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EFFECT OF SOJOURN AT ALTITUDE OF 3,500 M ON AUDITORY EVOKED POTENTIAL IN MAN

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Abstract : Auditory evoked potentials were studied on 27 male subjects to evaluate the effect of sojourn at high altitude (HA). They were initially studied at Delhi (260 m) for their auditory evoked potentials and were then flown to an altitude of 3,500 m. During their stay at HA the same parameter was tested twice, once on the second day of arrival at HA and another on 21st day of stay. Then they were flown back to sea level (SL) and were retested on the third day of return. The results showed a significant delay in the peak latency of wave I of both the right and left ears on the second day of arrival at HA with a persistent delay in wave V even after 3 days of return to SL. The results suggest that HA stress caused a delay in sensory conduction at the cochlear level during the first week of induction, which was normalised during further stay.

Key words : auditory evoked potentials; high altitude; peak latency; interpeak latency

INTRODUCTION

High altitude (HA) hypoxia is known to cause sleep disturbance (1) and decline in appetite (2). Those manifesting the symptoms of Acute Mountain Sickness (AMS) may have more cerebral symptoms like headache, nausea and vomiting. Though various suggestions have been put forward for the disturbances (3) most studies have failed to provide evidences for any underlying neurophysiological mechanism. It has been mentioned that various sensory organs are involved in manifestation for the prevailing systems at HA (4).

The sensory receptors that are most likely to be affected at HA are the auditory and visual receptors. Sohmer et al., (5) showed no variation in peak latency of brainstem auditory evoked potentials in short term exposure to hypoxia. Carlile et al. (6) found a slight increase in peak V latency. After short term exposure to a simulated altitude of 5148 m, shortening of I-V interval in the recovery period has been reported (1). Most of the studies have been carried out either in a simulated environment or during acute exposure to HA stress. Hence an effort has been made in this study to evaluate the effects of sojourn to an altitude of 3,500 m on the auditory evoked potential in man.

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METHODS

Twenty seven healthy men in the age group between 20–28 yrs with mean age of 25.4 ± 4.78 volunteered for the study. They were informed about the procedure and protocol of the study and informed consent was obtained. They were first tested at the laboratory maintained at 25 ± 2°C at Delhi (260 m). Then they were airlifted at an altitude of 3,500 m somewhere in Western Himalayas. At this altitude they were tested twice, once on the 2nd day of arrival at HA and other on the 21st day of stay at HA. The laboratory was maintained at a temperature of 25 ± 2°C. They were then flown back to sea level (Delhi) and retested on the 3rd day of their return.

Brainstem auditory evoked reponse (BAER)

Recording of BAER was carried out in a quiet and dimly lit room with subject in a comfortable supine position. Electrodes were attached at the vertex (Cz) and the Ear lobes, with the ipsilateral lobe serving as the reference and the contralateral lobe as the ground. Monaural auditory stimuli consisting of clicks of 100 µs square pulse were delivered through an electrically shielded earphone at a rate of 15/sec. The intensity was 70 dB above the click hearing threshold level (HL).

The evoked electrical activity was amplified 10,000 times. A band pass of 150–3000 HZ was used to filter out the undesired frequencies and the response to 2000 click presentations were averaged for 10 msec sweep time by a computer averager Nicolet Compact-4 (USA) and printed on paper by the printer. At least two trials were obtained from each side of stimulation to ensure reproducibility of the responses. The peak latencies of wave I, III and V, the interpeak latencies of I–III, III–V and I–V were analysed. The method used for recording the BAER was similar to one reported earlier from our laboratory (5).

Statistical analyses were carried out using Student's t-test.

RESULTS

The representative recording of BAER of a sojourner (SR) is shown in Fig. 1. The latencies and the interpeak latencies of the

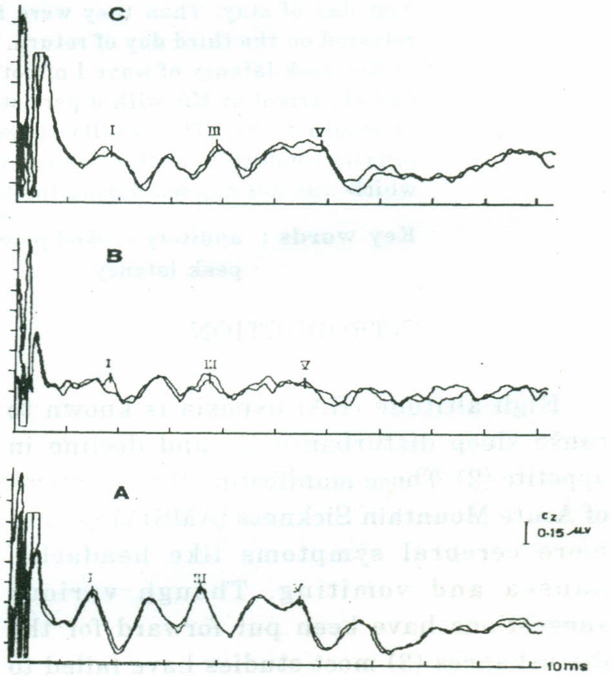

Fig. 1: Showing the BAER of a sojourner: (A) initially at sea level (SL), (B) at 3,500 m altitude, and (C) on return to SL. The figure is a sample representative record of one subject, and shows an increase in peak I latency at HA and in peak V latency after return to SL.

TABLE I : Right ear auditory brainstem response at different locations.

	Peak latencies (ms)			Interpeak latencies (ms)		
	I	III	V	I–III	III–V	I–V
At Delhi	1.79±0.169	3.89±0.157	5.73±0.254	2.11±0.181	1.83±0.186	3.90±0.373
Ist week at 3,500 M	1.88±0.161*	3.89±0.189	5.69±0.398	2.16±0.902	1.91±0.230	3.89±0.285
3rd week at 3,500 M	1.88±0.157*	3.82±0.246	5.67±0.392	2.14±0.914	1.92±0.267	3.87±0.284
Return to Sea Level	1.84±0.155	3.92±0.177	5.79±0.246*	2.08±0.176	1.88±0.296	3.92±0.327

Values are mean ± SD
*P<0.05

TABLE II : Left ear auditory brainstem response at different locations.

	Peak latencies (ms)			Interpeak latencies (ms)		
	I	III	V	I–III	III–V	I–V
at Delhi	1.78±0.138	3.90±0.198	5.70±0.287	2.12±0.196	1.80±0.227	3.93±0.323
Ist week at 3,500 M	1.88±0.154*	3.85±0.309	5.74±0.243	2.00±0.270	1.86±0.179	3.86±0.292
3rd week at 3,500 M	1.85±0.173	3.90±0.286	5.75±0.247	2.05±0.315	1.85±0.351	3.89±0.302
Return to sea level	1.81±0.151	3.87±0.213	5.77±0.281**	2.06±0.217	1.90±0.335	3.96±0.298

Values are mean ± SD
*P<0.05; **P<0.01

right and left ear BAER of the subjects at sea level (SL) in the 1st and 3rd week of stay at HA and after their return to SL are given in Tables I and II. The peak latency of wave I was significantly increased (P<0.05) in both right and left ear BAERs in the 1st week of stay at HA but the peak latency of wave V was found to be significantly increased (P<0.05) only after the subjects returned to SL. The interpeak latencies, however showed no significant change in either ear.

DISCUSSION

The right and left BAER peak latencies at the basal level did not show any difference and are well within the values found by Tandon (7). But the peak latency of wave I of both the right and left BAER was significantly increased (P<0.05) during first week of stay at HA. Sohmer et al. (8) found no change in BAERs latency and amplitude in subjects breathing a hypoxic gas mixture. In their experiments the subjects were exposed to hypoxia for a very short time. But in the present study the subjects were exposed to natural altitude environment for about 3 weeks and then brought back to SL. Hypoxic conditions prevailing at HA caused a block at the receptor level, that is cochlea (9) which persist for a few days even on return to SL as is evident from the delay in peak V latency recorded immediately after the subjects were brought back to SL. Carlile et al (3) found a short prolongation of wave V during a 20 minute exposure to mild hypoxia by breathing gas mixture.

In another study on chronic altitude hypoxia Carlile et al. (3) showed that wave V latency was prolonged after a 24 hrs ascent from 1300 m to 3900 m. After 72 h at the latter altitude, wave V latency returned to normal value. No further change was observed after the second rapid ascent from 3500 m to 4310 m. Increases in wave V latency during hypoxia were thus interpreted in terms of decline in auditory sensitivity. In Deecke's experiment (4) based on gas mixture breathing, both hypoxia and hypercapnia were involved and a positive correlation was found between the relative increase in PaCO2 and the increase in long latency cortical auditory evoked components. Hypercapnia is known to induce neural hyperpolarization and decrease excitability (6). In our experiments at HA, hypoxaemia induced respiratory alkalosis (10, 11) could be an important factor for the observed latency increase in wave V, since the neural excitability is altered indicating that the auditory nervous system modification occurs as a result of altitude induction though we have not measured blood PCO2 in this study. These findings suggest a decline in the cochlear sensitivity during the acute phase of induction at HA, which improve after one week of acclimatization.

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