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RESEARCH ARTICLE

Visual evoked potential changes among security guards of Government Medical College and New Civil Hospital, Surat

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ABSTRACT

Background: Sleep interruption and disturbance of circadian rhythm are inevitable phenomena among night shift workers. A very few evidence is available that describing effects of sleep disturbance and its effect on the visual pathway by measuring the visual evoke potential parameters. **Aims and Objectives:** To study the change in visual evoked potential (VEP) due to disturbance of circadian rhythm among rotating shift workers. **Materials and Methods:** This cross-sectional study was done on 80 security guards of 20-40 years of age working in Government Medical College and New Civil Hospital of Surat. They were divided into two groups comprising of 40 participants. Group 1 comprised of 40 security guards who did rotating night shift for more than 6 months and Group 2 include 40 security guards who did not perform any night shift duty for the past 2 years. VEP test was done, and results of both groups were compared with each other. **Result:** The result showed that there was statistically significant ($P < 0.05$) prolongation of P100 latency in rotating shift workers compared to day workers. The amplitude of P100 decreases in shift worker while comparing both the groups, but it was statistically insignificant ($P > 0.05$). Pearson correlation revealed, as the head circumference increases, latency of VEP increases, and amplitude decreases. **Conclusion:** Alteration in circadian rhythm affected the parameters of VEP in a negative way. In long-term, it may impair their general health. Furthermore, further study is required to support this conclusion.

KEY WORDS: Circadian Rhythm; Sleep Deprivation; Security Guards; Visual Evoked Potential

INTRODUCTION

The circadian rhythm is a cycle of biochemical, physiological, and behavioral processes coordinated by the suprachiasmatic nucleus (SCN) of the anterior hypothalamus, which regulates the release of melatonin from the pineal gland to maintain the sleep/wake cycle.[1] Due to this regulatory mechanism, a person can wake up in time for their routine needs to do with sunrise and fall asleep at night at the specific time of each day.[2]

Sleep disruption is unavoidable phenomena in rotating shift workers where night duty is involved for continuous availability of essential services such as medical, transport, and security services.[3] This day and night alternating shift work mostly changes each week. In such situation, sometimes, the body is unable to adjust to these external changes of each week and one's schedule of sleep-wake cycle is constantly

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disturbed. The main physiological consequence of such shift schedules is disruption of circadian rhythm which can have a deleterious effect on performance, sleep patterns, accident rates, and mental and physical health.[3] Psychological disturbances during night shift work were associated with altered cardiovascular and endocrine responses in healthy individuals.[4]

Visual evoked potential (VEP) is the electrical potential differences recorded from the scalp in response to visual stimuli.[1,5] The VEP studies provide an objective and sensitive method for documenting the abnormalities in the visual pathway, especially anterior to optic chiasma.[1] VEP depends on a large number of factors such as age, gender, eye dominance, eye movement, visual acuity, level of arousal, pattern luminance, pattern contrast, pattern reversal frequency, type of stimulation, size of visual field, and pupillary diameter.[6,7] Changes in the circadian pattern may affect pupillary diameter.[6]

Earlier many studies were done to assess the effect of sleep deprivation and shift work on reaction time.[1,8] Only one study showed the effect of rotating shift work on VEP.[1,9] Hence, with the aim of adding more evidence regarding the change in VEP due to the disturbance of circadian rhythm among rotating shift workers, this study was planned.

MATERIALS AND METHODS

Study measurement was recorded in the research laboratory of the Department of Physiology, Government Medical College, Surat. This was a cross-sectional study. The entire study was conducted over a period of 6 months after getting institutional approval from the Human Research Ethics Committee.

Inclusion Criteria

A total of 80 healthy asymptomatic male security guards of 20-40 years of age working in Government Medical College and New Civil Hospital of Surat were included. Participants were divided into two groups. Group 1 included 40 security guards who were doing rotating night shift duties more than 6 months, and Group 2 included 40 security guards who have not done any night shift duty at least for the past 2 years.

Exclusion Criteria

Participants with psychiatric and neurologic disorders, chronic alcoholics, smokers, individuals with visual field defects, and color blindness and participants on mydriatics/miotic drugs having diabetes mellitus or other metabolic disorders.

Procedure

Individuals were previously advised to avoid hairspray or oil after the last hair wash. They were asked to come to the physiology laboratory at 8 am after completing the night duty and having a light breakfast. Purpose of the study and procedure of measuring VEP were explained to all the study participants and written informed consent was taken. A complete neurological and ophthalmological examination was done, and a detailed clinical history was taken in which age of the participants and duration of the shift work were also noted. The height (cm), weight (kg), blood pressure (mm of Hg), and head circumference (HC) of the individuals were measured as a part of the general examination, and body mass index (BMI) was calculated as weight (kg)/height (m^2).

Pattern reversal VEP was performed on neurostim electromyography/nerve conduction velocity/EP system. Individuals were asked to sit 100 cm away from a video monitor with a 30 cm screen size. The video monitor presented a black and white checkerboard pattern with a red fixation spot in the center of the screen. The mean luminance of central field was 50 cd/m^2 and background luminance was 30 cd/m^2 and the contrast was 80%. The scalp skin was prepared by abrading and degreasing. Standard disc surface electrodes were placed according to the International 10/20 system of electrode placement using conductive jelly. The recording electrode was placed at Oz (10% from inion), the reference electrode at Fpz (10% from nasion), and the ground electrode at the vertex Cz.

Pattern reversal stimulation was given to each eye one after another. The rate of pattern reversal was 1 Hz. The recording sensitivity was kept at 5μV. The electrode impedance was kept below 5kΩ. The sweep duration was maintained at 200 ms, signals recorded were filtered by low cut and high cut frequency filter through a bandpass of 2-200 Hz. Responses to 200 stimuli were amplified and averaged for each eye.[10] Recordings were done and data were collected for each study group separately. The measured parameters were latencies of N75, P100, N145 waves, and peak-to-peak amplitude of P100 wave.[10,11]

Statistical Analysis

Data were recorded and entered into MS Excel and analyzed with SPSS software version 16. Data were represented as mean ± standard deviation. Unpaired Student *t*-test was used to compare the means of VEP between the two study groups. Pearson correlation was applied to know the change in latency and amplitude of VEP with respect to increase in HC. $P < 0.05$ was considered for statistical significance.

RESULT

Table 1 depicts the demographic details of study participants. While comparing HC, age, and BMI, the result of the test is statistically insignificant ($P > 0.05$), showing that both the groups were comparable to each other.

Table 2 shows comparisons of latencies of VEP in the right eye of both groups, there was significant prolongation of P100 latency in shift worker compared to day worker, and the difference is also statistically significant ($P < 0.05$). The amplitude of P100 decreases in shift worker while comparing both the groups but the data are not statistically significant ($P > 0.05$) (Figures 1 and 2).

Measurement of the latency and amplitude for the left eye is described in Table 3. It shows that statistically significant ($P < 0.05$) increase in latency among shift worker. The amplitude of the left eye decreases in shift worker, but the result is not statistically significant ($P > 0.05$) (Figures 1 and 2).

Pearson correlation in Table 4 is showing that as the HC increases, latency of VEP increases, and amplitude decreases. For each 1 cm increases in HC 0.166 ms and 0.031 ms of latency increases in the left and right eye, respectively. Amplitude decreases by 0.074 mV and 0.152 mV with an increase of HC of 1 cm.

DISCUSSION

The VEP is the measurement of visual function monitored at the level of the occipital cortex with scalp electrodes. The typical early visual components consist of P100 (a positive component peaking 100 milliseconds after the stimulus), N75, and N145 (a negative component 75 and 145 ms, respectively) elicited over occipital areas of the scalp.[12,13] The P100 is believed to reflect the activation of the primary visual cortex and is related to spatial attentive processes.[14,15]

In the present study, N75, P100, and N 145 latencies were found to be prolonged in the right and left eyes of rotating shift workers which were statistically significant ($P > 0.05$) when compared to the day workers (Tables 2 and 3). P100 wave amplitude was found to be decreased in night shift workers as compared to day workers. However, the difference between the groups was statistically insignificant ($P < 0.05$). Prolongation of latency suggests some clinical abnormality is present in rotating shift workers. The findings of our study are consistent with the results of a study done by Hemamalini et al., who found that rotating night shift workers who are more prone to alteration in circadian rhythm have prolonged latency of VEP.[1]

The retina of the eye also comprises of a distinctive division of cells other than rods and cones are known as intrinsically photosensitive retinal ganglion cells (ipRGCs). It provides irradiance input to the SCN along with the retinohypothalamic tract,[15] and acts as a relay for extrinsic dark and light signals from the rod and cone photoreceptors. IpRGCs express the photopigment melanopsin.[16] Their input synchronizes the SCN to maintain the circadian rhythm near a 24 h cycle by driving the nocturnal synthesis of the pineal hormone

Table 1: Demographic details of studied participants

Variables	Shift worker (*n*=40)	Day worker (*n*=40)	Unpaired *t*-test	*P**
Age (years)	36.53±9.73	32.82±11.21	*t*=1.580	0.479
BMI (kg/m^2)	22.24±2.99	21.57±4.18	*t*=0.824	0.118
HC (cm)	55.75±1.90	56.07±2.12	*t*=0.710	0.412

**P*<0.05: Statistically significant. BMI: Body mass index, HC: Head circumference

Table 2: Latency and amplitude of VEP of shift workers and day workers (right eye)

Right eye (VEP parameters)	Shift worker (*n*=40)	Day worker (*n*=40)	Unpaired *t*-test	*P**
N75 (ms)	78.83±15.85	63.63±11.22	*t*=4.950	0.0001*
P100 (ms)	128.50±18.07	97.14±12.99	*t*=8.912	0.0001*
N145 (ms)	170.05±12.04	146.63±18.19	*t*=6.790	0.0001*
P100 (µV)	9.96±2.10	10.17±4.25	*t*=0.280	0.79

**P*<0.05: Statistically significant. VEP: Visual evoked potential

Table 3: Latency and amplitude of VEP of shift workers and day workers (left eye)

Left eye (VEP parameters)	Shift worker (*n*=40)	Day worker (*n*=40)	Unpaired *t*-test	*P**
N75 (ms)	74.10±13.64	68.55±9.20	*t*=2.133	<0.05*
P100 (ms)	123.67±14.14	103.91±14.42	*t*=6.188	0.0001*
N145 (ms)	164.98±11.93	146.63±17.18	*t*=5.548	0.0001*
P100 (µV)	9.97±2.20	10.39±4.40	*t*=0.540	0.578

**P*<0.05: Statistically significant. VEP: Visual evoked potential

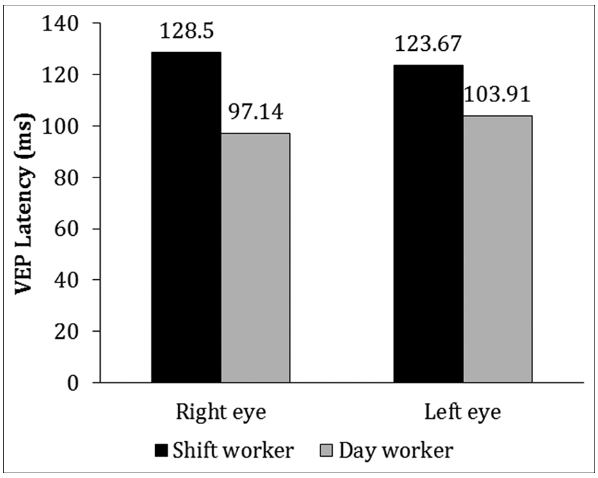

Figure 1: Latency of visual evoked potential, comparison of shift workers and day workers

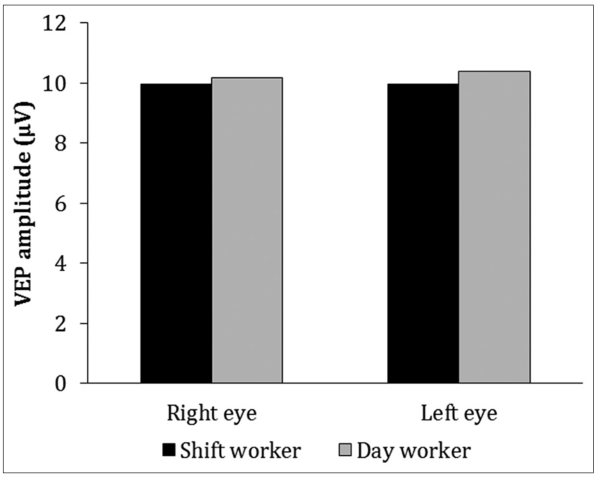

Figure 2: Amplitude of visual evoked potential, comparison of shift workers and day workers

Table 4: Correlation of HC with latency and amplitude of P100 wave

Variable	Correlation coefficient (r)	
	Left eye	Right eye
HC		
Pearson correlation		
Latency	0.166	0.031
Amplitude	−0.074	−0.152

HC: Head circumference

melatonin and feedback loops to mediate clock information to the peripheral tissues and induce circadian phase, sleep, and maintenance of pupil diameter.[17,18] Hence, melanopsin which has a role in the maintenance of pupil diameter[19-22] and providing the primary environmental light input to the SCN for photoentrainment of the circadian rhythm might be affected. A constricted pupil may decrease the area of retinal illumination and increase the average latency of P100.The average decrease in pupillary diameter of 1.75 mm increases the average latency by 4.6 ms.[1]

Our finding also supports the result of Jackson et al.,[23] who observed the increase in P100 latency and reduction in amplitude in professional drivers with sleep deprivation. According to them, these findings were related to the slower processing of visual information and changes in cognitive function due to sleep deprivation.

However, Namita et al.[24] confirmed that there was no effect on sensorimotor performance of the night shift workers when compared with the day workers. Binks et al.[25] found that short-term sleep deprivation does not impair higher cortical functioning because the consistent effect of sleep loss on cognitive function is due to decrease in functioning ability to sustain attention. These contradicting findings may be due to the better adaptability of the individuals to the shift work. According to Takahashi et al.[26] adaptation to shift work may be associated with fewer health problems compared to nonadapted shifts workers.

Age has been reported to influence latency of P100 at a rate of 2.5 ms/decade after the fifth decade. Retina and rostral part of the visual system also change as age advances, and with that latency of P100 also increases.[27] Hence, in our study, individuals within the age group of 20-40 years were taken to avoid age as confounding factor.

VEP latencies and amplitude are influenced by the HC of the individual.[28,29] Positive correlation of P100 latency and negative correlation of amplitude was observed with the advancement of mean HC. In our study, there was no significant difference in the HC of both night and day shift workers. Hence, this factor would have not influenced the latencies and amplitude of VEP.

Overweight and obesity documents the derangements in VEP parameters, indicating CNS conduction delays with brainstem as well as cerebral cortical involvement.[30] The influence of raised BMI (BMI >23) can affect the clinical interpretation of this test. Hence, to escape from the effect of above confounder, analogous groups were compared in our study.

CONCLUSION

Night shift workers who are at risk of alteration in circadian rhythm have prolonged latency of VEP, which in long-term may impair their general health. The cause for prolonged latency could be confirmed by measuring their pupillary diameter. Hence, regular visual checkups are required for them. The use of bright lights (artificial lights) at work and during awaking hours may help them to combat drowsiness and improve alertness. The use of bright lights from early in night shift and 2 h before shift ends would be helpful in preventing the consequences of disrupted circadian rhythm.

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