

Road Traffic Noise and its Effect on Brain Stem Auditory Evoked Potentials in Traffic Policemen

Keywords: BAEP; Road traffic noise; Sound pressure level; Traffic policemen

Abstract

Background and objectives: A major contribution to the noise is vehicular noise. The traffic policemen engaged in controlling traffic noise, particularly at heavy traffic junctions, belong to the high risk group to be affected by health hazards of noise pollution. Among all objective methods of hearing evaluation, brainstem auditory evoked potential (BAEP) is considered the most used precocious potential on clinical practice. Objective was to measure BAEP in traffic policemen and compare it with normal controls.

Materials and methods: Study population included 30 traffic policemen manning road traffic and 30 age matched controls who were involved in administrative work. Sound pressure level of road traffic noise was measured using sound level meter. BAEP was recorded in traffic policemen and was compared to normal controls.

Results: Mean values of sound pressure level measured at various traffic junctions was 83.12±4.23 dB(A) compared to 65.10±0.47 dB(A) ($p < 0.001$) measured in and around medical college campus. Significant prolongation ($p < 0.05$) of all wave latencies (I, II, III, IV and V) of BAEPs with non significant prolongation of IPL I-III, III-V and I-V in traffic policemen as compared to controls.

Interpretation and conclusion: Long term exposure to vehicular noise of high sound pressure level resulted in prolongation of wave latencies of BAEP in traffic policemen compared to controls. Thus it is suggested that some preventive modalities for hearing conservation in the form of safety equipment, periodic check-ups (using audiometer, BAEP) and duty scheduling for exposure limitation can be suggested and awareness should be created among traffic policemen about the harmful effects of noise on hearing by implementing education and training programmes.

Introduction

Increasing urbanization has led to mounting volumes of noise. Noise has been a bane and seems to have altered the ecological balance. A major contribution to the noise is vehicular noise. Damage to cochlear hair cells from noise depends on the frequency, intensity and duration of exposure to noise as well as individual susceptibility. The traffic policemen engaged in controlling traffic noise, particularly at heavy traffic junctions, belong to the high risk group to be affected by health hazards of noise and air pollution [1].

Typically the BAEPs comprise of five or more waveforms that are recorded within 10 milli seconds of an acoustic stimulus. Wave I originates from peripheral portion of cranial nerve VIII (auditory nerve) near the cochlear nucleus. Wave II originates from cochlear nucleus, Wave III from superior olivary nucleus, Wave IV from lateral lemniscus and Wave V from inferior colliculi in the midbrain [2]. Among all objective methods of hearing evaluation, brainstem auditory evoked potential is considered the most used precocious potential on clinical practice [3]. The auditory evoked potentials are



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a simple and non-invasive tool to assess noise induced changes in auditory function especially retro cochlear conduction.

Few studies are carried out for evaluating the effect of noise on auditory function of traffic personnel unlike organized industrial sector where periodic checks by audiometer are carried out as per legal requirements and also studies carried out for evaluating the effects of noise on human BAEP are minimal. With this background, the study aimed to measure wave latency and inter-peak latencies of BAEP in traffic policemen and compare it with normal controls.

Materials and Methods

Study was conducted in the Department of Physiology of Sri Devaraj Urs Medical College, Kolar, Karnataka, India. Ethical clearance was obtained from Institutional Ethical Clearance Committee. The study group comprised of 60 neurologically normal healthy male adults aged between 25 and 55 years. Thirty traffic policemen manning road traffic of Kolar district, Karnataka were selected as the test group and the remaining 30 age matched participants involved in administrative work in medical college were considered as controls. Informed written consent was taken from the subjects. Self-structured questionnaire which included demographic characteristics, years of experience, quality of hearing, use of personal protective equipment's like ear plugs, ear muffs, complains of tinnitus, ear ache etc., was administered to all the participants. Subjects with history of chronic medical illness like diabetes, hypertension etc and history of use of ototoxic drugs like streptomycin, cisplatin, neomycin, gentamycin were excluded from the study.

Sound pressure level of road traffic noise was measured at various traffic junctions of Kolar city and within medical college campus using sound level meter 2231 type with the Front Plate BZ 7110 and software Module "M-11". Measurement was taken during peak traffic

hours i.e., between 11 am and 1 pm and between 4.30 pm to 6.30 pm.

BAEP was recorded in an electrically shielded room by using EMG RMS MARK II machine. Surface electrodes were placed with two active electrodes placed over both the mastoid processes, with a reference electrode placed over vertex, and ground electrode over the forehead. One cycle of 4-KHz sinusoids at an intensity of 90 decibels was delivered through head-phones with alternating phase at interval stimulus of 75 ms. Signals were amplified and band-pass filtered from 3 to 100 khz. Signals were analysed with sampling intervals of 10 micro seconds and for 10.24 mili seconds after stimulus onset. After averaging 2000 sweeps the signals were digitally band-pass filtered. Peak latencies of waves were automatically detected with a time resolution of 0.01 mili seconds to minimize measuring errors. The BAEP results were interpreted for the latencies of Waves I, II, III, IV, V and interpeak Latencies (IPL) I-III, III-V and I-V.

Head size of the subjects was evaluated by measuring distances from nasion toinion with measuring tape. Then the head circumference was normalized in all the subjects to avoid inter subject variability. BAEP wave latencies and inter peak latencies (IPLs) obtained in the traffic policemen were compared with the age matched controls. The data obtained from the study was statistically analysed.

Descriptive statistical analysis was carried out on this data. Results on continuous measurements are presented as mean+standard deviation. BAEP recording was compared between traffic policemen and age matched controls using students' unpaired t-test. Significance was assessed at 5% level of significance. SPSS version 16 was used for statistical analysis.

Results

The mean age of study population was 42.46+6.78 years with a range from 25 to 55 years. Mean+standard deviation of sound pressure level measured at various traffic junctions was 83.12+4.23 dB(A) compared to 65.10+0.47 dB(A) (p<0.001) measured in and around medical college campus. Number of years of exposure to noise among traffic policemen was 8.77±4.25 years. There were 26 traffic policemen exposed to noise for 4-10 years of duration and were 4 in number for >10 years of exposure to noise. None of the traffic policemen used personal protective equipment's like ear plugs/ear muffs to prevent exposure to noise. Only three (10%) of the subjects in test group felt that their hearing ability was average compared to none in control group. Tinnitus was complained by five subjects in the test group.

Table 1 depicts comparison of wave latencies and inter-peak latencies (IPL) in control and test group (traffic policemen). There was a significant prolongation (p<0.05) of all wave latencies (I, II, III, IV and V) of BAEPs with non significant prolongation of IPL I-III, III-V and I-V in traffic policemen as compared to controls.

Discussion

Louder the noise one is exposed to over a continued period of time, the faster it leads to hearing loss. Noise louder than 80 dB(A) is considered to be potentially hazardous and continued exposure to >85 dB(A) of noise may cause gradual but permanent damage to hearing [4]. BAEP is one of the audiological tool used when diagnosing individuals exposed to noise, chemical agents which are

Table 1: Comparison of wave latency and inter-peak latency of BAEP in traffic policemen and control group

BAEP	Side involved	Control Group (Mean+SD)	Test Group (Mean+SD)	p value
Wave Latency				
I (ms)	Left	1.75±0.03	1.86±0.22	<0.05
	Right	1.74±0.04	1.84±0.22	
II (ms)	Left	2.82±0.05	2.91±0.09	
	Right	2.83±0.07	2.92±0.09	
III (ms)	Left	3.76±0.02	3.81±0.05	
	Right	3.76±0.02	3.83±0.05	
IV(ms)	Left	5.16±0.02	5.22±0.03	
	Right	5.17±0.02	5.23±0.04	
IV (ms)	Left	5.75±0.02	5.83±0.08	
	Right	5.75±0.02	5.85±0.08	
Inter-peak Latencies				
I-III	Left	2.04±0.03	2.06±0.19	>0.05
	Right	2.02±0.03	2.04±0.18	
III-V	Left	1.99±0.03	2.11±0.05	
	Right	1.97±0.10	2.12±0.14	
I-V	Left	3.90±0.14	3.93±0.16	
	Right	3.89±0.15	3.92±0.17	

SD: Standard Deviation, BAEP: Brain stem auditory evoked potentials, ms: milliseconds.

the common causes of irreversible sensorineural hearing loss in both children and adults [5].

Our study showed a significant prolongation (p<0.05) of all wave latencies of BAEPs with non significant prolongation of inter-peak latencies (IPL) I-III, III-V and I-V in traffic policemen as compared to controls.

Absolute peak latencies of BAEP reflect the neural conduction velocity in the corresponding segment of auditory pathways. A delay in time of APL of wave I to wave V in traffic policemen suggest decreased conduction velocity both at the level of the auditory nerve and central auditory pathways in the brainstem [6].

Study by Gupta et al. showed significantly prolonged absolute peak latencies, IPL I-III and non significant prolongation of IPL (III-V, I-V) in traffic policemen posted at crowded traffic intersections as compared to the normal controls in residential areas in Delhi [6]. Workplace environment in a rubber factory contains various lipid soluble compounds (e.g. PAH and benzo[a] pyrene) which are also present in vehicular emission. Study on these workers has shown prolonged wave latencies of I, II, IV, V and prolonged IPL I-III [7]. Study by Emará et al. showed delayed latency of Wave I of BAEP after stimulation of both ear which was found in adults and children workers exposed to noise, in adults the mean±SD was 1.92±0.77 in right ear and it was 1.95±0.58 in left ear but the interpeak latencies

(I-III), (III-V) and (I-V) from both ears were normal in both adults and children workers [8].

The amount and type of direct hair cell damage depends on the intensity of the sound. Higher sound levels damage the outer hair cell stereocilia further, including destruction of the inter-cilial bridges, and recovery takes longer. Outer hair cells amplify the movement of the basilar membrane of the cochlea by contracting when stimulated by sound. This increases the stimulus delivered to the inner hair cells which transduce the mechanical movement to trigger a nervous impulse in the afferent nerve endings of the 8th nerve. If the outer hair cells are not functioning, greater stimulation is required to initiate a nervous impulse; thus the threshold sensitivity of the inner hair cells is raised which is perceived as a hearing loss [9]. One more explanation is; it is known that organ of Corti present two functional systems, one is of high intensity composed of internal ciliated cells (inner hair cells) connected to the largest part of afferent neural fibers and the another called of low intensity composed by external ciliated cells (outer hair cells), which constitute the cochlear amplifier and interact with the inner hair cells, soothing it in order to respond to low intensity stimuli. Therefore occurrence of such results on hearing losses can be justified by the fact that the acoustic stimulus reaching cochlear area gets weakened due to peripheral involvement, eliciting the responses of outer hair cells which do synopsis with only 10% of the afferent neural fibers and need some time to soothe the inner hair cells, enlarging the latencies of waves of BAEP [5].

Traffic constables play a very significant role in controlling the traffic system especially in the metropolitan cities despite several limitations and are affected by health hazards of noise. Our study concludes that long term exposure to vehicular noise of high sound pressure level might have resulted in prolongation of wave latencies of BAEP in traffic policemen compared to controls.

Limitations of the present study included less sample size and there was no follow up of the study to confirm the long term hazardous effects of noise pollution on traffic policemen.

Conclusion

This study concludes that high noise exposed subjects working at road traffic junctions of Kolar city showed alteration in BAEP indicating altered auditory conduction up to the level of the brainstem. BAEP is a simple, non-invasive technique which can be used for early detection of hearing loss. Therefore, periodic hearing assessments for

traffic policemen should be recommended. They should be provided with personal protective equipment's such as ear plugs, ear muffs and number of hours working at roads per day should be reduced. If policemen could undergo a duty rotation among the divisions within the Department of Police, rather than working long periods in a same division, it will be helpful to prevent long time exposure to noise by traffic policemen. Traffic policemen who are already suffering from NIHL should be transferred to a section where noise levels are not excessive [10]. Awareness should be created among traffic policemen about the harmful effects of noise on hearing by implementing education and training programmes. Research studies are needed on a large scale with follow up to detect the long term hazardous effects of noise.

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