Research article

Variation in interpeak latencies of auditory brainstem responses with age in male adults: An observation

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ABSTRACT

Introduction and Aim: Aging of the auditory pathway is a complex phenomenon consisting of changes in the auditory processing along with a significant elevation of the hearing threshold. The aim of our study was to see the variation in interpeak latencies (IPLs) of Auditory Brainstem Responses (ABRs) with advancing age in males.

Materials and Methods: It was an observational study conducted on 60 Indian male subjects aged between 20 and 80 years divided into three groups on the basis of age: Group 1: 20-40 years, Group 2: 41-60 years and Group 3: 61-80 years. Auditory threshold and ABRs were recorded and analysed for interpeak latencies (IPLs) – I-III, I-V and III-V in msec. The comparison of data between the groups was done using one – way ANOVA and Tukey Kramer multiple comparison test. The results were considered significantly different between the groups when 'P value' was ≤ 0.05.

Results: It was found that there was no significant difference in the auditory threshold and interpeak latencies (IPLs) when comparison was made between the three groups.

Conclusion: Hence we conclude that age does not have any significant influence on neural conduction time of the auditory pathway which is represented by the IPLs in ABRs.

Keywords: Aging; auditory brainstem responses; interpeak latencies.

INTRODUCTION

The synchronised activity of the auditory nerve and brainstem is represented by the ABRs (Auditory Brainstem Responses) also called as the BAEPs (Brainstem Auditory Evoked Potentials). They fall in the category of early evoked potential changes that are recorded from the human scalp within 10 msec of an auditory stimulus (1). Typically, five waves are recorded in the human scalp recording that are labelled as I, II, III, IV and V with waves I, III and V being the most prominent (2). These waves represent neural conduction processes in the central auditory pathways and are used to measure peripheral auditory sensitivity, differentiate between cochlear and retro cochlear hearing loss and to evaluate the neurologic intactness of the brainstem (1). These waveforms in normal subjects vary with age, sex, stimulus parameters and the recording system used. Hence the interpretation of ABRs is an age dependant phenomenon (3).

In addition to the absolute latencies of the five waves, the interpeak latencies (IPLs) are also analysed that represent neural conduction time in the auditory pathway, the most common being used clinically are interpeak latencies I-III, I-V and III-V (4). IPLs measures the following:

- IPL I-III is a measure of conduction time from the VIII nerve across the subarachnoid space into the core of the lower pons.
- IPL I-V is a measure of conduction from proximal part of VIII nerve through pons to the midbrain
- IPL III-V measures conduction of impulse from lower pons to midbrain

Most studies done worldwide have studied the absolute latency of waves of ABRs with advancing age, but few have attempted to analyse the interpeak latencies only. It is well established that females have shorter latency and higher amplitude of the ABR waves which may be due to higher internal body temperature and shorter length of the brainstem auditory pathway (2). Hence, we have attempted to interpret the variation in the interpeak latencies I-III, I-V and III-V of ABRs with age in male subjects only as the results are considered equivocal.

MATERIALS AND METHODS

This study was conducted in the Neurophysiology lab of Department of Physiology, of a Government Medical College located in the Delhi/NCR region.

Selection of subjects

The study comprised of 60 subjects, divided into three groups of 20 each. Statistician of the institute was consulted in deciding the number of subjects before the study was started. They were selected amongst the students and staff of the college and associated hospitals and general population. Ethical clearance was taken from the Institutional Ethical Committee before the study was started. An informed written consent was taken and a proforma for detailed medical history was filled for all the subjects.

Inclusion criteria of subjects

1. Male subjects between the ages of 20 to 80 years.
2. Subjects having normal hearing (no apparent impairment of hearing between 0 – 25 decibels, taking the average of the thresholds of hearing for frequencies of 500Hz, 1000Hz and 2000Hz).

Exclusion criteria

1. Female subjects
2. Males having hearing loss due to metabolic disorders that affect hearing like diabetes, hypertension etc.,
3. Hearing loss due to middle or internal ear pathology.
4. Subjects taking ototoxic drugs, alcohol and those with noise induced hearing loss.

The subjects were divided into three groups on the basis of age as: Group 1 - 20 - 40 years; Group 2– 41 – 60 years; Group 3 – 61-80 years.

Examination

Systemic examination included general physical along with respiratory and cardiovascular system examination. Any hearing loss due to pathology in the external ear – excess wax, polyp, debris, discharge and perforation in the tympanic membrane were rules out by a detailed ENT examination. Pure tone audiometry (PTA) was used to determine the hearing threshold accurately.

Recording of ABRs

Computerised EBNeuro system, made in Italy was used to record the ABRs. It was ensured that the subject was lying down comfortably at the time of recording. The ambient room temperature was maintained and the room was soundproof. '10 – 20 International System' was used to place the electrodes at the time of recording. Small standard disc shaped electrodes were used that were made of Ag/AgCl. Placement of active electrode was done on ipsilateral ear lobule (Ai), reference electrode was placed at C_z and ground electrode was kept at the forehead (F_Z). Electrical impedance was kept below 5k ohms. Acoustic transients (alternating clicks) were now delivered through earphones. Each brief click stimulus is a square wave pulse of 0.1 msec.

A click rate of 11kHz was used. A total of 1500 individual sweeps were recorded using filter band pass of 300 - 3000 Hz with artefact rejection level up to 25 micro volts (6).

To ensure reproducibility of the results every recording was repeated 2-3 times. Latency of the waves on each recording agreed with each other within 0.1 msec or less. The interpeak latency between the waves was also measured.

Statistical analysis

The variation between the groups was assessed using one-way ANOVA and Tukey Kramer multiple comparison test. The results were considered statistically significant when 'P value' was ≤ 0.05.

RESULTS

The auditory threshold of the three groups can be seen in Table 1. The hearing threshold increased progressively with age, but this change was found to be non-significant on comparison. ($p > 0.05$).

Table 1: Hearing threshold (in dB) of the three groups (values are expressed in mean ± SD)

Groups	Hearing threshold
1.	43.0±11.74
2.	48.0±8.01
3.	48.4±9.07

The interpeak latencies (IPLs) of the three groups can be seen in Table 2. No statistical significance could be seen when comparison was made between the three groups ($p > 0.05$).

Table 2: Interpeak latencies in the groups (mean ± SD) along with their comparison

Interpeak latencies I – III, I-V and III – V (msec)			
Groups	**1**	**2**	**3**
I-III	1.93 ± 0.24	2.01 ± 0.18	1.99 ± 0.16
I-V	3.81 ± 0.33	3.90 ± 0.23	3.91 ± 0.21
III-V	1.89 ± 0.35	1.89 ± 0.21	1.92 ± 0.22
Intergroup comparison of Interpeak latencies (IPLs)			
Parameter	**Group 1 vs 2**	**Group 2 vs 3**	**Group 1 vs 3**
IPL I-III	NS	NS	NS
IPL I-V	NS	NS	NS
IPL III-V	NS	NS	NS

'**NS**': not significant $p > 0.05$

DISCUSSION

The aim of our study was to record ABRs in males of different age groups and to compare their interpeak latencies that represent the neural conduction time through the auditory pathway.

Our study shows that there is no significant change in the interpeak latencies of ABRs with advancing age unlike the absolute latencies of waves I-Vas has been reported by a number of studies done so far on both humans and animals over the years (2). They represent the changes in the neural conduction time in the auditory system. IPLs should be analysed in detail besides the absolute latencies of ABRs to identify possible changes in the auditory brainstem that may occur independently of changes in the auditory periphery and are commonly used diagnostically in acoustic neuromas and demyelinating disorders (2).

Onset of aging changes in the auditory pathway is considered to be a peripheral phenomenon. There are several differences in the ABRs of the new-born and adults. In the new-born:

1. The amplitude of waves is smaller
2. Double peaked wave I
3. Wave II is insignificant
4. Wave I is followed by a prominent negative wave
5. Wave III is followed by a negative wave that is less prominent
6. The ratio of amplitude of Wave V/Wave I is much smaller

As early as 30 weeks of gestational age in a premature infant an ABR can be recorded. The waves mature to an adult pattern over a period from birth to the age of 18-24 months. The latencies of all components of the response decrease with increasing conceptional age. For recording ABRs in premature infants the stimulus given should be of higher intensity and slower rate (6).

The glutamate hypothesis has been proposed as a mechanism for these changes by Pujol (7). Glutamate is the neurotransmitter between the inner hair cells and the auditory nerve. The hypothesis suggests that excess release of glutamate due to excess auditory stimulation either by noise, or in hypoxic conditions that are thought to occur with age results in a large influx of calcium ions. As a result, calcium homeostasis is compromised, and calcium becomes toxic to the cells leading to cell death (7). Females were excluded from the study because hormones are known to interact with neurotransmitters of the auditory pathway (8).

A number of studies have been done over the years investigating the relationship between aging and changes in the IPLs of BAEPs particularly I-III, I-V and III-V. In similar studies done by other researchers it was seen like us that IPL values did not increase significantly with age (15-16,12). However, others have found prolongation of I-III IPL with increasing age from younger to older (9-11,17).

Fallah *et al.,* (9) showed increasing trend in age from younger to older participants causing values of interpeak latencies I-III, III-V& I-V to increase accordingly. Similar findings were reported by Harinder *et al.,* (10) for I-III & I-V IPLs but no significant difference for waves III-V interpeak latency was seen whereas, Rowe MJ reported increased wave I-III interpeak latency in older than in young people (11). These findings are contradicted by another study, observing no significant correlation between the age and the I-III IPL but reported small increase in III-V and I-V IPL with age as has been seen in our study also (12).

On the other hand, Stephen (13) found interpeak latencies were equivalent in the two age groups. Rosenhall *et al.,* (14) noted that with increasing age there was no significant change in the IPL I-V, however an increase of 0.1-0.2 msec was noted in the latency of the waves I, III and V Costa et al., (15) found that interpeak latency values do not increase with increasing age as has been seen in our study, in particular IPL I-II and I-III decrease, showing a negative r value and IPL I-V and II-V do not show a significant change. The study came to the conclusion that age-related changes are essentially a peripheral phenomenon, not affecting the central part of the acoustic pathway.

Khatoon *et al.,* (17) in the year 2012 recorded IPLs in the elderly population. The reasons for degenerative changes in the elderly could be atrophy of the auditory nerve, synaptic delay and peripheral hearing loss. Age also changes the permeability of the neural membrane along with neuronal loss, that may contribute to increased latency of the ABRs (10). It is not unreasonable to suggest therefore that the age differences that were found are not solely the result of ageing processes at the receptor organ and that changes in transmission or neuronal propagation within the brainstem may contribute to these age differences.

A recent study was done in the Indian population in the year 2017 to analyze the range of IPLs and amplitude in healthy normal persons aged between 1-73 years. It included 150 men and 145 women, where it was seen that IPL I-III was significantly higher in males aged more than 45 years on comparison to females of the same age. The value of IPL III-V and I-V were highest in the age group of 25-34 years and 1-14 years respectively. The findings of the study support the possible role of age and gender as a significant contributor to normal variation in the ABRs (18).

As can be seen from all these studies conducted so far, the changes in the interpeak latencies of ABRs with age are best considered equivocal and inconsistent.

Limitations of the study

1. The study was done in single institution of Delhi/NCR region so that limits us to generalize the results.
2. The second major limitation of the study was the small number of subjects.

CONCLUSION

Our study indicates that there is no significant change in the interpeak latencies of ABRs (I-III, I-V and III-V) with aging. However, the inter peak latencies have important diagnostic value since the interpretative accuracy of the evaluation of the ABRs can be enhanced only when these normal variations are taken into consideration with relevant case history information. One of the important limitations of our study could be the small number of subjects that were studied.

CONFLICT OF INTEREST

Authors declare no conflicts of interest.

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