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Original Research Article

Study of Brainstem Auditory Evoked Potentials in Normal Hearing Men and Women

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ABSTRACT

Background: Brainstem auditory evoked potentials (BAEPs) constitute important neuro-electro-physiological test of auditory brainstem function, i.e. the conduction of impulse from inner ear through auditory nerve and tracts to cortex. Age and gender influence on the BAEPs deserve keen appraisal for correct clinical application and inference. An attempt to examine these determinants is made

Method: BAEPs from either ear of normal hearing 44 men and 30 women in 18 year to 66 year age range were studied. Absolute peak latencies of waves I, III and V as well as inter peak latencies I-III, III-V and I-V were examined in reference to influence of age and gender.

Result: Women generally displayed lower latency profiles than men in all the studied wave peaks I, III and V. In right ear, such lower latencies of peak V and inter peak latency I-V were statistically significant. Women however, did not exhibit any age related tendencies in distribution of absolute peak latencies or inter peak latencies. Men displayed statistically insignificant age related prolongation in latencies of wave I and V and also inter peak latencies I-III and I-V.

Conclusion: Normal hearing subjects may not readily exhibit age related changes in BAEP parameters. Men did but women did not display tendency to age related changes in BAEP. Selection criteria of study subjects and sample size may be important determinants of significant inferences from BAEP studies.

Keywords: Brainstem auditory evoked potentials; Auditory pathway; Auditory processing; BERA.

INTRODUCTION

Evoked potentials are records of small electrical activity from scalp surface, in response to an auditory, visual or somatosensory stimulus. Source of these potentials are the electrical fields generated through activities of synaptic discharges and postsynaptic potentials of respective afferent neural tracts. The auditory evoked potentials are summative of electrical activities resulting from activation of VIIIth cranial auditory nerve, cochlear nucleus, the tracts and nuclei of the lateral lemniscus and inferior colliculus. The potentials span activity from full length of auditory pathway emerging at hair cells of organ of Corti and ending up in cerebral cortex. The electrical activity reflected and recorded from scalp in electroencephalograph following an acoustic stimulus, occurs within 10ms of stimulus application and is a short latency response. Brainstem auditory evoked potentials (BAEPs) can assess peripheral auditory function directly. This makes them useful tools of infant auditory screening. BAEPs are useful in objective determination of hearing threshold in subjects not able to participate in behavioural tests, e.g. infants,

handicapped individuals etc. BAEPs may be used also to monitor sensory profiles of cases of traumatic brain injury and intra-operatively. [(1)] In monitoring applications, the latencies of the major waves are observed over time and major changes outside statistical fluctuations are interpreted to help physiological evaluations.

BAEPs consist of a series of five positive waves occurring within 10ms, following the acoustic stimulus and are labeled I to V in Roman. The waves depict neuro-electrical activity generated sequentially by structures in auditory neural pathway. Apart from technical variables of stimulus, subject variables as gender, age, hormonal status, hearing status, body temperature e.t.c. can influence BAEP profile. [(2,3)] Peak latency and inter peak latency (IPL) of BAEP is often described to be affected by aging. [(4)]

MATERIALS AND METHODS

Present study was carried out at electrophysiology facility in otolaryngology Department of MGM Medical College, Navi Mumbai between October 2007 to October 2008. The study protocol was examined and approved by college research board. Over the period, subjects were recruited as volunteers from hospital staff and accomplices of the in-patients. They were thoroughly clinically examined, including otoscopy to exclude chronic ear and other diseases or any continuing medications for chronic diseases. Blood pressure was taken to exclude hypertensive, blood random sugar estimation and urea profiles were requisitioned and diabetes and renal dysfunction were ruled out.

Subjects were elaborately explained about the test procedures and study objective. After their informed consent was obtained they became study subjects. No disclosure of their identity without their concurrence was assured. Participants were hearing screened on pure tone audiometric test. Only those with hearing threshold equal to or below 20dB (decibels) at routine frequencies were included. In all, 74 subjects 44 men and 30 women participants were finally included in study. They were in age range of 18 years to 66 years (mean 36.31 years).

The BAEP study: The BAEP recording room was quiet and air-conditioned with temperature about 28°C. Electrode application followed 10/20 system of electrode placement with one channel setting. Silver chloride cup electrodes were attached on each ear lobule (A1/A2); at the vertex (Cz), as the reference electrode in 10/20 electrode placement system, and on the fore head (G), as the ground electrode. The site of application was cleaned with spirit. Conductive paste was applied to electrode and placed on prepared site. Recording was done using RMS EMG EP Mark 2 machine (RMS recorders and machine systems, Chandigarh, India).

Stimulation: Alternate clicks at repetition rate of 11.1/second were presented mono-aurally through earphone. Intensity of stimulus was 90dB. For each record computerized averaging was done. Each ear was separately tested. Two trials were given in each subject.

Peak latencies were measured for each ear, from the leading edge of the driving pulse to positive peaks. Peak amplitude was measured from the pre-stimulus baseline. The latencies of waves I, III, and V were selectively measured. Waves VI and VII were not clearly defined with the apparatus system.

The inter peak latencies (IPLs), between wave I-III; III-V and I-V were also measured from peak to peak of two defined waveforms and hearing threshold.

OBSERVATION AND RESULTS

Table.1: Absolute latencies of different peaks and their median values (men and women 148 ears combined)

Latency	Mean ±SD (ms)	Median Values in 148 ears
Absolute peak latencies		
Wave I	1.81 ±0.13	1.81
Wave III	3.92 ±0.18	3.89
Wave V	5.71 ±0.19	5.70
Inter peak latencies		
I-III	2.20 ±0.18	2.19
III-V	1.88 ±0.17	1.85
I-V	4.01 ±0.22	3.98

The profile of various peak latencies and inter peak latencies in BAEP from right and left ears in men and women, irrespective of age is presented in table.1.

Table 2: Gender and side wise BAEP parameters

Latency	Right ear (Mean ±SD (ms))		Left ear (Mean ±SD (ms))	
Absolute peak Latency	**Male**	**Female**	**Male**	**Female**
Wave I	1.83 ±0.13	1.81 ±0.15	1.82 ±0.13	1.82 ±0.16
Wave III	3.94 ±0.19	3.85 ±0.17	3.89 ±0.21	3.87 ±0.18
Wave V	5.78 ±0.22	5.62 ±0.1	5.74 ±0.2	5.68 ±0.24
Inter peak Latency				
I-III	2.22 ±0.18	2.20 ±0.17	2.18 ±0.15	2.17 ±0.18
III-V	1.92 ±0.18	1.76 ±0.17	1.88 ±0.16	1.74 ±0.16
I-V	4.31 ±0.30	3.88 ±0.21*	4.01 ±0.24	3.94 ±0.19

Although not statistically significant, women exhibited lesser peak latencies than men throughout. In right ear women have significantly lower wave V latency as well as I-V inter peak latency.

In table 3, Moods median analysis is presented of BAEP parameters distributed as per age above or below respective medians in men and women. Median age of 44 men was 43 years and age median of 30 women was 34 years. Similarly the median values of various BAEP parameters were found. Latencies of peak I, III and V have respective medians 1.81 ms, 3.89 ms and 5.7 ms. the median values were, 2.19 ms, 1.85ms and 3.98ms for inter peak latencies I-III, III-V and I-V respectively.

Table 3: Functional distribution of ear of relatively young and old male and female subjects under lesser or greater absolute peak latencies

	Men		Women	
	≤ 43 yrs	**> 43 yrs**	**≤ 43 yrs**	**> 43 yrs**
Ears (n)	45	43	32	28
Absolute peak latency				
Wave I, Median & lower	31	23	13	14
Wave I, Above median	14	20	19	14
Wave III, Median & lower	22	21	14	12
Wave III, Above median	23	22	18	16
Wave V, Median & lower	26	17	12	10
Wave V, Above median	19	26	20	18

Table 4: Functional distribution of ear of relatively young and old male and female subjects under lesser or greater interpeak latencies

	Men		Women	
	≤ 43 yrs	**> 43 yrs**	**≤ 43 yrs**	**> 43 yrs**
Ears (n)	45	43	32	28
Inter peak latency				
I-III, Median & lower	24	20	16	10
I-III, Above median	21	23	16	18
III-V, Median & lower	23	22	13	13
III-V, Above median	22	21	19	15
I-V, Median & lower	25	18	12	10
I-V, Above median	20	25	20	18

Men under the median age appear to cluster in lower latency profile of waveform I and V, and no such trend in waveform III. Women sample does not display any trend in the regard.

Males of relatively younger age again tended to be more in lower inter peak latencies I-III and I-V, the latter being quite prominent. Women sample did not display a pattern.

DISCUSSION

The generation and propagation of action potentials at various stages from auditory nerve to auditory cortex are represented by various peaks of BAEP. Peak I occurs at auditory nerve; peak II at cochlear nucleus; peak III at superior olivary complex; peak IV at lemniscus tracts; peak V at upper part of pons and lower midbrain; peak VI at medial geniculate body and peak VII due to

generator activity of the auditory anatomical relations. Peak VI and VII are not clinically employed. Only peaks I, III and V are in routine consideration in auditory evoked potential studies. [4]

Wave I latency measures electrophysiological activity of auditory nerve. Results do indicate insignificant direct relation of age and Wave I latency (auditory nerve electrophysiology) in men but not in women. Wave III latency indicates electrophysiology of superior olivary nuclei. In this study no variations either in men or women were indicated with different age groups of the subjects. Reports [5,6] that wave III latency increases with age, could not be substantiated by the finding. Wave V relates to electrophysiological activity of inferior colliculus. There are conflicting reports of wave V latency and aging relationship. As per some there is no relation. [7] Others suggest direct relation, [8,9] as suggested in men but not in women in this study.

Inter peak latency I-III denotes auditory nerve conduction through the subarachnoid space. The tendency of direct relation of this parameter in aging men is in agreement with reports [10] only partly, as women did not exhibit this. At the same time the observation conflicts with conclusion of no age relation of the parameter.[11] IPL III-V represents conduction time from lower pons to midbrain. No definite patterns emerged in our observations in relation to aging and gender. Reports [9,11] suggest prolongation of this parameter by aging. Others [10] did not find such relation, in line of current observations. IPL I-V indicates conduction from proximal auditory nerve through pons to midbrain. Majority of older men and women were associating above median inter peak I-V latencies, which is also suggested by Chu. [9] No such relation was supported by findings of others. [5,10,12]

BAEPs are employed to evaluate integrity of brainstem nuclei and peripheral auditory pathways. [13] The ear sides can differ in BAEP profile as per differing integrity of auditory tracts on two sides, and hence both ears were studied. Although fundamental values of BAEP parameters did not suggest variation, age related differences prominently occurred in right ear in women. Reports of varied factors affecting BAEP profile, like age, gender, hormonal status etc exist, however increased wave latencies in people above 60 year age are reported by many [5,14,15] and also denied. [7] Age related hearing loss shows up in BAEP as increased electrophysiological threshold, increased latencies and decreased wave amplitudes. [5,14] Studies that examined subjects without hearing loss did not find age related effect on absolute wave latencies. [7,16] Our selection criteria also demanded normal hearing and hence failure of finding significant age associations may be explained. There is of course deficit of sample size that may improve real chances of discovering truth, yet study indices may be usefully pursued for generating evidence base both for understanding the condition and for rational interventions.

CONCLUSION

BAEP studies may be influenced differently in normal hearing and hearing loss subjects by the age factor. Behaviorally dominant side also appeared to cast impact on BAEP from two ears. Adequate sample size and specific criteria of subject's selection may better settle the inferred statistically insignificant tendencies of BAEP change under various influences.

Conflict of interest statement

There are no conflicts among the authors.

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