

Effect of Perceived Stress on Electrocardiographic Parameters of Female Health Professionals: A Cross Sectional Observational Study

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ABSTRACT

Background: Stress can trigger both atrial and ventricular arrhythmias and perceived stress has been reported higher among female health professionals. Aims: To observe the effects of perceived stress on ECG parameters in female health professionals.

Materials and methods: The present cross sectional observational study was conducted in the department of Physiology of Burdwan Medical College after taking institutional ethical clearance and informed consent of the subjects. Hundred healthy female health professionals were selected from the local population as study group (Group S) and hundred healthy age matched working women were selected as control (Group C). Stress level in the subjects was assessed according to the Presumptive stressful life event scale (PSLES) and subjects with PSLES scores more than 200 were only included. The Perceived Stress Scale of Sheldon Cohen was used to measure perceived stress scores. ECG was recorded in both the groups. Unpaired T Test was used to compare the two groups.

Results: Study group had significantly higher perceived stress scores as compared to controls though there was no significant difference in their PSLES scores. PSS scores: Group S 28.2 ± 3.09 vs. Group C 24.2 ± 3.4 ; P value < 0.0001 . Study of ECG parameters revealed the following observations: There was significant difference between the two groups in respect of R-R interval, with control group having higher values as compared to study group. Mean \pm SD values of R-R interval: Group S 0.71 ± 0.08 vs. Group C 0.73 ± 0.68 ; P value < 0.0001 . Subjects with higher perceived stress scores had significantly lower QRS complex. Mean \pm SD values of QRS complex: Group S 0.049 ± 0.019 vs. Group C 0.068 ± 0.02 ; P value < 0.0001 . Subjects with higher perceived stress scores had significantly higher T-wave amplitude. Mean \pm SD values of T-wave: Group S 0.28 ± 0.09 vs. Group C 0.17 ± 0.09 ; P value < 0.0001 . P-R interval was significantly prolonged in controls as compared to study group. Mean \pm SD values of P-R interval: Group S 0.16 ± 0.05 vs. Group C 0.195 ± 0.03 ; P value < 0.0001 . S-T-segment amplitude was significantly less in controls. Mean \pm SD values of S-T-segment in Group S 0.112 ± 0.03 vs. Group C 0.044 ± 0.017 ; P value < 0.0001 . QT interval was significantly greater in controls as compared to study group. PSS scores were negatively correlated with Q-T interval. Mean \pm SD values of Q-T interval: Group S 0.328 ± 0.032 vs. Group C 0.345 ± 0.038 ; P value < 0.0001 .

Conclusions: Female health care professionals perceive more stress as compared to females of the same age group having similar PSLES scores. Increase in perceive stress levels bring about various changes in electrocardiographic parameters which is a reflection of the adverse cardiovascular changes and autonomic imbalance precipitated by increased perceived stress levels.

Keywords: Female health professionals, Perceived stress, ECG changes.

INTRODUCTION

Perceived stress has been reported higher among health professionals. [1] A national survey of physicians in Canada showed that both male and female doctors experienced high levels of occupational stress. [2] A study in a teaching hospital in Pakistan showed that 68% of the doctors were overloaded with their jobs. [3] In previous studies female doctors have been found to have significantly lower satisfaction with their workload. [4] American Foundation for Suicide Prevention reported that, death by suicide is about 70% more likely among male doctors than among other professionals and 250-400% higher among female doctors. [5] Higher levels of stress are also seen in the majority of the nurses. [6]

Female health professionals perceive more stress as compared to males, as has been observed in different studies. [3-5] Work stress and burnout remain significant concerns in female health professionals. Individuals and organizations are both affected by work stress. For individuals, the neuroendocrine response to stress yields physiologic reactions that may contribute to illness. [6]

Stress at workplace is an important risk factor for the emergence of metabolic syndrome. A study by Ghosh AK et al in 2018 [7] highlighted the high prevalence of metabolic syndrome among health professionals with female preponderance. This was specifically associated with poor quality of life, in respect of physical health; psychological health and social relationships. Pathophysiology may involve direct neuroendocrine effects and autonomic imbalance. [2-6]

Many epidemiological studies have demonstrated the crucial role of psychological stress, in potentially fatal arrhythmic events. [8-20] This relationship has been extensively explored in recent studies involving patients with implantable cardioverter-defibrillators. Mechanisms linking anger and arrhythmias may be ANS imbalance with a rapid sympathetic outflow

and/or a vagal tone withdrawal, and an acute change in electrophysiological myocardial properties. [20,21] ECG changes during emotional stress are similar to the ECG changes during right stellate ganglion stimulation, while the ECG changes during exercise were similar to the ECG changes obtained during left stellate ganglion stimulation. [22]

The present study was conducted to observe the effects of perceived stress on ECG parameters in female health professionals as they have been found to perceive more stress in previous studies, and increase stress levels may lead to cardiovascular problems. Evaluating ECG signatures of stress can provide mechanistic information, as well as serve as surrogate endpoints for studies investigating therapeutic approaches. There are a number of approaches to evaluating repolarization and repolarization heterogeneity in the ventricle, but options for looking noninvasively at atrial electrophysiology are fewer and this may be a valuable area for future research. [23] This is the reason why we included ECG as a parameter in our study.

MATERIALS AND METHODS

The present study was conducted in the department of Physiology, Burdwan Medical College after taking institutional ethical clearance and informed consent of the subjects. This cross sectional observational study was conducted in a time span of one year.

Stress level in the subjects was assessed according to the Presumptive stressful life event scale (PSLES). [1] Hundred female health professionals with PSLES scores more than 200 were selected as study group and hundred age, PSLES score matched working females from the general population were selected as control. [1]

• Inclusion criteria: Working women under severe stress (according to PSLES scores) without any gross systemic, metabolic and infective disease were selected.

• Exclusion criteria:

Subjects suffering from chronic debilitating diseases such as:

1. Cardiac arrhythmias.
2. Hypertension.
3. Diabetes mellitus.
4. Ischemic heart disease.
5. Retinopathy.
6. Nephropathy.
7. Respiratory diseases.
8. Neuropathy.
9. Smokers and alcoholics.
10. Females receiving any drugs that may affect the autonomic reflexes.
11. Postmenopausal females, subjects on treatment from psychiatry problem or with past history of treatment were excluded.
12. Sportswomen, yogis, subjects on regular meditation and exercise regime were not included.

Increased sympathetic activity has been observed during the premenstrual phase and this was positively correlated with the stress levels in previous studies. To avoid stress effects of the premenstrual phase, we examined our subjects during the postmenstrual phase. [1]

On the first appointment, particulars of the subject, personal history, family history, history of past illness, treatment history, and dietary history of the subjects were carefully recorded.

Informed consent was obtained from the subjects. After clinical examinations were conducted and pre-test instructions were given to avoid consumption of any drugs that may alter the autonomic function 48 hours prior to the test, the subjects were advised to have a good restful sleep. The subjects were advised to have light dinner within 8 p.m. and go to bed early, and avoid stressful situations during the day before the tests were conducted. Relaxing bedtime routine, like soaking in a hot bath or then reading a book or listening to soothing music, was advised. They were also asked to avoid caffeine, nicotine, and alcohol close to bedtime.

On the day of the test, no cigarette, nicotine, coffee, or drugs was permitted.

The Perceived Stress Scale (PSS) of Sheldon Cohen [1] was used to measure perceived stress scores. It is a measure of the degree to which situations in one's life are appraised to be stressful. from 0 to 40. [1]

PSLES scores and PSS scores were calculated. The test score results were not revealed to the subjects and the examiners who were examining the subjects to prevent any bias.

In resting and supine posture, 12 lead ECG of the subjects were recorded by digital Electrocardiograph machine attached to a computer. Different waves, segments and intervals with their amplitude and duration of the recorded ECG were then carefully examined. Subjects with any pathological waveform were excluded. Lead II was used for analysis of data. Long lead II was recorded for at least 10 seconds. If the rhythms were regular, i.e., successive RR intervals were fairly constant, 1500/RR in mm was considered as a reasonably accurate value of HR. However, when there was variation in RR interval, the number of RR intervals that were contained in the 10 s strip was taken and multiplied by six.

RESULTS

The present study was conducted in a time span of one year to observe the effects of perceived stress on ECG in female health professionals. 100 subjects were selected as study group (Group S) and 100 as control (Group C). The subjects were age (Age in years: 30.8±6.6 vs. 31.5 ±6.7; P value: 0.38) and PSLES score (342.4 ± 55.4 vs.352.6 ± 49.8; P value 0.8) matched. Their food habits were comparable. Study group had significantly higher perceived stress scores as compared to controls though there was no significant difference in their PSLES scores. PSS scores: Group S 28.2±3.09 vs. Group C 24.2±3.4; P value<0.0001. Study of ECG parameters revealed the following observations: There was significant difference between the two groups in respect of R-R interval, with control group having higher values as compared to study group. Mean ± SD values of R-R interval:

Group S 0.71 ± 0.08 vs. Group C 0.73 ± 0.68 ; P value < 0.0001 . There was no significant difference in P wave amplitude between the two groups. Mean \pm SD values of P-wave: Group S 0.114 ± 0.027 vs. Group C 0.113 ± 0.03 ; P value 0.19 . Subjects with higher perceived stress scores had significantly lower QRS complex. Mean \pm SD values of QRS complex: Group S 0.049 ± 0.019 vs. Group C 0.068 ± 0.02 ; P value < 0.0001 . Subjects with higher perceived stress scores had significantly higher T-wave amplitude. Mean \pm SD values of T-wave: Group S 0.28 ± 0.09 vs. Group C 0.17 ± 0.09 ; P value < 0.0001 . P-R

interval was significantly prolonged in controls as compared to study group. Mean \pm SD values of P-R interval: Group S 0.16 ± 0.05 vs. Group C 0.195 ± 0.03 ; P value < 0.0001 . S-T-segment amplitude was significantly less in controls. Mean \pm SD values of S-T-segment in Group S 0.112 ± 0.03 vs. Group C 0.044 ± 0.017 ; P value < 0.0001 . QT interval was significantly greater in controls as compared to study group. PSS scores were negatively correlated with Q-T interval. Mean \pm SD values of Q-T interval: Group S 0.328 ± 0.032 vs. Group C 0.345 ± 0.038 ; P value < 0.0001 (Table 1, Figure 1, 2).

TABLE 1: SHOWS COMPARISON OF DIFFERENT PARAMETERS OF THE TWO GROUPS

PARAMETERS	Group S (N=100) MEAN \pm SD	Group C (N=100) MEAN \pm SD	P VALUE
PSS	28.2 \pm 3.1	24.2 \pm 3.4	< 0.0001 **
RR(sec)	0.71 \pm 0.08	0.73 \pm 0.68	< 0.0001 **
P WAVE (mv)	0.114 \pm 0.026	0.113 \pm 0.025	0.19
QRS(sec)	0.049 \pm 0.02	0.068 \pm 0.02	< 0.0001 **
T(mv)	0.28 \pm 0.09	0.17 \pm 0.08	< 0.0001 **
PR(sec)	0.158 \pm 0.05	0.195 \pm 0.03	< 0.0001 **
ST(mm)	0.112 \pm 0.032	0.044 \pm 0.017	< 0.0001 **
QT(sec)	0.328 \pm 0.032	0.345 \pm 0.038	< 0.0001 **

All parameters excepting p wave were significantly different between the two groups. P < 0.05 * was considered as significant and P < 0.01 ** was considered as highly significant.

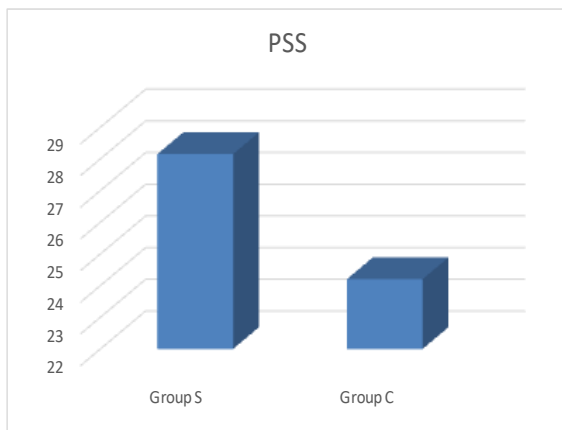


FIGURE 1: COMPARISON OF PSS OF BOTH GROUPS.

DISCUSSION

The present study was conducted in a time span of one year to observe the effects of perceived stress on ECG in female health care professionals. 100 subjects were selected as study group (Group S) and 100 as control (Group C). Study group had

significantly higher perceived stress scores as compared to controls.

Stress can trigger both atrial and ventricular arrhythmias. The electrocardiographic response patterns during exercise at low and high heart rate were compared with the response pattern during emotional stress in a study by Hijzen TH et al in 1995. [22] Significant differences in ECG during exercise and emotional stress were observed:

1. During exercise the ST segment was more depressed as compared to emotional stress
 2. T-wave amplitudes were larger and QT and PQ were significantly shorter than during emotional stress.
- QT interval was significantly greater in controls as compared to study group in the present study which is comparable to the observations made by Hijzen TH et al. [22]

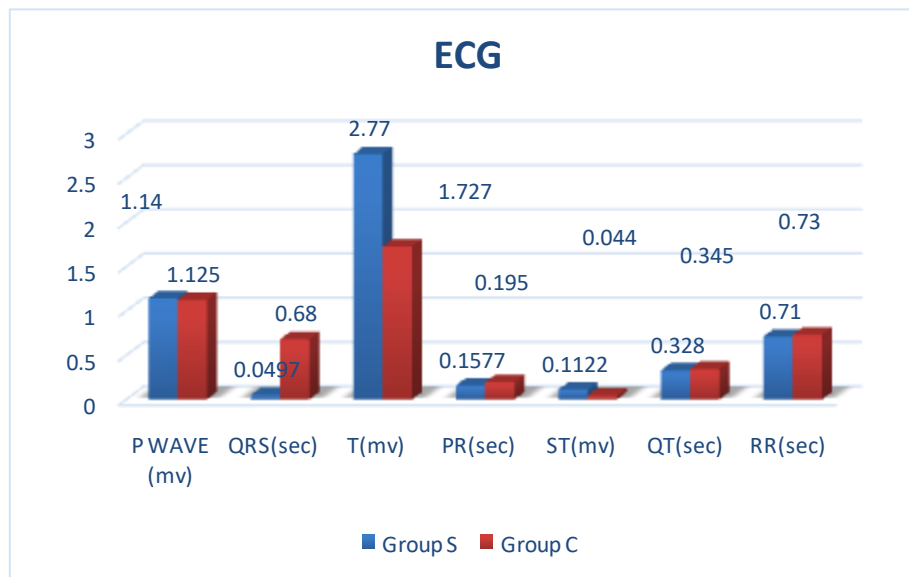


FIGURE 2: SHOWS COMPARISON OF ECG OF SUBJECTS OF BOTH GROUPS

An observational study was conducted by Sharma M et al in 2017. [24] The participants were divided into three groups. The first group comprised of 10 participants of Advance Meditation Program (AMP), who were doing this program for the first time; the second group comprised of 10 participants who were doing AMP along with regularly practicing Padam Sadhna for at least 2 years; the third group consisted of 10 participants who were not practicing any kind of meditation or yoga. After taking informed consent, subjects were asked to fill up the Cohen's stress questionnaire. Electrocardiography (ECG) was recorded prior to AMP and following AMP. There was significant difference in heart rate; systolic blood pressure; diastolic blood pressure; RR interval; PR interval; stress score in first time participants. In the second group also significant difference was also observed. There was also a significant change in QT interval in Group 2–3 after AMP ($P = 0.037$). In the present study there was significant difference between the two groups in respect of R-R interval, with control group having higher values as compared to study group. Subjects with higher perceived stress scores had significantly lower QRS complex. Subjects with higher perceived stress scores had significantly higher T-wave amplitude. P-R

interval was significantly prolonged in controls as compared to study group. S-T-segment amplitude was significantly less in controls. QT interval was significantly greater in controls as compared to study group.

The QTVI10 beats measures the characteristics of both heart rate and QT variability, is a suitable index for a short-lasting ANS and myocardial transmural dispersion changes in response to an acute stress. [18,19] Another pathophysiological mechanism is remodeling of the slow component of the delayed rectifier potassium current (IKS). There is significant downregulation of IKS, as reported in heart failure patients, may be responsible of a delay in action potential duration shortening during the initial few seconds of sympathetic stimulation. [20,21] The spatiotemporal heterogeneity of myocardial repolarization would be more apparent for a short period during AR, whereas it will gradually reduce as time lag increases.

The QT interval is regulated by cardiac sympathetic innervation; shortening of the QT interval occurs with left stellate ganglion block (LSGB) whereas lengthening of the QT interval occurs with right stellate ganglion block. [25]

Signal processing techniques can provide insight into electrophysiological

mechanisms of stress-induced arrhythmia. Toivonen et al [26] used a human model of stress. The on-call medical house officers were recruited for the study to look at QT changes during stress. QT intervals during periods of arousal due to a page were compared to periods of rest with identical heart rates. They found hysteresis of the QT interval during periods of stress, with longer QT during stress than at rest, similar to the QT hysteresis found during exercise. [27] Exaggerations of QT hysteresis with exercise are thought to be one mechanism underlying sudden death in exercise, and could similarly be a mechanism of stress-related sudden cardiac death (SCD). In the present study we also observed changes in QT intervals in subjects perceiving more stress.

Lampert R in 2015 [23] looked directly at effects of stress on heterogeneity of repolarization. Heterogeneity of repolarization has long-recognized to be an important factor in arrhythmogenesis. This was studied by measuring T-wave alternans (TWA) during a laboratory mental stress protocol. Similar to a creating physical stress on a treadmill exercise test, they created mental stress in the laboratory which included the following protocols: these included asking the subject to do arithmetic mentally without any other support e.g. serial subtraction of 7 from a 3-digit number, or involve in a speaking task with emotional content. They also did “anger recall” test. The subjects were asked to recapitulate and speak out about a recent incident in which they were irritated or angry. They evaluated effects of mental stress on three surface measures of heterogeneity which can be determined from Holter monitoring:

1. T-wave alternans (TWA,)
2. T-wave amplitude (Tamp,)
3. T-wave area (T area,) calculating TWA in the time domain using the inter beat average technique.

In this study, 33 patients with ICDs and a history of ventricular arrhythmia were included. TWA was seen to increase from

22 at baseline to 29 during mental stress ($p < 0.001$.) All other measures of heterogeneity also increased following mental stress. Broad-range repolarization instability was also increased during stress.

The effect of anger on TWA in the laboratory may be predictive of arrhythmias in real life. In a long time, follow-up of the study of anger and TWA it was found that anger-induced TWA was a significant predictor of arrhythmia. Patients with gross abnormal results in this test had 10 times more common incidences of ventricular arrhythmias as compared to that of other patients (CI 1.6-113, $p < 0.05$.) Anger-induced TWA remained predictive factor after controlling for standard predictors of arrhythmia such as ejection fraction, prior clinical arrhythmia, and wide QRS. The findings of this study are consistent with the impact of autonomic factors on TWA which previous studies have observed.

Potential mechanisms of the arrhythmogenic effects of stress on AF are less well documented. Repolarization as measured in invasive experiments by the atrial effective refractory period shortens with sympathetic stimulation in most [28] although not all [25] studies. Also, sympathetic stimulation acts synergistically when combined with vagal stimuli. [28]

Emotionally charged events are often known to be associated with an increased risk of sudden cardiac death (SCD). [25-28] In a study Magri D et al in 2012 [29] assessed RR and QT variability index (QTVI) at baseline during anger recall test (AR). They calculated QTVI around the presumed maximum sympathetic activation in thirty post-myocardial infarction patients under β -blocker therapy and 10 controls underwent. Both the low-frequency component of RR and SBP increased during AR in all groups. The QTVI calculated on a 5-min ECG recording and the QTVI10 beats were higher in patients than in controls. During AR, the QTVI10 beats in controls diminished significantly from baseline whereas in patients remained unchanged. The inability to buffer an acute stressful

event induced increase in sympathetic activity may explain why acute stressful events are associated with an increased risk of ventricular arrhythmias in these patients. Cognitive behavior stress management strategies may be helpful in these cases as suggested by the study. The present study also demonstrated changes in QT interval with changes in perceived stress levels in female health professionals. Incorporation of stress management programmes in daily life of health professionals is of immense importance in the present day health care system. ^[1,24]

CONCLUSIONS

Female health care professionals perceive more stress as compared to females of the same age group having similar PSLES scores. Increase in perceived stress levels bring about various changes in electrocardiographic parameters which is a reflection of the adverse cardiovascular changes and autonomic imbalance precipitated by increased perceived stress levels.

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