

BRAINSTEM AUDITORY EVOKED POTENTIALS AMONG RUBBER FACTORY WORKERS

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Abstract : The study was conducted on 27 rubber factory workers for the functional assessment of brainstem auditory pathway. Neurobehavioural questionnaire was administered to the workers and the personal sampler was used to evaluate the respirable particulate load inhaled per day of each worker along with qualitative analysis for PAH compounds. Evoked potential recording was carried out for brainstem auditory responses. Chest X-rays of workers exhibited varied abnormal features. Multiple regression analysis of data showed definite prolongation of latencies with increasing concentration of respirable particulate load though it was not statistically significant. Comparison with normative data indicated prolongation of latencies of rubber factory workers.

Key words : brainstem auditory evoked potential (BAEPs)
polycyclic aromatic hydrocarbon (PAH) rubber factory

INTRODUCTION

The process involved in manufacture of tyres and tubes consists of processing, curing and talc areas (1). During these, raw materials including number of chemicals mostly in the powder form are added in the furnace and entire procedure is carried out at high temperature and pressure, emitting lots of fumes and vapours (2). Consequently workers are exposed to different combinations of airborne contaminants. These various organic compounds such as n-hexane are known for their neurotoxic effects as they are capable of crossing the blood brain barrier due to their high lipid soluble nature (3, 4, 5). Chronic

exposure to such compounds can lead to demyelination of sensory tracts producing deterioration of higher CNS functions like intelligence, attention, learning, memory and the personality of the individuals (6). Progressive demyelination in certain vulnerable areas of brain results in dissociated functions including delayed conduction in sensory pathways. The prevalence of neurobehavioural disorders related to pollutant exposure at workplace can be significantly reduced only if the involvement of CNS can be detected at an earlier or subclinical stage. This could be done by using non-invasive electrophysiological techniques in the form of recording evoked potentials. These

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potentials have a high temporal resolution in the range of milliseconds, thus permitting the study of dynamic changes occurring in the brain (7, 8). On literature survey very few such studies are available and therefore, we conducted this study of BAEPs to detect central nervous system involvement in rubber factory workers.

METHODS

Rubber factory workers (n 27, male) of east Delhi having mean age of 34.30 ± 8.22 years were selected for the present study. The workers were selected randomly from rubber factory and they were involved in different sections of rubber tyre tube manufacturing process. Comprehensive questionnaire for neurobehavioural parameters and smoking habits was worked out for each worker. Recalling capability was used for diagnosing memory defects and step test with open and closed eyes was used for detecting co-ordination disorders. BAEPs were carried out on 22 workers only as 5 were having hearing impairment and were thus excluded. The subjects were tested monoaurally by a click stimulus 70 dB above normal hearing threshold, of 0.1 msec duration with presentation rate of 10/sec. Masking of other ear was done by white noise-40dB nHL. Positive electrode was placed at CZ referenced to ipsilateral ear lobe. Electrode hook up and other technical details were as per our earlier study (9). Total of 2 trials (2048 clicks each trial) were given and the response amplified by evoked potential recorder (Nihon Kohden, Japan) for the calculation of latencies of waves I to V, amplitude of waves V and I and interpeak latencies I-III, III-V and I-V. Besides this respirable particulate load was

assessed for each worker using personal sampler (Envirotec Pvt. Ltd., Delhi) having flow rate of 2 L/m^3 . The sampling was done for total duration of 8 hrs. The collected samples were subjected to qualitative and quantitative analysis for PAH compounds at Central Pollution Board by gas chromatographic procedures. Besides this the chest X-ray examination of all the workers was done. Multiple regression analysis of the data was carried out to find correlation between BAEPs (dependent variable) and particulate load (independent variable) inhaled per day by using SPSS PC package.

RESULTS

Mean age of workers ranged from 34.30 ± 8.22 years. The mean height and weight were recorded as 165.78 ± 5.88 cm and 54.70 ± 9.37 kg respectively. The total number of working hours/day for which the workers were engaged ranged from 6.53 ± 3.16 hr. Mean duration of work was 7.56 ± 5.58 years. Analysis of collected samples from factory area showed particulate load concentration of 2.41 mg/m^3 . 22% of the rubber factory workers gave positive history of smoking. On neurobehavioural assessment, majority of workers complained of fatigue (62%), memory loss (33%) and headaches during weekends and holidays (37%). Table I represents the data pertaining to BAEPs, depicting latencies of waves I to V, inter peak latencies I-III, III-V and I-V along with amplitude of waves V and I. Multiple regression analysis of the latencies and amplitudes of BAEP waves with respirable particulate load (Table II) did not show any statistical significant association, but on comparing the values of

TABLE I : Data indicating mean \pm SD of absolute peak latencies and amplitudes of BAEPs in rubber factory workers (n=22).

BAEP Parameters	Rubber factory workers		Normal* individual (n=132)
	Left ear (Mean \pm SD) (n=22)	Right ear (Mean \pm SD) (n=22)	
Peak Latencies (ms)			
Wave I	1.74 \pm 0.16	1.62 \pm 0.13	1.60 \pm 0.13
Wave II	2.74 \pm 0.22	2.71 \pm 0.21	2.64 \pm 0.14
Wave III	3.86 \pm 0.20	3.75 \pm 0.25	3.96 \pm 0.17
Wave IV	4.98 \pm 0.26	4.89 \pm 0.29	4.86 \pm 0.24
Wave V	5.70 \pm 0.39	5.59 \pm 0.31	5.56 \pm 0.24
Amplitude (μv)			
Wave V	0.25 \pm 0.11	0.28 \pm 0.12	0.31 \pm 0.14
Wave I	0.16 \pm 0.06	0.23 \pm 0.09	0.16 \pm 0.07
Inter Peak Latencies (ms)			
I - III	2.13 \pm 0.21	2.12 \pm 0.18	2.11 \pm 0.13
III - V	1.84 \pm 0.29	1.86 \pm 0.19	1.84 \pm 0.18
I - V	3.97 \pm 0.40	3.98 \pm 0.25	4.01 \pm 0.22

*Normal reference values from our lab.
Significant P value <0.01

TABLE II : Correlation coefficients (r) of particulate load with absolute peak latencies and amplitude of BAEPs in rubber factory workers (n=22).

BAEP Parameters	Particulate Load	
	Left ear r (n=22)	Right ear r (n=22)
Peak Latencies (ms)		
Wave I	0.00231	0.09816
Wave II	0.00010	0.09627
Wave III	0.00017	0.03750
Wave IV	0.02444	0.00675
Wave V	0.05479	0.06107
Amplitude (μv)		
Wave V	0.00591	0.00591
Wave I	0.03861	0.03861
Interpeak Latencies (ms)		
I-III	0.00170	0.00365
III-V	0.09162	0.01979
I-V	0.05868	0.02848

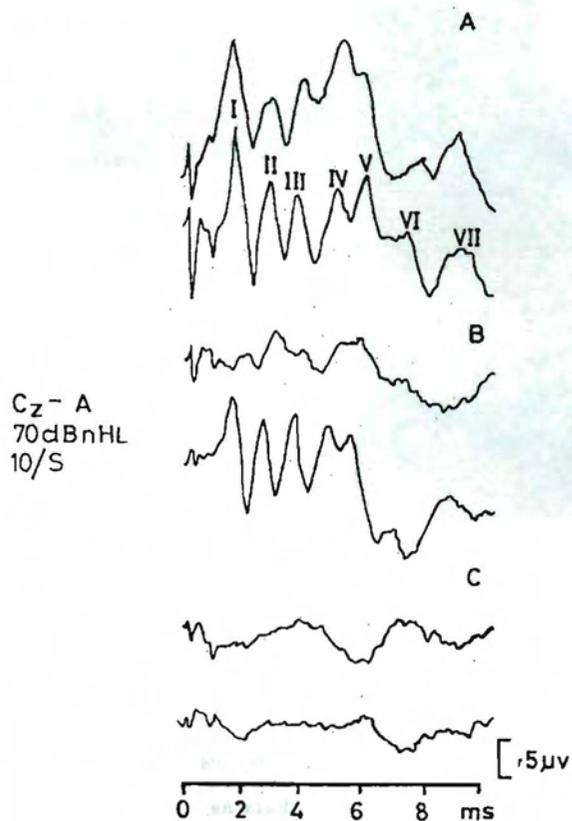


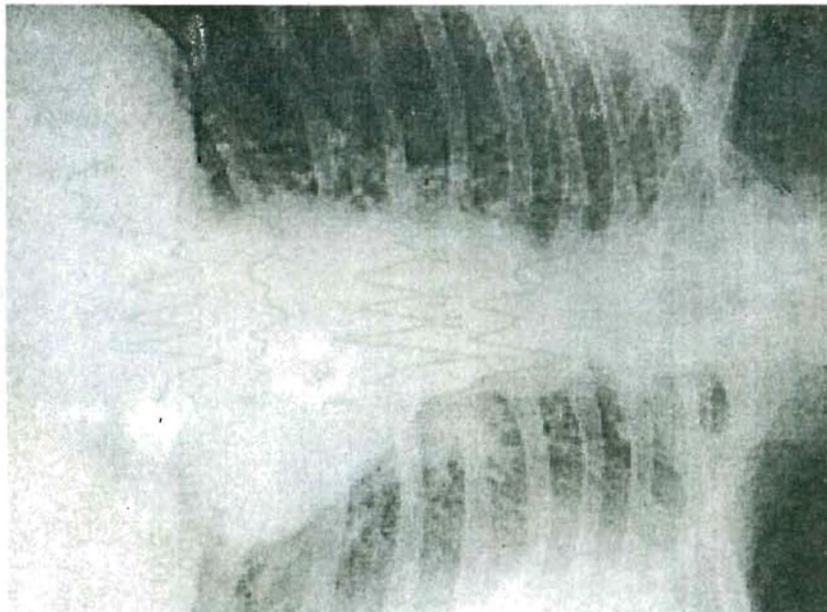
Fig. 1 : Representative records of BAEPs in rubber factory workers.

- A - Normal BAEP
- B - Unilateral abnormality in BAEP, absence of wave I and delayed, low amplitude of wave V (SBS)
- C - Bilateral abnormality of BAEP - no definite waveform (BG) seen.

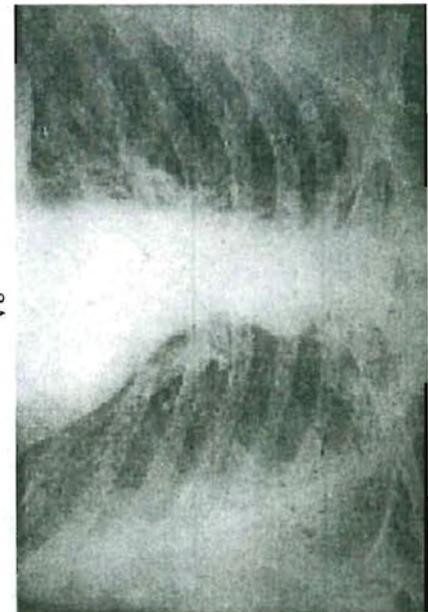
TABLE III : Data depicting latencies and interpeak latencies of BAEPs beyond 95% & 99% TL in some of rubber factory workers, along with particulate load & PAH compounds in work place environment (n=22).

S. No.	Name	Age (yr)	Particulate Load (mg/m^3)	DOW (yr)	PAH Benzanthracene (ng/m^3)	DOS (yr)	Ear	BAEPs							
								Latencies (ms)				Interpeak Latencies (ms)			
								I	II	III	IV	V	I-III	III-V	I-V
1.	SBS	35	1.296	2	1420.7	13	L	1.96*	2.96*	3.88	5.08*	5.68	1.92	1.80	3.72
							R	1.48	2.48	3.52	4.64	5.40	2.00	1.88	3.40
2.	RAY	32	2.0833	22	81.6	12	L	1.96*	3.00*	3.96	5.03*	5.84	1.96	1.92	3.88
							R	1.64	2.64	3.60	4.28	5.40	1.92	1.84	3.76
3.	JPC	26	1.562	2	241.1	20	L	1.92*	3.00*	3.96	4.68	5.64	2.04	1.73	3.76
							R	1.52	2.64	3.72	4.58	5.36	2.76*	1.68	3.84
4.	RC	40	1.0416	6	179.5	-	L	1.68	2.88	3.88	5.00*	5.68	2.16	1.88	4.04
							R	1.92*	3.16**	3.92	5.28	6.28*	2.72**	1.84	3.96
5.	CS	55	1.0416	7	668.6	49	L	1.52	2.20	4.24	5.24	6.88**	2.32*	2.68**	5.36**
							R	1.76	2.46	4.20	5.20	5.84	2.36*	2.68**	4.04
							95% TL	1.86	2.92	4.28	5.32	6.04	2.23	2.17	4.34
							99% TL	1.99	3.06	4.47	5.51	6.28	2.50	2.31	4.54

DOW-Duration of work; DOS-Duration of smoking; *-Beyond 95% Tolerance Limit (TL); **-Beyond 99% Tolerance Limit (TL)



2B



2A

Fig. 2A : Prominent Bronchovascular markings and patchy opacities in both middle and lower zones (SBS*).
 2B : Prominent bronchovascular markings and reticulonodular opacities in both lower zone (BG*)
 * Name of the workers as shown in Table III.

BAEPs with our normative data (7) a few workers showed latencies beyond 95% or 99% tolerance limit (Table III). These workers showing abnormal BAEPs had higher concentration of particulate load, Benzanthracene along with long duration of working (DOW) and smoking history (DOS). Fig. 1 shows the representative recordings of BAEPs of factory workers. PA view of chest X-ray of factory workers (SBS & BG) who also showed abnormal BAEPs (Fig. 1B & C) are given in Fig. 2A and 2B respectively. The chest X-ray of SBS showed prominent broncho vascular markings and patchy opacities in both middle and lower zones (Fig. 2A) whereas of B.G. reflects the prominent bronchovascular markings and reticulonodular opacities in both lower zones (Fig. 2B).

DISCUSSION

The manufacture of rubber products involves a variety of solvents, accelerators, activators, pigment organic compounds, etc. Many of these solvents due to their lipophilic nature are known neurotoxic compounds. These organic compounds in rubber industries have the potential to cause brain damage. These compounds have impact on both peripheral and central nervous system causing demyelination of various sensory tracts. The highly lipid soluble nature of these compounds is responsible for their ability of crossing the competent blood brain barrier and producing damage to fatty acid constituents of myelin sheath (10, 11, 12). The resultant demyelination can be reversed only if detected at subclinical stage, saving many workers from becoming victims of sensory damage in brain. Stimulus related evoked

responses such as brainstem auditory evoked potentials are capable of detecting subtle changes in central nervous system even before they become clinically manifest and thus they are very helpful in evaluating the functional integrity of various sensory pathways. Keeping these facts in mind, we studied brainstem auditory responses of rubber factory workers and compared our results with normative data of our laboratory carried out earlier in similar age group subjects (9). On comparison, it can be observed that some rubber factory workers had prolonged latency of waves and interpeak latencies beyond 95% and 99% TL (Table III). The possible explanation can be attributed to long duration of working and smoking history along with particulate inhalation consisting of PAH compounds.

As BAEPs represent series of potentials corresponding to sequential activation of peripheral medullopontine, pontine and mid brain portions respectively (7), any prolongation of latencies are indicative of delayed conduction in brainstem auditory pathway. On statistical analysis of our data though we did not see any significant correlation of BAEPs with respirable particulate load in subjects however, the abnormal BAEPs records of some workers having definite prolongation of latencies and interpeak latencies (Table III), presenting with complaints like fatigue and headache and chest X-ray abnormalities (Fig. 2A & 2B) showed association with high levels of Benzanthracene, one of the PAH compounds in workplace environment of these factory workers. Our results have been supported by other studies reporting median nerve somatosensory evoked potentials (SEPs) &

visual evoked potentials (VEP) of rubber factory workers (13, 14). They have shown prolongation of latencies of SEPs and P1 in VEP suggesting that this hazardous factory environment does affect the integrity of generators of SEPs located at thalamocortical level and conduction in visual pathways (14). Another study reflected deviation in auditory pathway caused by toluene exposure due to smoking habits (15). The abnormal X-rays along with deviated BAEP responses probably explain the route and the hazardous effect of PAH compounds crossing the blood brain barrier via respiratory system (16, 17). Therefore it is inferred that rubber factory environment is highly hazardous in

affecting CNS along with other vital system of the body. Though we do not have the facilities to identify the culprit chemical inducing changes in BAEP, it is therefore, suggested that these types of chemical lesions due to neurotoxicity of ambient factory pollutants should be ascertained in larger samples.

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