Origin of each waveforms: [3,10,11,16-19]

Wave forms	*Genesis*
I	Cochlear division of VIII th cranial nerve
II	Cochlear nucleus
III	Superior olivary nucleus
IV	Lateral lemniscus
V	Inferior colliculus

The primary clinical application of the BAEP is the objective determination of hearing threshold in individuals who cannot participate in behavioral testing, such as infants and handicapped individuals. These are also used in monitoring traumatic brain injury patients and intraoperative monitoring. It helps to confirmation a localization of brainstem dysfunction. In addition, the BAEPs have ability to test peripheral auditory function directly has made it a valuable tool in infant hearing screening.[19]

Various factors affect on BAEP such as recording variables (electrodes, filters), stimulus variables (stimulus intensity, stimulus rate, stimulus mode, stimulus phase) and subject variables (age, sex, temperature, hearing status)[10,17] As it is mentioned in earlier studies, progression in age directly affect the peak latency and interpeak latency of BAEP.[17,19,20] Hence the present study was undertaken to analyze the effect of age on BAEP waves.

2. Material and Method

Present study was conducted at Electrophysiology Lab, Department of Physiology, Government Medical college, Bhavnagar after obtaining permission from Institutional Review board(IRB) of Government Medical college, Bhavnagar. In our study, 100 normal healthy subjects were assigned to the following age groups.

Group 1 : 15-24 yrs (M=25, F=25)
Group 2 : ≥45 yrs (M=25, F=25)

Subject was asked to sit comfortably, to be relaxed and reassured that the procedure is totally harmless. Written informed consent obtained from the subjects (>18 years) or from the legal guardians of the subjects (<18 years). A detailed history was taken to rule out any hearing impairment. Their height and weight were also taken. The recording was done in the sitting position with appropriate head positing so as to minimize postural muscle activity in the head and neck. BAEP was recorded by using PC-based machine RMS EMG EP MARK II. Electrodes are placed as per 10-20 International system of EEG electrode placement. Reference electrode was placed at Fz position on the forehead above Nasion. The Ground electrode was placed on vertex Cz and active electrode was placed on left and right mastoid of each ear. The electrode impedance was kept at 5 k ohm. A band pass of 100-3000Hz was used to filter out undesirable frequencies. BAEP was produced by a brief click that stimulates headphones at 11.1 per second at intensity of sound 60 dB. Computerized averaging was done. A series of five waves were recorded during the first 10 ms, following the sound stimulus. The absolutes latencies of the waves I to V and the interpeak latencies between the wave's I-III, I-V and III-V were recorded for each ear separately.

3. Result

The data was analysed statistically by using the Student's unpaired t test. Trial version of GraphPad InStat – [DATASET1.ISD] used for data analysis. p value of less than 0.05 considered statistically significant. The mean and standard deviation of the latency and interpeak latency in milliseconds are shown in Table 1 and 2.

Table 1: Comparison of latencies and interpeak latencies between Young & Older Males.(mean ±SD)

BAEP Waves	Young males	Older males	p value	Significant
I	1.70±0.17	1.81±0.13	0.0124	S
II	2.65±0.15	2.75±0.16	0.0182	S
III	3.70±0.18	3.86±0.13	0.0006	ES
IV	4.83±0.14	4.94±0.25	0.0536	NS
V	5.65±0.19	5.77±0.25	0.0591	NS
I-III	2.00±0.23	2.05±0.17	0.4177	NS
III-V	3.95±0.26	3.96±0.27	0.9149	NS
I-V	1.95±0.20	1.91±0.27	0.5639	NS

S: Significant, ES: Extremely Significant

Table 1 shows statistically significant difference in latency of wave I, II and III, when young males compared with older males. No significant differences were found in absolute latencies of wave IV, V and the interpeak latencies of waves I-III, I-V, III-V.

Table 2: Comparison of latencies and interpeak latencies between Young & Older Females

BAEP Waves	Young Females	Older Females	p value	Significant
I	1.62±0.15	1.77±0.18	0.0021	VS
II	2.53±0.28	2.80±0.15	0.0001	ES
III	3.55±0.15	3.71±0.31	0.0290	S
IV	4.72±0.18	4.84±0.20	0.0380	S
V	5.53±0.25	5.65±0.44	0.2340	NS
I-III	1.94±0.18	1.93±0.16	0.8775	NS
III-V	3.91±0.28	3.94±0.35	0.7850	NS
I-V	1.98±0.29	2.08±0.27	0.2053	NS

S: Significant, ES: Extremely Significant, VS: very significant

Table 2 shows the absolute latencies of waves I,II,III and IV were significantly increased in older females than in younger females. No significant differences were observed in latencies of waves V and interpeak latencies of I-III,I-V,III-V IPL.

4. Discussion

This study tested the influence of age on BAEP latencies in younger and older age groups. In present study, Table 1 shows that there were significant longer latencies for waves I, II and III in older males as compared to younger males. In Table 2 shows that there were significant differences found for waves I,II,III and IV in females. There were no

significant difference found for interpeak latencies in male and female with advancing age.

(a) Wave I :

Wave I latency which is a measure of electrophysiological activity of the eight nerve. In our study, wave I latency was significant longer in older age groups. Rowe[20], Stephen W H[21], Rosehhall U et al [22],Costa P et al[23], Fallah TM[17] and Oku and Hasegewa[24] also found latencies of wave I were progressively delay in the older participants due to peripheral processes. These studies support our findings.

(b) Wave II:

Wave II latency which is a measure of electrophysiological activity of cochlear nucleus. Table 1 and 2 shows that wave II latency was longer in older age groups. Julie V. Patterson et al[25] also found age effects for waves II in older persons compared to younger which is similar to our study. Harinder JS et al[4] and Maria Khatoon et al[26] found no significant difference for wave II in older adult compared to young adult.

(C) Wave III:

Wave II latency which is a measure of electrophysiological activity of superior olivary nuclei. Table 1 and 2 shows that wave III latency was longer in older age groups**.** Harinder JS et al[4], Fallah TM[17], Maria Khatoon et al[26] Rosehhall U et al[22], Oku and Hasegewa[24], Trune DR et al[27], H S Johannsen[28] and Martini et al[29] also reported that older adults had increased latency for wave III. These studies support our findings.

(d) Wave IV:

Harinder J S et al[4] also reported that no significant differences were found for wave IV between younger males and older males while the latency of wave IV showed an increasing trend with age in female which support our study.
H S Johannsen[28] observed significant long latency in older subjects for wave IV.

(e) Wave V:

Beagley and Sheldrake[30], Mogens Kjaer[31], T J Manjuran et al[32], Costa P et al[23], Lille F et al[33] also reported that no significant difference in latencies for wave V between subgroups of older and younger subjects which support our study. Maria Khatoon et al[34], Jarger & Hall[35], Nai-shin Chu[36] showed small progressive prolongation in the peak latency with increasing age particularly peak V.

(f) I-III IPL:

I-III IPL is measure of conduction from VIII nerve across subarachnoid space. Table 1 and 2 shows that no difference found between younger and older age groups. Nai-shin Chu[36], Oku and Hasegewa[24] and Costa et al[23] also noted that the interpeak latency values do not increase with increasing age, in particular I-III IPL decrease. Maria Khatoon et al[34], Fallah TM[17], Harinder JS et al[4] and Rowe[20] found prolongation of I-III IPL as the age is increasing from younger to older.

(g)III-V IPL:

III-V IPL is measure conduction from lower pons to midbrain. Table 1 and 2 shows no significant difference found with increasing age.

Costa et al[23] and Harinder JS[4] found no significant change in III-V IPL between younger and older subjects. Maria Khatoon et al[34], Fallah TM[17], Nai-Shin chu[36] and Uziel A et al[37] found prolongation of III-V IPL as the age is increasing from younger to older.

(h) I-V IPL:

I-V IPL is a measure of conduction from proximal VIII nerve through pons to midbrain. Table 1 and 2 shows no difference seen with increasing age. Stepehn WH[21], Roshenhall U et al[22] and Costa P et al[23] also noted that IPL I-V do not show a significant change which support our study.

Harinder JS et al[4] showed I-V IPL increased in older males as compared to the young males while no significant difference was observed in the I-V IPL when young females were compared with older females. The increased latencies which were observed in elderly individuals could be due to degenerative changes like auditory nerve atrophy, synaptic delay and peripheral hearing loss with age. Increasing age also causes neuronal loss and changes in the permeability of the neural membrane, which might have led to the increased latencies of the BAEP[4,34]

The latency prolongation of the BAEP components showed that the cognitive processing was affected with aging. Cognitive alterations which were observed with aging have been related to the dopaminergic and the cholinergic systems which play an important role in the process of cognition, because the number of mascarinic Ach receptors in the central nervous system and the activity of choline acetyltransferase in the nerve terminals were shown to decrease with aging. On the other hand, nigrostriatal axons, nigrostriatal dopaminergic neurons and strial endogenous dopaminergic concentration in the human brain and in the D2 dopamine receptor binding sites were found to decrease with age. So, the cognitive decline is found to have been caused by the deterioration of the dopaminergic and the cholinergic systems .Thus, cognitive decline occurs as age advances, which may be the reason for the changes in the BAEPs as age advances.[4,26]

Age related neuronal and structural changes within the human brainstem predict brainstem auditory evoked response differences. Findings regarding cell loss are contradictory but degenerative changes such as cell size and cell shape irregularities and accumulation of lipofusion pigments in the ventral cochlear nucleus, superior olivary nucleus, inferior colliculus, medial geniculate body and inferior olive. Degenerative changes in the myeline sheaths and axis cylinders of the structures.[26] Prolonged latency due to age may be progressive neural atrophy within peripheral and central auditory system with advanced age.[26]

5. Conclusion

Latencies and Interpeak latencies of BAEP have important diagnostic values. The results of this study shows that subject variable i.e Age have statistically significant influence on BAEP latencies. Therefore age can affect BAEP interpretation. Clinicians should consider them in clinical settings. It is recommended that in clinical practice, different norms be established for different age groups and genders.

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