, had 15 people with no known systemic disorders and normal peripheral hearing on both sides (hearing threshold level 25 dB at any frequency between 250 and 8000 Hz). People with preexisting health conditions (such as endocrine, cardiovascular, renal, or neurological complaints) or a history of otological illness were not included in the study. Group 2: Thirty-five people with mild-to-moderate sensorineural hearing loss (hearing threshold does not exceed 60 dB even at single frequency in the 250-8000 Hz range) were tested. They did not suffer from any endocrine, cardiovascular, renal, or neurological disorders. Conditions such as unilateral or asymmetrical hearing loss, conductive or mixed hearing loss, middle ear diseases, and the suspicion of retrocochlear lesions will rule out a patient from participation. There was a total of 15 participants in the control group, split evenly between 2 men and 13 women. They were between the ages of 17 and 52. Pure tone thresholds averaged 10.22 ±1.04 dB (right ear) and 10.13±1.09

dB (left ear), respectively. All participants in the control group had word discrimination scores of 1000.00% in both ears, and their auditory reflex thresholds were within the normal range. The G2 trial group had 35 participants, 17 men and 18 females of similar ages to the control group. All individuals exhibited bilateral mild to severe SNHL (23 mild cases and 12 moderate cases). Hearing loss might last anywhere from one year to fifteen years. The average and standard deviation of pure tone thresholds were 39.71 and 13.54 decibels in the right and left ears, respectively. The right ear scored 95.8±6.01% on the word discrimination test, whereas the left ear scored 96.41±5.33%. Hearing thresholds and acoustic reflex thresholds both were within normal ranges.

Introduction

Somewhere between five and eight percent of preschool-aged youngsters have language and speech difficulties (1). Language is a larger method of conveying and receiving information, whereas speech relates specifically to vocal expression, including the way words are constructed (2). Exposure to more than one language, learning disabilities, hearing loss, psychosocial deprivation, elective mutism, receptive aphasia, cerebral palsy, and autism and similar disorders can all contribute to difficulties with language and speech (3). The sooner these issues are noticed and addressed, the better for the youngster (1).

Delay in the onset of normal speech development, often known as speech delay, is a clinical diagnosis (2). Children often have a speech delay for no apparent reason. These youngsters have normal results on standard hearing tests and no abnormalities on a neurologist's evaluation, suggesting they do not suffer from autism or a related illness (2). The challenge in diagnosing and treating speech delay of unknown cause is that, after normal findings in routine hearing tests among this group of patients and the absence of any neurological causes of speech delay, this diagnosis is the last differential diagnosis (3)

As a neurological test, the auditory brainstem response (ABR) measures how well the auditory brainstem processes a click as an auditory input (4) The most widespread use of auditory evoked responses is the technique initially described by Jewett and Williston in 1971 (5). Results from this test may be used to learn more about the auditory system in the brain (6). The subject need not make any verbal or nonverbal responses throughout this evaluation. The examiner looks at a succession of vertex-positive waves, from I to V, to determine the outcome of the test (7). The start of an auditory input is followed by these waves, shown by Roman numbers, within the first 10 milliseconds (7). The ABR is an example of an exogenous reaction since it is triggered by stimuli from the outside world (8).

The examiner looks at the wave amplitude to determine the number of neurons firing, the wave latency to determine the speed of transmission, the interpeak latency to determine the time between peaks, and the interaural latency to determine the difference in wave latency between the two ears (9).

The auditory brainstem response (ABR) is used in a variety of clinical settings, such as during surgery (10), to check for retrocochlear disease (11), and to screen all newborns for hearing loss (12). Other uses include monitoring patients in intensive care units (ICUs), estimating hearing sensitivity at different frequencies, and diagnosing demyelinating diseases like multiple sclerosis. Although the wave V delay has been the primary focus of these applications, there have been a few studies (16-18) that have included the wave amplitude as a diagnostic feature.

This study aimed to know the correlation between delayed speech and hearing loss by using auditory brainstem response test.

Materials and Methods:

Fifty people between the ages of 17 and 52 years were participated in this study. Patients, families of patients, and those travelling to the clinic for pre-employment testing in Baghdad all played roles in the selection process. Each participant provided written informed consent before participation.

Participants were split into two categories for this study:

The first group, the control, had 15 people with no known systemic disorders and normal peripheral hearing on both sides (hearing threshold level 25 dB at any frequency between 250 and 8000 Hz). People with preexisting health conditions (such as endocrine, cardiovascular, renal, or neurological complaints) or a history of otological illness were not included in the study.

Group 2: Thirty-five people with mild-to-moderate sensorineural hearing loss (hearing threshold does not exceed 60 dB even at single frequency in the 250-8000 Hz range) were tested. They did not suffer from any endocrine, cardiovascular, renal, or neurological disorders. Conditions such as unilateral or asymmetrical hearing loss, conductive or mixed hearing loss, middle ear diseases, and the suspicion of retrocochlear lesions will rule out a patient from participation.

All of the cases in this study underwent a comprehensive audiological history, otological examination, as well as basic audiological evaluation that included pure tone audiometry, speech audiometry (including both the Speech Recognition Threshold (SRT) test with Arabic spondee words (18) and the Word discrimination % (WD) test with Arabic phonetically balanced words (19), and immittancemetry (including Tympanometry, ipsilateral and contralateral acoustic reflex) (20).

SPSS, a statistical computer tool, version 23, was used to organise, tabulate, and statistically analyse the acquired data.

Results:

There was a total of 15 participants in the control group, split evenly between 2 men and 13 women. They were between the ages of 17 and 52. Pure tone thresholds averaged 10.22 ±1.04 dB (right ear) and 10.13±1.09 dB (left ear), respectively. All participants in the control group had word discrimination scores of 1000.00% in both ears, and their auditory reflex thresholds were within the normal range.

The GII trial group had 35 participants, 17 men and 18 females of similar ages to the control group. All individuals exhibited bilateral mild to severe SNHL (23 mild cases and 12 moderate cases). Hearing loss might last anywhere from one year to fifteen years. The average and standard deviation of pure tone thresholds were 39.71 and 13.54 decibels in the right and left ears, respectively. The right ear scored 95.8±6.01% on the word discrimination test, whereas the left ear scored 96.41±5.33%. Hearing thresholds and acoustic reflex thresholds both were within normal ranges (Table 1).

Table 1 Latencies of S-ABR in response to /da/ stimulus in right and left ears of control (G1) and study groups (G2).

		(S-ABR)		*P*
		G1	G2	
V wave	R	10.22 ± 1.04	11.55 ± 5.22	0.033*
	L	10.13 ± 1.09	11.36 ± 7.47	0.021*
A wave	R	13.19 ± 1.72	14.23 ± 2.54	0.076
	L	12.92 ± 1.61	14.31 ± 2.6	0.013*
C wave	R	20.13 ± 1.84	21.53 ± 1.46	0.084
	L	20.52 ± 1.29	21.45 ± 1.67	0.046*
D wave	R	28.17 ± 1.75	28.46 ± 1.36	0.96
	L	28.71 ± 1.49	28.95 ± 2.05	0.92
E wave	R	37.27 ± 1.27	37.49 ± 1.46	0.653
	L	37.42 ± 1.71	37.26 ± 2.63	0.955
F wave	R	45.21 ± 1.83	45.48 ± 1.38	0.729
	L	46.63 ± 1.46	46.61 ± 2.84	0.885
G wave	R	54.1 ± 2.37	54.85 ± 2.10	0.285
	L	54.55 ± 2.68	55.81 ± 2.58	0.438

Discussions:

Complex signals (such as speech) are likely processed differently by those with hearing loss compared to those with normal hearing (21,22,23). Cochlear, eighth nerve, brainstem, and/or auditory cortical abnormalities in the representation of complex speech signals likely contribute to processing problems (24, 25). The degree and duration of hearing loss both contribute to the alterations in the auditory nerve system
(26).

Accurate encoding is dependent on a synchronised brain response due to the complicated spectro-temporal structure of speech signals. The elicited reactions rely on this synchronised activity, making them a good model for investigating how the brain processes speech (16). Speech auditory brainstem response (S-ABR) seems to be a very promising audiological method for studying temporal encoding of speech in the brainstem (27). The goal of this research was to use speech evoked potentials to detect speech processing abnormalities in persons with mild to moderate SNHL.

Our findings were consistent with those of Vander Werff and Burns9, who similarly did not discover a REA. In contrast, (28) found a REA manifesting as either decreased FFR latency in the right ear compared to the left or increased FFR amplitude in the right ear compared to the left. The REA was also observed by Hornickel et al. (29) to appear as a greater amplitude of the frequency encoding in the ranges corresponding to the 1st formant but not the fundamental frequency in the right ear. Both experiments provided evidence that the auditory brainstem shared the left lateralization of processing that was shown to be critical for speech discrimination.

The amplitude findings of S-ABR were consistent with those published by (9;30). There was no statistically significant difference between the control and SNHL groups. We also found no statistically significant difference in amplitudes between the two groups, which is consistent with the findings of (34). In addition, neither slope nor area differed significantly between the two groups.

Finally, hearing loss impacts the latencies but not the amplitudes of SABR. This result suggested that the response synchronisation was impacted before the discharge rate. More so than the FFR, the onset response of S-ABR was impacted. Phase locking to the fundamental frequency and its harmonics was unaffected, suggesting that the issue among the participants with hearing loss was the lack of synchronisation to the start. We found that people with mild to severe SNHL have a deficit in brainstem-level speech processing.

References:

1. Force USPST. Screening for speech and language delay in preschool children: recommendation statement. *Pediatrics.* 2006;117:497–501. doi: 10.1542/peds.2005-2766.
2. Prelock PA, Hutchins T, Glascoe FP. Speech-language impairment: how to identify the most common and least diagnosed disability of childhood. *Medscape J Med.* 2008;10:136.
3. Norrix LW, Trepanier S, Atlas M, Kim D. The auditory brainstem response: latencies obtained in children while under general anesthesia. *J Am Acad Audiol.* 2012;23:57–63. doi: 10.3766/jaaa.23.1.6.
4. Kallstrand J, Lewander T, Baghdassarian E, Nielzen S. A new method for analyzing auditory brain-stem response waveforms using a movingminimum subtraction procedure of digitized analog recordings. *Neuropsychiatr Dis Treat.* 2014;10:1011–6. doi: 10.2147/NDT.S59178.
5. Spitzer E, White-Schwoch T, Carr KW, Skoe E, Kraus N. Continued maturation of the click-evoked auditory brainstem response in preschoolers. *J Am Acad Audiol.* 2015;26:30–5.
6. Motalebi Kashani M, Saberi H, Hannani M. Prevention of Acoustic Trauma-Induced Hearing Loss by N-acetylcysteine Administration in Rabbits. *Arch Trauma Res.* 2013;1:145–50
7. Lima JP, Alvarenga Kde F, Foelkel TP, Monteiro CZ, Agostinho RS. Polarity stimulation effects on brainstem auditory evoked potentials. *Braz J Otorhinolaryngol.* 2008;74:725–30.
8. Rosa LA, Suzuki MR, Angrisani RG, Azevedo MF. Auditory brainstem response: reference-values for age. *Codas.* 2014;26:117–21.
9. Aihara N, Murakami S, Takahashi M, Yamada K. Preoperative characteristics of auditory brainstem response in acoustic neuroma with useful hearing: importance as a preliminary investigation for intraoperative monitoring. *Neurol Med Chir (Tokyo)* 2014;54:267–71. doi: 10.2176/nmc.oa.2013-0258.
10. Kemp DT. Otoacoustic emissions, their origin in cochlear function, and use. *Br Med Bull.* 2002;63:223–41. doi: 10.1093/bmb/63.1.223.
11. Clemens CJ, Davis SA, Bailey AR. The false-positive in universal newborn hearing screening. *Pediatrics.* 2000;106:E7.
12. Unlu I, Guclu E, Yaman H. When should automatic Auditory Brainstem Response test be used for newborn hearing screening? *Auris Nasus Larynx.* 2015;42:199–202.

13. Xu ZM, Cheng WX, Yao ZH. Prediction of frequency-specific hearing threshold using chirp auditory brainstem response in infants with hearing losses. *Int J Pediatr Otorhinolaryngol.* 2014;78:812–6.
14. Saberi A, Hatamian HR, Nemati S, Banan R. Hearing statement in multiple sclerosis: a case control study using auditory brainstem responses and otoacoustic emissions. *Acta Med Iran.* 2012;50:679–83.
15. Kraft GH. Evoked potentials in multiple sclerosis. *Phys Med Rehabil Clin N Am.* 2013;24:717–20.
16. Bayazit Y, Bekir N, Gungor K, Kepekci Y, Mumbuc S, Kanlikama M. The predictive value of auditory brainstem responses for diabetic retinopathy. *Auris Nasus Larynx.* 2000;27:219–22.
17. Mason SM, Mellor DH. Brain-stem, middle latency and late cortical evoked potentials in children with speech and language disorders. *Electroencephalogr Clin Neurophysiol.* 1984;59:297–309.
18. Nicholas JG. Age differences in the use of informative/heuristic communicative functions in young children with and without hearing loss who are learning spoken language. *J Speech Lang Hear Res.* 2000;43:380–94.
19. S. Soliman. Speech discrimination audiometry using Arabic phonetically balanced words Ain Shams Med J, 27 (1976), pp. 27-30
20. Liberman, P. Delattre, F. Cooper, L. Gerstman, D. Abrams, N. Kraus The role of consonant vowel transitions in the perception of the stop and nasal consonants Psychol Monogr, 68 (8, 379) (1954), pp. 1-13
21. Quoted from Abrams D, Kraus N. Auditory pathway representations of speech sounds in human. In: Katz J, Medwetsky L, Burkard R, Hood L, editors. Handbook of clinical audiology. 6th ed. Lippincott: Williams and Wilkins Co.; 2009. p. 611–626 [Chapter 26]
22. S. Blumstein, E. Issacs, J. Mertus The role of gross spectral shapes as a perceptual cue to place of articulation in initial stop consonants J Acoustic Soc Am, 72 (1982), pp. 43-50
23. D. Kewley-Port Time-varying features as correlates of place of articulation in stop consonants J Acoust Soc Am, 73 (1983), pp. 322-335
24. N. Russo, T. Nicol, G. Musacchia, N. Kraus Brainstem responses to speech syllables Clin Neurophysiol, 115 (2004), pp. 2021-2030
25. N. Hemanth, P. Manjula Representation of speech sounds at the auditory brainstem JISHA, 26 (2) (2012), pp. 1-13
26. 25. A. Khaladkar, N. Kartik, S. Vanaja Speech burst and click evoked ABR (2005). www.audiologyonline.com
27. A Krall, J. Tilleina Brain Plasticity under Cochlear Implant Stimulation A. Moller (Ed.), Cochlear and brainstem implants. Adv. Otorhino. Laryngol., 64 (2006), pp. 89-108
28. Akhoun, S. Gallégo, A. Moulin, et al. The temporal relationship between speech auditory brainstem responses and the acoustic pattern of the phoneme /ba/ in normal-hearing adults Clin Neurophysiol, 119 (4) (2008), pp. 922-933
29. Sinha, V. Basavaraj Lateral asymmetry in speech processing at the brainstem: evidence from speech evoked ABR JAIISH, 29 (1) (2010), pp. 101-109
30. Hornickel, E. Skoe, N. Kraus Subcortical laterality of speech encoding Audiol Neurootol, 14 (2009), pp. 198-207

31. J. Song, T. Nicol, N. Kraus Test-retest reliability of the speech-evoked auditory brainstem response Clin Neurophysiol, 122 (2) (2011), pp. 346355
32. S Anderson, A Parbery-Clark, T. White-Schwoch, N. Kraus Aging affects neural precision of speech encoding J Neurosci, 32 (41) (2012), pp. 14156-14164
33. J. Hornickel, S. Anderson, E. Skoe, H. Yi, N. Kraus Subcortical representation of speech fine structure relates to reading ability Neuroreport, 23 (1) (2012), pp. 6-9
34. J.H. Song, K. Banai, N.M. Russo, N. Kraus On the relationship between speech- and non-speech-evoked auditory brainstem responses Audiol Neurootol, 4 (2006), pp. 233-241
35. Lipson Sh. The relation between speech recognition in noise and the speech-evoked brainstem response in normal-hearing and hearingImpaired individuals, Washington University School of Medicine Program in Audiology and Communication Sciences, A Capstone Project submitted in partial fulfillment of the requirements for the degree of: Doctor of Audiology; 2013.
36. Johnson, T. Nicol, S. Zecker, A. Bradlow, E. Skoe, N. Kraus Brainstem encoding of voiced consonant–vowel stop syllables Clin Neurophysiol, 119 (11) (2008), pp. 2623-2635
37. B. Martin, L. Tremblay, P. Korczak Speech evoked potentials: from the laboratory to the clinic Ear Hear, 29 (3) (2008), pp. 285-313
38. J. Hornickel, E. Skoe, T. Nicol, S. Zecker, N. Kraus Subcortical differentiation of stop consonants relates to reading and speech in noise perception Proc Natl Acad Sci USA, 106 (31) (2009), pp. 13022-13027
39. E. Skoe, T. Nicol, N. Kraus Cross-phaseogram: objective neural index of speech sound differentiation J Neurosci Methods, 196 (2011), pp. 308317
40. Krishnan, Y. Xu, J. Gandour, P. Cariani Encoding of pitch in the human brainstem is sensitive to language experience Cogn Brain Res, 25 (2005), pp. 161-168