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Examination of Attention Level in Nurses Working Night Shifts in terms of the Relationship between Electrodermal Activity and Sex Hormones

Vardiyalı Çalışan Hemşirelerde Dikkat Düzeyinin Elektrodermal Aktivite ile Cinsiyet Hormonları Arasındaki İlişkisi Yönünden İncelenmesi

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ABSTRACT

Introduction: Electrodermal activity (EDA) is an electrical activity of eccrine sweat gland stimulated by the sympathetic nervous system. Skin conductance level (SCL) is measured with EDA. SCL and sweat gland activity increase in emotional situations, such as high activation, attention or stress. In this study, we investigated whether working in shifts affects attention level of nurses with EDA and explored the relationship between EDA and sex hormones.

Method: The study was carried out on nurses working night shifts (16.00-08.00 h) (n=22) and nurses working without a shift (08.00- 16.00 h) (n=20). Firstly, The Epworth Sleepiness Scale which evaluates a person's daytime sleepiness was applied to the subjects. For EDA measurement, Ag/AgCl electrodes were put on two fingers of their dominant hand. SCL was measured via MP30 system and GSR connection. The blood samples were analyzed for cortisol and ACTH hormone levels to investigate the changes in sleep and circadian rhythm.

Result: It was found that there was no statistically significant difference in skin conductance levels between the groups. Moreover, in the comparison of hormone values between the groups, the cortisol levels in night shift nurses were higher than in those working without a shift.

Conclusion: Night shift had no significant effect on the attention levels in the nurses. This situation is thought to be related to the fact that the nurses responsible for the night service raise their attention level to the highest point. The reason for higher level of cortisol in nurses working shifts may reflect that cortisol has no effect on the breadth of attention but reflects a high level of stress. *(Archives of Neuropsychiatry 2013; 50: 197-201)*

Key words: Electrodermal activity, attention, circadian rhythm, sleep, nurse

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ÖZET

Giriş: Elektrodermal aktivite (EDA), sempatik sinir sistemi ile uyarılan ekrin ter bezlerinin elektriksel aktivitesidir. EDA ile deri iletkenlik seviyesi ölçülmektedir (DİS). Yüksek aktivasyon, dikkat artışı veya stres gibi emosyonel durumlarda ter bezi aktivitesi ve DİS artmaktadır. Çalışmamızda, vardiyalı çalışan hemşirelerde uykusuzluğun dikkat düzeyini etkileyip etkilemediği elektrodermal aktivite ile incelendi ve EDA parametreleri ile cinsiyet hormonları arasındaki ilişki araştırıldı.

Yöntemler: Çalışma vardiyalı (16.00-08.00 saatleri arasında) (n=22) ve vardiyasız çalışan (08.00- 16.00 saatleri arasında) (n=20) gönüllü hemşirelerde gerçekleştirildi. İlk olarak kişinin uyanıklık durumunu değerlendiren Epworth Skalası uygulandı. EDA kaydı için, kişilerin dominant ellerinin iki parmağına agar jeli ile Ag/AgCl elektrotlar yerleştirildi. MP30 sisteminin GSR bağlantısı aracılığıyla deri iletkenliği kaydedildi. Hemen ardından kan alınarak, sirkadien ritm değişikliği gösteren kortizol ve ACTH hormon düzeyleri araştırıldı.

Bulgular: Vardiyalı çalışan hemşireler ile vardiyasız çalışan hemşirelerin deri iletkenlikleri karşılaştırıldığında istatistiksel olarak farklı olmadığı bulunmuştur. Hormon değerlerinin karşılaştırılmasında da gece çalışan hemşirelerin kortizol düzeyleri, gündüz çalışanlara göre yüksek bulunurken, ACTH seviyeleri arasında anlamlı fark gözlenmemiştir.

Sonuç: Vardiyalı çalışmanın hemşirelerin dikkat düzeylerinde değişiklik oluşturmadığı bulunmuştur. Bu durumun, gece servis sorumluluğunu tek başına üstlenen hemşirelerin dikkat düzeylerini en üst düzeye çıkarması nedeni ile olabileceği düşünülmektedir. Gece çalışanlarda kortizolün daha yüksek bulunmasının, kortizolün dikkate etkisinin olmaması nedeniyle, yüksek stresi yansıttığı düşünülmektedir. (Nöropsikiyatri Arşivi 2013; 50: 197-201)

Anahtar kelimeler: Electrodermal activity, attention, circadian rhythm, sleep, nurse

Çıkar çatışması: Yazarlar bu makale ile ilgili olarak herhangi bir çıkar çatışması bildirmemişlerdir.

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Introduction

Hospitals are institutions where service is given for 24 hours seven days a week and working nightshifts is mandatory to continue the services given. The healthcare personnel is a group who have to work in times other than the normal working hours and days, who have tasks and responsibilities which may be life-threatening, who compete with time, who use different technologies and who work under intensive stress and pressure (1). Nursing is specified as a stressful occupation with intensive work load because of many negative factors arising from this working setting. The International Labour Organization (ILO) defines the main stressors related with the working setting of nurses as conflicts experienced with administrators, role conflict and uncertainity, excessive work load, emotional stress experienced because of working with patients, working with patients who need intensive care and who are about to die, conflicts experienced with patients and working in shifts (1). Studies have reported that working in shifts or in watch duty system lead to negative effects on the physiological, psychological health of individuals and this affects the safety of both the employees and patients negatively (1).

It is known that working in shifts disrupts body rythms. It has been reported that the risk of mortalities including immune system depression, gastrointestinal system disorders, hypertension, diabetes mellitus, metabolic disorders and depression increases as a result of lack of sleep (1). In addition, regular release of hormones including melatonin, ACTH, cortisol and sex hormones is disrupted in individuals who work in shifts (2,3,4,5).

Working hours change as daytime and night for nurses who work in shifts. They can sometimes stay on duty for 12-16 hours. Thus their biological rythms may be disrupted. Working of a tired sleepless nurse also affects patients' care and safety. Wakefulness and attention level are affected by long-term sleeplessness. Disruption in sleep time and process leads to a decrease in cognitive processes, need for a longer time for the individual to give a reaction and a decrease in coordination. A marked relation has been found between nightlong sleeplessness and decreased attention and a decrease in performance of cognitive functions. When healthy individuals sleep for a time approximately shorter than 5 hours, cognitive performance starts to decrease (6).

Electrodermal activity (EDA) is defined as electrical activity of eccrine sweat glands stimulated by symphathetic cholinergic fibers and peripheral dermal-epidermal tissues. Increased activity of the symphathetic nervous system increases the activation of eccrine sweat gland and skin conductance increases and resistance decreases. Edelberg defined two different sources related with the origin of EDA in the central nervous system. The source named as EDA1 is the limbic-hypothalamic source. It is related with thermoregulation and is affected by emotional changes. EDA2 arises from premotor-basal ganglions. It reflects EDA changes which occur during specific motor movements. In addition, it is known that reticular modulation system mediates responses which occur in EDA in changes of attention and awakeness levels (7,8). With demonstration of the important role of especially the centers of the central nervous system related with the functions of attention, knowledge, perception in formation and control of EDA, EDA became one of the measurements used in determination of psychophysiological conditions (9).

Tonic parameters recorded in EDA show the activities which have a continuance during the period of rest. Skin conductance level (SCL) is the tonic activity of sympathetic sudorific fibers which innervate sweat glands. The properties of the barrier layer of the skin determine the tonic level of EDA. SCL at rest reflects autonomic and corticoreticular awakeness process. In the literature, it has been reported that SCL can be used as an awakeness index in various psychophysiological areas (10).

The effects of working in night shifts in nurses have been mostly investigated in terms of exhaustion level (11) and development of anxiety (12). No study related with attention and awakeness could be found.

In our study, it was aimed to investigate the attention level in nurses who worked in night shifts by measuring skin conduction levels using electrodermal activity (EDA) record. In addition, the relation between skin conduction (attention level) and hormones was evaluated by measuring blood hormone values (adrenocorticotropine (ACTH), cortisol and sex hormones (follicle stimulating hormone (FSH), luteinizing hormone (LH), estradiol, progesterone, free testosterone) of the nurses at the end of shift.

Method

Experiment Groups

The study was conducted with a total of 42 volunteer nurses who worked in Erciyes University Gevher Nesibe Hospital in different clinics, who had a mean age of 30.23±4.11 years and who were healthy and did not use any medication. The study group was composed of 22 nurses who worked in shifts starting at 16:00 p.m and and leaving off at 08.00 a.m in the morning. Twenty nurses who were selected as the control group worked between 08.00 a.m and 16.00 p.m. All participants were made to sign informed consent forms. The experiments were conducted with the approval of the ethics committee of Erciyes University.

The Epworth Scale

The Epworth Scale which evaluates the awareness status of individuals was applied to the nurses included in the study. Eight questions were asked to the subjects in the scale and they were asked to aswer as none (0), mild (1), moderate (2) and high (3). The questions measured tendency to sleep while sitting or reading, watching TV, sitting in the social sphere without performing any activity, travelling by car for one hour or longer, laying down in the afternoon, sitting and talking with somebody, sitting after lunch and stopping for a few minutes while driving. It was found that the individuals with a total score of 10 or above were sleepy and a total score of 18 or above were very sleepy (13).

Electrodermal Activity Recording

EDA was recorded in Erciyes University, Medical Faculty, Department of Physiology, Brain Dynamics Unit at normal room temperature (20±2 ºC) in a dim-lit room isolated from external factors with galvanic skin response (GSR) connection of the MP30 system.

EDA was recorded with two Ag/AgCl electrodes with a diameter of 0,8 cm placed on the surface of the distal phalanxes of the thumb and index finger of the dominant hand. These two electrodes were connected to the MP30 system which operates with constant voltage method. 0.05M agar gel was used to decrease the resistance between the electrodes and skin. Agar agar gel was prepared by dissolving 2.39 gr NaCl in 100 cc distilled water and adding 2 g agar agar and boiling. The MP30 system was connected to a computer. GSR was selected in the BIOPAC software of the MP30 system and tonic resting skin conductances were recorded for 2 minutes (14,15,16). During the resting recording, spontaneous fluctuations were counted and the number of spontaneous fluctuation/ minute (SFN) was calculated. A sample of EDA recording is shown in (Figure 1).

Hormone Tests

5 ml blood was taken from all nurses included in the study in the Nuclear Medicine Laboratory. Blood was obtained from the study and control groups at the same time. The bloods were centrifuged and their sera were separated. ACTH, cortisole, FSH, LH, estradiol, progesterone and free testosterone hormone levels were measured in serum samples by radioimmunoassay (RIA) kits.

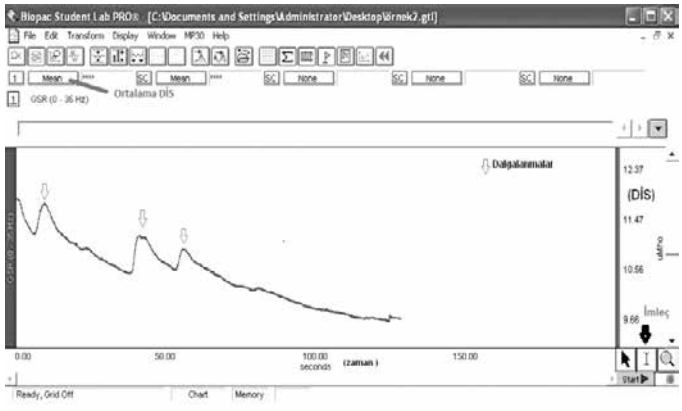

Figure 1. Sample electrodermal activity recording. The mean skin conductance level (SCL) is calculated by selecting 2-minute recording with pointer in data analysis. In addition, skin conductance fluctuation number per minute (SFN) is found by counting fluctuations which occur during recording

Experiment Method

The individuals included in the study were taken to the laboratory one by one and they were given information about the applications to be performed. The recording system was introduced. To prevent the study stress the individuals were relaxed by performing pre-experiment procedures for a period of approximately half an hour (including filling out the forms which contained demographic information). Consent forms were made to be signed. The Epworth scale was applied primarily. Afterwards, the subjects were prepared for EDA recording. The person to be recorded was made to sit in a confortable chair and his/her hands were wiped with alcohol. After the electrodes were prepared by applying gel, they were placed on the fingers. Tonic recordings were made with the MP30 system. The participants were informed that 2-minute recordings would be made without any warning and they were instructed not to move their hands during recording and not to breath in very deeply. EDA recordings were made in the nurses in the study and control groups at the same time (08.00-09.00) and SCLs were measured (17). Afterwards, their blood samples were taken and their sera were separated and kept to perform hormone tests.

Data Analysis

EDA recordings were analyzed by a special software belonging to the MP30 system. Skin conductance analyses were evaluated in micromho (µmho). Spontaneous fluctuation numbers per minute which occurred during tonic recording were calculated. Sores given for each question of the Epworth scale were added.

Statistical Analysis

SPSS 11.0 package program was used for statistics. Independent two sample Student t test was used for analyses. Pearson correlation test was applied between SCL and hormones. A p value of ‹0.05 was considered significant. The values were presented as mean ± standard deviation.

Results

Epworth Scale Measurements

No statistically significant difference was found in comparison of the Epworth scales of the study and control groups (p›0.05).

EDA Recordings

The mean SCL and SFN values of the study and control groups are presented in (Table 1). No statistically significant difference was observed in comparison of SCL and SFN in both groups (p›0.05).

Table 1. Mean values of skin conductance levels (SCL) and skin conductance fluctuation number per minute (SFN) of the nurses who work in night shifts and in daytime and statistical comparison (valueas are given as mean ± standard deviation)

	Nurses workin in daytime	Nurse working in night shifts	t	p
SCL (µmho)	8.24±2.5	8.86±3.8	0.62	0.52
SN (fluctuation number/min)	8.70±5.1	8.09±6.7	0.32	0.74

Hormone Results

When the hormone levels of the groups were compared, a statistically significant difference was found in cortisol, FSH and free testosterone levels ($p<0.05$), whereas no statistically significant difference was found in ACTH and other sex hormone levels ($p>0.05$). The hormone values of the two groups are presented in (Table 2).

When the correlation between SCL and cortisol levels was examined in both groups, no correlation was found between SCL and cortisol levels. ($r=-0.037$, $p>0.05$).

Discussion

Electrodermal activity (EDA) is one of the indicators of the sympathetic nervous system which evaluates the effect of the peripheral autonomic nerve function and especially unmyelinated sympathetic fibers on the function of sweat glands (16). EDA recording studies have been used in measurement of cognitive and emotional processes in psychophysiology for a long time. EDA which is a good indicator of the activity of the central nervous system and the level of awakeness has a wide usage area in psychophysiologic studies. EDA shows variance in all stimuli and reflex events which increase the sympathetic activity and thus sympathetic sudorific activity (10). In this study, it was found that the sympathetic skin response and thus attention and awakeness levels did not change in nurses who worked in night shifts and had variable circadian sleep rhythm, but the cortisol levels in blood samples obtained after night shifts were significantly higher compared to the nurses who did not work in night shifts. The higher level of cortisol in nurses who worked in night shifts suggests that cortisol reflects high level of stress, since cortisol has no effect on attention (3).

In the literature, no study investigating the effect of working in night shifts on attention and awakeness levels in nurses could be found. In a study in which the effect of working in night shifts on anxiety and arterial blood pressure was examined in nurses, the blood pressures of nurses were measured and the "State-Continuous Anxiety Inventory" was used. According to the results obtained in the study the diastolic blood pressure values of the nurses who worked continuously in daytime shifts were found to be higher compared to the nurses who worked in daytime and night shifts. While the continuous axiety level of nurses was not affected by working in shifts, the second state anxiety level was found to be higher in nurses who worked continuously in daytime shifts compared to the ones who worked in daytime and night shifts (12). These findings which were incompatible with the literature were explained by the high mean age of the nurses who worked continuously in daytime shifts (8 hours), extra payment for the nurses who worked in night shifts (16 hours) and the fact that these nurses slept at least for 3-4 hours in night shifts. In our study, it was concluded that the anxiety level was higher in nurses who worked in night shifts, since the cortisol levels were found to be higher in the nurses who worked in night shifts compared to the ones who worked in daytime. In contrast to the study of Demir, the nurses who worked in night shifts and in daytime shifts were in the same age group. Therefore, we think that increased cortisol and anxiety levels did not arise from the difference in age.

Boucsein and Ottmann investigated the effects of working in shifts and noise on the level of awakeness and attention with electrodermal activity. While working at nighttime affected primarily general awakeness, noise was found to affect both general and target-related awakeness (18). The reason that no difference was found between the nurses who worked in nighttime and daytime in our study may be the fact that night shifts did not affect target-related awakeness levels.

Hot et al. investigated the variability of SCL during the day and showed that SCL found in EDA recordings made at 18.00 p.m. was higher compared to SCL found in EDA recordings made at 09.30 a.m. in the morning (17). Therefore, EDA recording and blood sample taking was performed at 08.00-09.00 in the morning in the nurses who worked both during daytime and nighttime.

In our study which we conducted with rats whose sleep cycles were changed, it was shown that change in sleep cycle increased skin conductance level (19). We think this difference in nurses is due to the fact that they have target-related awakeness level.

Although many studies related with EDA have been conducted, there are no sufficent studies related with its relation with sex hormones. In the study presented,

Table 2. Mean values of the hormones of the nurses who work in night shifts and in daytime and statistical comparison (valueas are given as mean ± standard deviation)

Hormones	Normal values	Nurses workin in daytime	Nurse working in night shifts	t	p
ACTH (pg/ml)	1-60	1.4±140.3	1.3±132.4	0.27	0.78
Cortisol (µg/dl)	9-26	16.77±5.23	11.91±5.57	2.59	0.014*
FSH (mIU/ml)	1.2-12.5	4.15±2.08	7.82±3.94	3.34	0.002*
LH (mIU/ml)	2.5-10.2	9.15±13.4	8.84±9.3	0.08	0.93
Estradiol (pg/ml)	1-18	1.22±99.7	1.04±122.8	0.45	0.64
Progesterone (ng/ml)	1.5-7.5	6.98±5.7	3.17±5.3	2.00	0.053
F, Testosterone (pg/ml)	0.3-3.1	204±0.62	1.39±0.64	2.98	0.005*

ACTH: Adrenocorticotropic hormone, FSH: Follicle stimulating hormone, LH: Luteinizing hormone, F, Testosterone: Free testosterone

FSH levels of the nurses who worked in night shifts were significantly lower compared to the nurses who worked in daytime. It was taken care of that EDA recordings were made outside the menstrul period. Therefore, it was thought that the high stress in the ones who worked in nighttime might have supressed FSH (20). In the literature, it has been reported that physical, immunological or psychological natural stressors decrease the circulation levels of gonadotropins (21,22,23). In this study, we thought that the physiological increase in plasma cortisol levels inhibited the secretion of gonadotropins. Free testosterone levels were also found to be significantly higher in the study group compared to the control group. Testosterone is converted to estradiol with the action of FSH and aromatase in granulosa cells. Increased testosterone may be related with decreased FSH in this group. In a study performed by Hermans et al., it was reported that exogenous testosterone contributed to central stress responses in healthy young individuals (24). However, more studies are needed in this area.

Conclusively, it was shown that working in night shifts did not lead to any change in attention levels in nurses. This was thought to be related with target-related awakeness of the nurses who took the responsibility of ward alone in nighttime and increased their attention levels to a maximum level. However, sleep rhythm changes may affect hormone levels in individuals and individual attention disorders and stress conditions may occur as a result of changes in hormone levels.

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