Original Article

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Physiology Section

Influence of Rotating Shift Work on Visual Reaction Time and Visual Evoked Potential

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ABSTRACT

Background: The present day life style is changing the circadian rhythm of the body especially in rotating night shift workers. The impact of this prolongs their reaction time. Night shift also interferes with the circadian variation of pupil size which may affect the visual evoked potential.

Aim: To compare the visual reaction time, visual evoked potential (VEP) in rotating night shift workers & day workers and also to correlate the changes in visual reaction time with visual evoked potential.

Materials and Methods: Forty healthy male security guards & staff (25 – 35 y) who did rotating night shifts at least for six months & 40 d workers (25 – 35 y) who did not do night shift in last two years were involved in the study. Visual reaction time and the latency & amplitude of VEP were recorded.

Result: Kolmogorov- Smirnov test for normalcy showed the latencies & amplitude of VEP to be normally distributed. Student's unpaired t test showed significant difference ($p<0.05$) in the visual time and in the latencies of VEP between night shift & day workers. There was no significant difference in the amplitude of VEP.

Conclusion: Night shift workers who are prone to circadian rhythm alteration will have prolonged visual reaction time & visual evoked potential abnormalities. Implementation of Bright Light Therapy would be beneficial to the night shift worker.

Keywords: Circadian rhythm, Shift workers, Visual reaction time, Visual evoked potential

INTRODUCTION

In rotating shift workers, internal biological clock which is keyed to daylight and darkness is disrupted. As a result it leads to substantial deterioration in sleep quality and duration [1]. These shift workers perform one week of night shift and one week of day shift alternatively. This makes their circadian rhythm highly unstable which in turn puts them at risk of health problems.

Sleep deprivation have a negative effect on cognitive performance in individuals [2]. Reaction time provides an indirect index of the processing capability of CNS and a simple means of determining sensorimotor performances [3]. Reaction time is the time interval between the onset of stimulus and the initiation of response under the condition that the subject has been instructed to respond as rapidly as possible [4]. The impact of substantial deterioration in sleep quality and duration in night shift workers might prolong their reaction time.

Visual evoked potential (VEP) is the electrical potential differences recorded from scalp in response to visual stimuli. It depend on various factors and one among them is the pupillary diameter [5] .The pupillary diameter follows a circadian pattern [6]. In rotating night shift workers the circadian pattern of the pupil size may be interfered. This may affect their visual evoked potential.

There is only one study showing that sleep deprivation increases reaction time [7] and another one study demonstrating that sleep deprivation affects visual evoked potential [8]. A very few studies have shown the effect of shift work on reaction time. But there is lack of research work addressing the impact of shift work on visual evoked potential.

So this study was done to correlate the reaction time, evoked potential changes and the shift work pattern & also to establish a probable cause for variation in the visual reaction time.

MATERIALS AND METHODS

Our study was conducted in the Department of Physiology in Pondicherry Institute of Medical Sciences, India. It was a cross sectional study. Fourty security guards & staff who did rotating night shift with one week of day shift and one week of night shift for atleast six months and 40 day workers who did not do night shift atleast for the past two years were involved in the study.

Inclusion criteria: Only males within the age group of 25-35y.

Exclusion criteria: Alcoholics, Smokers, individuals with Visual field defects, Patients on mydriatic/miotic drugs, individuals with Psychiatric disorder, Diabetes Mellitus were excluded.

BRIEF PROCEDURE

After obtaining the institutional ethical clearance, the study was carried out. The night shift workers were asked to report to the Physiology Research lab at 8.00 AM after completing their night duty. Each worker was subjected to recording of simple visual reaction time and visual evoked potential. Recordings were carried out in day workers also and the results were compared.

Visual reaction time was done by the standard method followed by Nikam LH, Gadkari JV [9] by using the reaction time apparatus (Anand Agencies, Pune, India).

VEP was measured after explaining the subject about the procedure to ensure full cooperation. Subjects were advised to avoid hair spray or oil after the last hair wash. Subjects with refractive errors were asked to put their usual glasses during the test.

The scalp skin was prepared by abrading and degreasing. The recording electrode was placed at OZ, the reference electrode was placed at FpZ and the ground electrode was placed at the vertex (Cz) using conducting jelly.

The electrode impedance was kept below 5KΩ.Low cut filters were set at 2 HZ and high cut filters at 100 HZ. The filters setting were

	Shift worker	Day worker
Age	28.68 ± 3.9	27.88 ± 3.4
BMI	21.84 ± 1.06	22.37 ± 1.04
HC (cm)	55.95 ± 1.5	56.38 ± 1.0

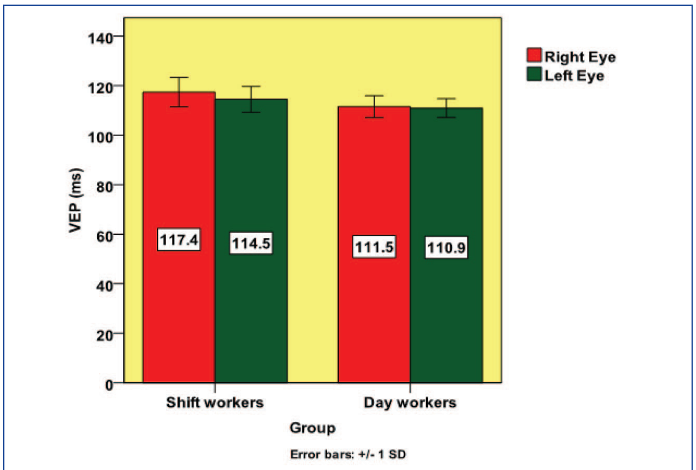
[Table/Fig-1]: Demographic characteristics of shift workers and day workers., *BMI – Body Mass Index , HC – Head Circumference*

Latency (msec)	Shift worker	Day worker	p-value
VRT (m sec)	264.5 ± 30.6	182.8 ± 14.9	< 0.05

[Table/Fig-2]: Visual reaction time of shift workers and day workers
p < 0.05 – Significant

	Shift worker	Day worker	p value
Rt Eye	117.4 ± 6.0	111.5 ± 4.4	< 0.05
Lt Eye	114.5 ± 5.2	110.9 ± 3.8	0.001

[Table/Fig-3]: Latency of visual evoked potential of shift workers and day workers
p < 0.05 – Significant



[Table/Fig-4]: Latency of visual evoked potential: SW vs DW

kept constant throughout the study. The sweep duration was kept at 300ms [10].

The eye was stimulated by pattern reversal stimulation and the response was recorded. The responses of 100 stimulations are averaged and two similar averages are considered for each eye. It was ensured that the patient did not sleep during the procedure.

P100 latency is chief discriminator between normality and abnormality of visual pathway [11]. So, emphasis was laid upon P100 wave and its latency and amplitude was recorded from the averaged waveforms.

STATISTICAL ANALYSIS

Analysis of data was done with the help of SPSS version 16 software package. Data were represented as mean ± standard deviation. Normalcy of data was tested by Kolmogrov-Smirnoff test.

Unpaired Student t- test was used to compare the means of Simple visual reaction time and visual evoked potential between the study groups. Pearson correlation analysis was done to establish correlation between two variables. p< 0.05 was considered for statistical significance.

RESULTS

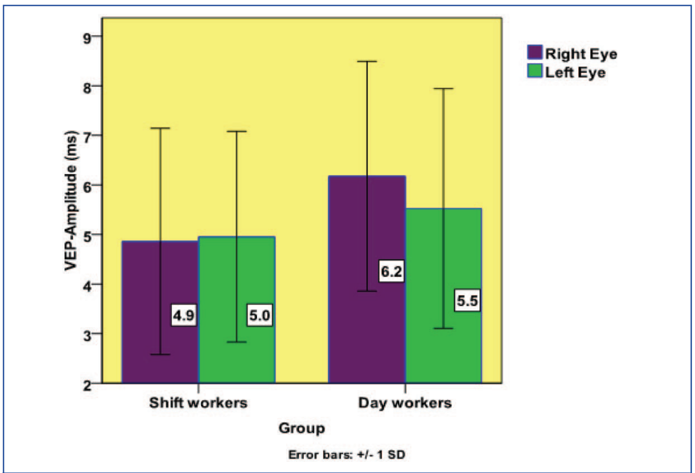
[Table/Fig-1] shows mean and standard deviation of the variables. Individuals with larger head size tend to have prolonged latency in P100 wave [12]. To avoid this confounding factor between the two groups, head circumferences were compared.

There was no significant difference in the head circumference of the shift workers and day workers.

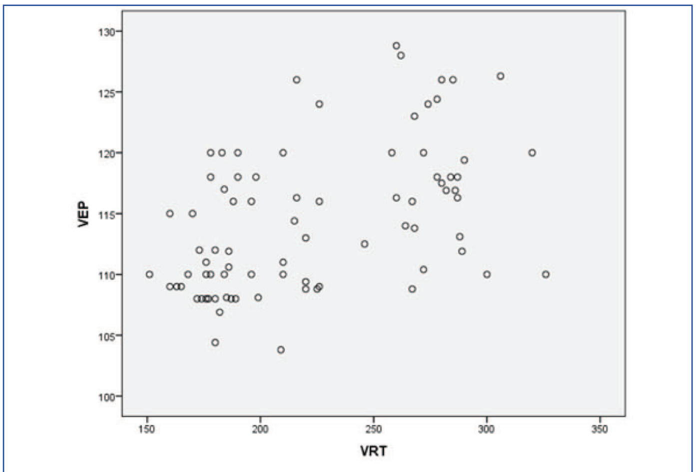
[Table/Fig-2] Represents significant difference in the visual reaction time of shift workers and day workers. Shift workers had significantly increased visual reaction time.

Amplitude (µv)	Shift worker	Day worker	p value
Rt Eye	5.0 ± 2.1	6.2 ± 2.3	0.115
Lt Eye	4.9 ± 2.3	5.5 ± 2.4	0.265

[Table/Fig-5]: Amplitude of visual evoked potential of shift workers and day workers., *p > 0.05 - Insignificant*



[Table/Fig-6]: Amplitude of visual evoked potential: SW vs DW



[Table/Fig-7]: Correlation between VRT & latency of VEP

[Table/Fig-3,4] Compares the latency of visual evoked potential in right and left eye of both the groups. There was significant prolongation in the latency of VEP in shift workers when compared to day workers.

[Table/Fig-5,6] Describes the amplitude of visual evoked potential in right and left eye of both groups. No significant difference was observed in the amplitude of both groups.

[Table/Fig-7] Establishes significant positive correlation between visual reaction time and latency of visual evoked potential.

DISCUSSION

In this present study rotating night shift workers had prolonged visual reaction time when compared to day workers. This result is consistent with the findings of the study done by McCarthy et al., [13]. They revealed significant effects of sleep deprivation on reaction time. Their findings indicated that sleep deprivation decreased subject's attentional responsivity to new information and simultaneously reduced the efficiency of their cognitive processing. Few other studies also support that sleep deprivation slows reaction times [14,15].

In contrast, Namita et al., [16] confirmed that there was no significant difference in the visual reaction time between the two groups. Pilcher et al., found that sleep deprivation has a significant effect on human functioning and mood was much more affected than either cognitive or motor performance [17]. According to Bings

PG, short term sleep deprivation does not impair higher cortical functioning [18].

The probable reason for contradicting results could be due variation in the adaptability of the individual to the shift work. Adapted shift workers report fewer problems in health and well being than the non adapted workers [19].

The visual evoked potential is the objective 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 around 100 milliseconds after the stimulus) and N100 (a negative component around 100 milliseconds) elicited over occipital sites [20]. The P100 is believed to reflect early activation of the primary visual cortex and is related to spatial attentive processes [21,22].

Age has been reported to influence latency of p 100 at a rate of 2.5ms/decade after fifth decade [12,23]. This has been attributed to age related changes in both retina and the rostral part of visual system [23]. So, in our study individuals within the age group of 25-35 yrs were considered to avoid age as confounding factor.

In visual evoked potential, P100 latency variation is the most reliable indicator of clinically significant abnormality. The latency of visual evoked potential was found to be prolonged in both eyes of the rotating night shift workers when compared to day workers. There have been mixed findings with regards to visual evoked potential and sleep deprivation [24,25]. The effect of defocusing and of distracted attention upon recordings of the visual evoked potential would have brought about variation in the results [26,27]. In our study this factor was keenly observed when visual evoked potential was recorded in the subject. The probable cause for prolongation in latency could be due to variation in pupil size.

Recently discovered intrinsically photosensitive melanopsin retinal ganglion cells contribute to the maintenance of pupil diameter [6,28-32] and provide the primary environmental light input to the suprachiasmatic nucleus for photoentrainment of the circadian rhythm.

The circadian rhythm is a cycle of biochemical, physiological and behavioural processes co-ordinated by the suprachiasmatic nucleus of the anterior hypothalamus [33]. The suprachiasmatic nucleus regulates the release of melatonin from the pineal gland to regulate the sleep/ wake cycle [34,35].

Rotating shift workers work during the night and their sleep pattern gets altered. Disrupted circadian rhythm might bring about change in the pupil size [36] . Constricted pupil may decrease the area of retinal illumination thus increase the average latency of P 100.The average puipillary diameter constriction of 1.75mm increases the average latency by 4.6ms [37] .

Among night shift workers, the latency of VEP was found to be significantly prolonged in right eye when compared to left eye. In day workers though there was difference in the latency between both eyes but was found to be insignificant. There was difference in the latency prolongation of VEP in right and left eye. This has been attributed to the neuroanatomic asymmetries of human striate cortex [38] .

P100 wave amplitude was found to be decreased in night shift workers when compared to day workers. But the difference between the groups was insignificant. Both in the night shift workers and day workers, P100 wave amplitude of right eye was found to be greater than left eye. The P100 wave obtained by stimulating the dominant eye has greater amplitude when compared to non dominant eye in normal individuals [39].

VEP latencies and amplitude are influenced by the head circumference of the individual [40,41]. There is a positive correlation of P 100 latency with the mean head circumference, while a highly significant negative correlation were noted of P100 amplitude with head circumference [42].

In our study there was no significant difference in the head circumference of both night and day shift workers. So, this factor would have not influenced the latencies and amplitude of visual evoked potential.

In night shift workers, increased visual reaction time could be due to prolongation in latency of visual evoked potential. In this study there is significant positive correlation between visual reaction time and latency of visual evoked potential.

CONCLUSION

Rotating night shift workers who are more prone to alteration in circadian rhythm have increased visual reaction time and prolonged latency of visual evoked potential. The cause for prolonged latency could be confirmed by measuring their pupillary diameter at baseline and after certain periods of follow up.

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