AJCM
Avicenna Journal of Clinical Medicine

Avicenna J Clin Med, 2026; 33(1): 46-51 Doi: 10.53208/ajcm.33.1.46
https://sjh.umsha.ac.ir

Original Article

Effect of Stimulation Speed on Auditory Brainstem Responses in the Elderly

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Article history:
Received: 24 January 2026
Revised: 30 March 2026
Accepted: 06 May 2026
ePublished: 15 June 2026

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BRIEF TEXT

Background and Objective

Presbycusis is a hearing disorder that develops with age [1]. The increase in central reaction time significantly reduces the functional speed of older adults [2]. The changes occur in most brainstem nuclei and auditory cortex [3, 4]. The extent of the destructive effects of aging on the auditory system poses a challenge in clinical treatment, which can make it difficult to differentiate lesions caused by diseases and complications [5]. … [3]. Despite normal hearing thresholds, abnormal auditory brainstem responses (ABR) may occur due to factors, such as fatigue in auditory nerve fibers or increased excitability of the auditory system [6]. According to some previous studies, increasing the stimulation rate may increase ABR interpeak intervals (IPI), indicating reduced neural synchrony of brainstem afferent fibers [7, 8]. … [3,4]. It is a significant challenge to use ABR to investigate the effects of aging, stimulation rate, and hearing loss, as these factors can disrupt the amplitudes and latencies [9]. Therefore, this study aimed to determine the effect of stimulation rate on ABR in the elderly.

Materials and Methods

This study was performed on 45 elderly people (case group) aged 65-81 years (71±0.65) and 45 young people (control group) aged 18-23 years (20±0.92) during 2025-2026. Regarding gender, each group included 22 male (48.89%) and 23 female (51.11%) participants. The inclusion criteria of the control group were the presence of normal results in all tests. For the case group, the inclusion criteria were normal results on questionnaires and tympanometry and tone decay tests. …. [6]. To avoid exclusion of ABR due to hearing loss, older adults with hearing thresholds less than 45 dB HL at 2 kHz and less than 60 dB HL at 4 kHz were selected [3]. Moreover, participants were required to have pure-tone thresholds less than 30 dB HL, based on the average of three frequencies at 2, 3, and 4 kHz, with no signs of retrocochlear lesion. Patients with dizziness or balance disorders, middle ear infections, cognitive disorders and retrocochlear lesionswere excluded from the study. …. [4, 7]. All tests were performed by two experienced audiologists, who were blinded to the study procedure. The statistical analysis was performed using the independent t-test in SPSS software (version 24). A p value of less than 0.05 was considered statistically significant.

Results

Normal distribution of data was confirmed using the Shapiro-Wilk test. At slow stimulation speed, the mean amplitudes of waves I (p=0.03) and III (p=0.04) were smaller in the old adults than in young adults, whereas the difference in the mean amplitudes of wave V was not statistically significant (p=0.90). Latency times of waves I-V were longer in the old adults than in the young adults (p=0.01). The IPIs of waves I-III (p=0.09) and III-V (p=0.08) were not significantly different between the two groups. At fast stimulation speed, the mean latency times of waves 1 (p=0.23), 3 (p=0.18), and 5 (p=0.26) increased, and the amplitudes of waves 1 (p=0.46), 3 (p=0.32), and 5 (p=0.19) decreased in both groups; however, these differences were not significant (Table1).

Discussion

Tessle et al. (2022) concluded that the temporal processing and synchrony of brainstem nerve fiber excitation are impaired in the elderly, which is

due to functional deficits in the auditory brainstem pathways and the detrimental effects of aging [1]. Their findings are consistent with those of the present study, in that the latency of all ABR waves increased and their amplitudes decreased in old adults assessed by the conventional or slow method. … [2].

Burkard and Sims (2001) demonstrated that as the rate increased, the amplitude of wave 1 decreased and its latency increased. They suggested that this was due to fatigue of the auditory nerve during increased stimulation, which occurs with age [3]. Perhaps the reason for the difference between their results and those of the present study was the research method. Participants of the present study showed no signs of retrocochlear lesions or damage to the earlier part of the auditory nerve based on the normal tone decay test. Furthermore, no signs of auditory nerve fatigue, which is evident in retrocochlear lesions [6], were detected in their ABR.

Konrad-Martin et al. (2012) observed that in adults older than 60 years, the latencies of all waves increased and their amplitudes decreased, which was due to impaired synchronization of auditory nerve fibers in the central portion [10]. It seems that when the stimulation rate is increased, and there is no retrocochlear lesion, the greatest impact is on the responses of the earlier part of the central auditory system, which is located between the auditory nerve fibers and the superior olivary complex [4, 7, 8].

Anderson and Karvani (2020) reported that older adults experience impairments in temporal processing and the function of auditory brainstem pathways, while the accuracy of reconstructing responses to continuous speech increases in older listeners [9].

Lira et al. (2019) reported that stimulation rate influences the latency and amplitude of ABR waves. Specifically, reducing the stimulation rate decreases the latency of wave V and increases its amplitude. It also improves the morphology of waves I, III, and V [10]. The ABR findings, which were associated with increased latency of all waves in older adults, indicated impaired auditory brainstem processing time and reduced information processing speed.

Conclusion

Age-related changes appear to have a greater impact on the lower-level parts of the central auditory system and reduce the synchronization of auditory afferent fibers at lower levels of the brainstem. Therefore, presbycusis may have more adverse consequences on the performance of ABR wave generators at the junction of the auditory nerve and the superior olivary complex.

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Table 1. Descriptive analysis of latency time (click/second) and amplitude of waves I, II, and V of the ABR response in the right and left ears of the participants (90 ears) based on stimulation rate.

Mean ± SD (control group)						
Stimulation rate (cs)	**Wave I**	**Wave III**	**Wave V**	**Waves I-III**	**Waves III-V**	**Waves I-V**
			Latency Time (ms)			
11	1.51±0.42	3.59±0.29	5.64±0.33	1.98±0.13	1.80±0.45	2.1±0.13
91	1.56±0.19	3.65±0.35	5.74±0.27	2.14±0.24	1.97±0.16	2.2±0.28
			Amplitude (uv)			
11	0.67±0.88	0.71±1.04	0.61±0.73	-	-	-
91	0.59±1.53	0.63±1.48	0.60±0.98			
Mean ± SD (case group)						
Stimulation rate (cs)	Wave I	Wave III	Wave V	Waves I-III	Waves III-V	Waves I-V
			Latency Time (ms)			
11	1.70±1.09	4.43±1.14	6.32±0.78	1.91±0.63	1.94±0.37	2.4±0.64
91	1.76±0.65	4.57±0.99	6.36±0.64	2.07±0.84	2.11±0.48	2.4±0.89
			Amplitude (uv)			
11	0.38±0.21	0.44±0.34	0.59±0.19	-	-	-
91	0.34±0.38	0.42±0.29	0.57±0.10			

CS: click/second, ABR: auditory brainstem responses