QT interval and dispersion among emergency medical responders in Mansoura city

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Abstract

Background: Occupational factors are likely to contribute to increased cardiovascular disease risk among emergency medical responders (EMR). The aim of this study was to clarify whether EMR stressful Job and their prolonged exposure to work stress are associated with an increase in QT interval and QT dispersion.

Methods: A comparative cross sectional study was conducted upon 137 EMR and a 119 matched control group composed of non-emergency workers. All study population were subjected to history taking for age, risk factors such as diabetes mellitus, hypertension, and smoking, history of cardiovascular disease, and the use of medications. Measurement of blood pressure, and body mass index (BMI) was recorded. Standard 12-lead ECGs were recorded for the analysis of heart rate (HR), QT, QTc, QT dispersion, Tpeak and Tend (Tpe), and Tpe dispersion. In addition the levels of epinephrine and nor-epinephrine hormones in urine during the work shift were analyzed.

Results: High risk EMR had a significant increase in blood pressure, urinary epinephrine and nor-epinephrine compared to the control group (p < 0.05). There were no differences between studied groups as regards heart rate, QT, QTc, QT dispersion, Tpeak, and Tend (Tpe), and Tpe dispersion. In addition the levels of epinephrine and nor-epinephrine hormones in urine during the work shift were analyzed.

Conclusion: QTc and dispersion were not increased among emergency medical responders in spite of having higher catecholamine levels.

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1. Introduction

Psychological stress is a normal reaction to a threat or disturbing change in the environment. Stress produces both psychological and physical responses. Together, these responses lead to a biochemical cascade which sets off a flight-fight or freeze reaction by the body.1
The stress response (fight-or-flight/freeze) is a normal reaction that leads to an increase in arousal and the ability to deal with threat. In the absence of a continued threat, the body relaxes and goes back to its normal state of tension. Small doses of daily stress are not unhealthy at all. They are part of life and the body is adapted to handle them. In times of extreme stress, however, this stress response can become turned on at all times, with no relaxation. This can have serious physical and psychological consequences.7

It is possible that there is a discrepancy between an experience of mental distress and objectively assessed life event stress. Usually, however, stressful life events lead to prolonged mental stress, which in turn, may impair one’s physiological ability to cope with acute stress.3 Prolonged mental stress has been related to unpleasant effects and behavioral inhibition, and has been shown to predict myocardial infarction.5,8 Mental stress has also been shown to have an influence on sudden cardiac death, ventricular arrhythmias and cardiac autonomic function.6

The strenuous duties of emergency responders (firefighters, police officers, and emergency medical services (EMS) personnel) can interact with their personal risk profiles, including elevated blood pressure, to precipitate acute cardiovascular events. Typically, the work of emergency responders involves long stretches of relative inactivity, punctuated by unpredictable and stressful bursts of high intensity, and potentially life-threatening activities.7 The latter produce adrenergic surges and higher demands on the cardiovascular system.8 Likewise, alarm response, which results in elevated heart rates and blood pressure through a fight-or-flight response, carries risks of on-duty coronary artery events on the order of 3–15 times higher than nonemergency duty.9

Occupational factors likely to contribute to increased cardiovascular disease risk among emergency responders include: a lack of regular exercise, poor nutrition (sometimes attributable to limited opportunities for healthy food choices while on-duty), shift work (sleep disruption/deprivation), noise exposure, posttraumatic stress disorder (PTSD), and imbalance between job demands and decisional latitude.10,12 The QT interval (QTI) has long been useful as a clinical index of the duration of ventricular repolarization, has gained clinical importance because prolonged QT intervals have been shown to be predictors of potentially lethal ventricular arrhythmias and sudden cardiac death.13,14 Normally, the QT interval duration varies in a circadian pattern depending on variations in autonomic tone, concentrations of circulating catecholamine and electrical properties of the myocardium.15,16

The aim of this study was to clarify whether emergency medical responders stressful job and their prolonged exposure to work stress are associated with an increase in QT interval and QT dispersion.

2. Patients and methods

2.1. Study populations

A comparative cross sectional study was conducted upon (n = 132) emergency medical responders (EMRs) and a matched control group (n = 115, mean age 39.35 ± 11.19 years) composed of non-emergency university workers.

Emergency medical responders (EMRs) group was subdivided into:

2.1.1. Group I

Represents high risk group (n = 121), mean age 37.64 ± 9.08 years. High risk group includes junior workers working 24-h shifts every day in emergency medical responding duties only.

2.1.2. Group II

Represents low risk group (n = 11), mean age 40.27 ± 11.36 years. Low risk group include senior workers who previously had emergency responding duties but currently handle office work mainly.

Emergency medical responders were collected from Mansoura’s main ambulance center from January 2012 until April 2013.

The protocol was approved by our ethics committee, and an informed consent was taken from the study subjects.

2.2. Inclusion criteria

Workers with at least one year in emergency medical services were included in the present study. Emergency medical responders are specially trained workers to provide out-of-hospital care in medical emergencies. They include persons who give the first aid, basic life support, advanced life support, and emergency car drivers.

Healthy subjects were recruited and screened by history, physical examination and 12-lead electrocardiogram (ECG).

2.3. Exclusion criteria

Participants with a history of ventricular arrhythmias, coronary heart disease, acute serious illnesses and those currently taking medications known to influence the QT interval were not included in the study.

All study populations were subjected to history taking for age, risk factors such as diabetes mellitus, hypertension, and smoking, history of cardiovascular disease, and the use of medications. Measurement of blood pressure, and body mass index (BMI) was recorded.

2.4. Measurement of QT interval and dispersion

Standard 12-lead ECGs were recorded at a paper speed of 25 mm/s using ECG Cardimax electrocardiogram device, Fukuda Denshi FX-2111 model 93908-02, Tokyo, Japan. All ECGs were done in the morning after the individual had rested in a semi recumbent posture for five minutes in an outpatient clinic at the workplace. QT intervals were measured in each lead of the precordial six lead ECGs (V1–V6). QT intervals were measured from the onset of the QRS complex to the end of the T wave. The end of the T wave was defined as the intersecting point of a tangent line on the terminal T wave and the TP baseline. When U waves were present, the QT interval was measured to the nadir of the curve between the T and U waves.17 If the height or depth of the T wave was
<1.5 mm, its lead was excluded from analysis. Leads with excessive noise, iso-electric or biphasic T waves were excluded from the analysis. Values of the QT intervals and dispersions were corrected for heart rate using Bazett’s formula (QTc = QT/RR

1/2).

In order to eliminate both inter-observer variability and bias, QT intervals were measured in all valid ECG leads by a single observer who was blinded to all clinical data. The intra-observer measurement variability was calculated by repeated measurements of the same ECGs by the same observer. QT intervals were measured from the same three consecutive heartbeats and the readings were averaged. The QT was measured from each of the 12 leads, and the mean QT calculated. A QT interval >450 ms was considered prolonged in men, and a QT interval >460 ms was considered prolonged in women.

QT dispersion was defined as the difference between the maximum and minimum QT intervals occurring in any of the 12 leads. The Tpe and T end interval (Tpe) were measured in precordial leads from the peak to the end of the T wave, and Tpe dispersion (defined as the difference between the maximum and minimum Tpe interval) was calculated.

2.5. Urine collection and catecholamine analysis

Collection of urine samples from the subjects was during the work shift. Each employee was instructed to come to the test room at a specific time and was asked to empty his bladder exactly 2 h before coming to the test room. Upon arrival at the test room, the subjects were asked to provide a urine sample. The urine samples were kept and transferred into an icebox. Urine stick test was performed immediately to screen for urinary occult blood, urinary protein and urinary sugar in order to exclude subjects with renal function abnormalities. Urine specimens were aliquotted in four 1.5 ml ependoorf tubes and stored at −40 °C until analysis. The levels of epinephrine and nor-epinephrine hormones in urine were analyzed using the ELIZA technique. The concentration of each hormone was estimated at the µg/g creatinine rate.

2.6. Statistical analysis

Data were analyzed with SPSS version 17 for Windows. The normality data were first tested with the one-sample Kolmogorov–Smirnov test. The groups were compared with the Student t test for continuous parametric variables and the Wilcoxon Mann Whitney test (z) for non-parametric continuous data. Chi square (χ²) test was used for categorical variables. Fisher’s exact test was used when 50% of cells or more was less than 5; p < 0.05 was considered as statistically significant.

3. Results

Table 1 represents demographic and laboratory data in the studied groups shows significant increase in systolic and diastolic blood pressure in high risk EMR compared to the control group (p < 0.0001, and <0.005, respectively), and significant increase in urinary epinephrine and nor-epinephrine in high risk EMR compared to the control group (p < 0.001). No statistically significant differences seen between the study groups as regards age, gender, BMI, diabetes mellitus, and smoking.

There were no statistically significant differences between studied groups as regards QT, QTc, QT dispersion, QTc dispersion, Tpe, Tpe dispersion, and heart rate (Table 2). No sig-
significant correlation between QT dispersion and urinary catecholamine levels among emergency medical responders (Fig. 1).

4. Discussion

A prolonged QT interval signifies a delay in the ventricular repolarization phase, which renders the heart vulnerable to malignant arrhythmias such as torsade de pointes ventricular tachycardia. The possible association of a stressful work faced by emergency medical responders and QT interval and dispersion has not been studied previously, which emphasizes the need for studies on EMRs and the risk of arrhythmic events.

In present study the higher blood pressure among EMRs is attributed to their strenuous duties which can interact with their personal risk profiles, and the high adrenergic surge leads to blood pressure elevation. Likewise, the use of alarms, sirens, which results in elevated heart rates and blood pressure. Shift work causes circadian disruption, which affects blood pressure and serum lipids, increases the secretion of glucocorticoids and catecholamine’s, activates the sympathetic nervous system, suppresses hormone secretions, and enables the clinical expression of central obesity, hypertension, dyslipidemia, endothelial dysfunction and metabolic syndrome.

In our study catecholamine levels were higher in high risk EMRs, due to the impact of work stressors on the autonomic nervous system and the high adrenergic surge.

The present study shows no statistically significant difference in QTc, and QT dispersion between the EMRs and the control group which could be explained on the basis that we record the ECG in the early morning only, and the QT interval duration varies in a circadian pattern depending on variations in autonomic tone, concentrations of circulating catecholamine and electrical properties of the myocardium. The QT interval shortens rapidly during the waking hours due to rapid increases in adrenaline concentrations, inhibition of the parasympathetic cardio inhibitory center, physical activity, and meals. The effect of such changes on the QT interval is mainly via changes in heart rate, although the heart rate in our study was higher in EMR than the control group but it did not reach statistical significance. The fluctuations in heart rate would not occur during stable physiologic states.

ECG was performed while the individual was rested in a semi recumbent position for five minutes. The QT interval is a fluid measurement that is influenced by the physiological and metabolic state of the patient at the time of the ECG. Owing to multiple variables interacting at any given time, patients may have different QT intervals during subsequent ECG examinations.

The shift work of EMRs changes the circadian pattern of QT interval durations; the maximum QT duration was observed during the night shift, high values were observed during the morning shift, and the minimum values were observed during the afternoon shift. Shift work-associated QT prolongation was previously demonstrated by Murata et al. in a 10-years follow-up study that compared 158 shift workers with 75 day workers.

Another explanation for the lack of significant difference in QT, and QT dispersion among EMR in comparison to control group is the significant medical and physical requirements related to the selection of candidates and their hiring process, as well a legislated disability provisions.

According to our knowledge, there were no previous studies addressing QTc and dispersion in EMR. The maximum QT dispersion in our study group was 80 ms, which is considerably less than that found to be associated with torsade de pointes by Day et al.

The present study shows no significant difference in The Tpeak and Tend interval (Tpe), and Tpe dispersion. The differ-
enе between T_{peak} and T_{end} (Tpe) reflects transmural heterogenei-
ty. Other authors consider the Tpe interval to reflect to-
tal left ventricular dispersion of repolarization, and is related to
arrhythmogenesis.\textsuperscript{28–30} while QT dispersion or QT range,
was proposed as an index of the spatial dispersion of the ven-
tricular recovery times.\textsuperscript{31} However, in most of the studies with
positive results, values for QT dispersion are well within the
demonstrated measurement error of both manual and auto-
matic methods.

In spite of the lack of difference in QTc, and dispersion
among EMR, efforts should be undertaken to diminish both
internal and external stressors in those individuals. Modifiable
risk factors, whether or not they are related to occupation,
should be aggressively addressed, and the promotion of
healthy habits such as aerobic exercise, maintenance of normal
weight, healthy diet, sleep hygiene, and stress management
should be made available to the entire workforce.

4.1. Limitations of the study

1st we measure the QT only in the early morning while the
EMR was at stable physiologic states in addition to the lack
of measurement at night for the diurnal variation in QTc.
ECG should be done at least three times during the day to un-
cover any changes in the QT throughout the day and with var-
ious stresses. The 2nd limitation was the lack of information
on socioeconomic status, or pre-employment ECG was available.

4.2. Conclusion

QTc, and dispersion was not increased among emergency med-
ical responders in spite of having higher catecholamine levels.

Conflict of interest

All authors declare that there are no conflicts of interest.

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