

RESEARCH ARTICLE

Heart rate variability and electrocardiographic changes during acute mental stress in first MBBS students: An analytical study

Pravallika Pagadala¹, Manaschakravarthy K², Sharvani Nerella³, Shankarappa V², Ramesh Babu M⁴

¹Department of Physiology, Sri Devaraj Urs Medical College, Tamaka, Kolar, Karnataka, India, ²Department of Physiology, Sambhram Institute of Medical Sciences, Kolar Gold Fields, Karnataka, India, ³Department of Physiology, Sri Padmavathi Medical College for Women, Tirupati, Chittoor, Andhra Pradesh, India, ⁴Department of Biochemistry, Sambhram Institute of Medical Sciences, Kolar Gold Fields, Karnataka, India

Correspondence to: Sharvani Nerella, E-mail: sharvani.anna@gmail.com

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ABSTRACT

Background: Stress is an inevitable part of life. It is a known fact that health of students is affected by the stresses of academic life. Excessive stress results in psychological problems such as depression, anxiety, substance abuse, poor decision-making, and suicide ideation. Stress disrupts the physiological functions of the body by affecting the brain. Cardiovascular system is also affected by stress. Stress and arrhythmias are linked with each other. Electrocardiogram (ECG) is commonly used to study cardiovascular disorders. This study was undertaken to highlight the effect of acute mental stress on the electrocardiographic changes and heart rate variability in first MBBS students. **Aims and Objectives:** The objectives of this study were as follows: 1. To assess the ECG changes and heart rate variability during stress in medical students and 2. to compare the changes of ECG and heart rate variability in resting state and during stress condition. **Materials and Methods:** After obtaining ethical clearance, the study included 50 healthy medical 1st year students in the age group of 18–22 years. ECG was recorded in those students at rest in supine position. Then, mental stress was induced on each by a number of mental tasks and ECG was recorded in them immediately. ECG recordings in relaxed state were compared with those in acute stress state. **Results:** There was statistically significant increase in heart rate, QT_c, and P duration and decrease in PR, QRS, and QT interval in that QT interval was statistically significant found during acute mental stress. **Conclusion:** The study shows that there were varieties of ECG changes in acute mental stress that may affect the skill developments in medical graduates. Early identification, awareness creation, and necessary interventions such as meditation, yoga, body scanning, deep breathing, and self-massage may decrease the same.


KEY WORDS: Arrhythmia; Heart rate variability; Distress; Eustress; Depression; Anxiety

INTRODUCTION

Stress is an inevitable part of life. It is a state characterized by a broad range of physiological and behavioral changes

resulting from one or more stressors. Biologically, it is defined as “the non-specific response of the body to any demand.”^[1] Stress is of two kinds - eustress - a positive form of good stress that motivates an individual to continue working and distress - manifests when stress is no longer tolerable and/or manageable.^[2]

It is a known fact that health of students is affected by the stresses of academic life.^[3] Several international studies have revealed that high rates of health problems and tremendous stress were seen in medical students during various stages of their medical education including undergraduate and

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postgraduate levels.^[4-6] The initial years of the course were more stressful for students than the last years of the course.^[7]

Stressors specific to medical students are found to be information and input overload, relationships disharmony, high parental expectations, financial indebtedness, lack of leisure time, pressures of work, work relationships, and career choices.^[4] Communication gaps in English and the local language might also induce academic-related stress.^[8]

Studies conducted on medical students at different countries have shown that they are at risk of psychological stress, mental disorders, and decreased life satisfaction.^[9,10]

Abdulghani *et al.* reported a prevalence of 57% of stress in medical students from King Saud University, Riyadh, (Saudi Arabia), whereas El-Gilany *et al.* found an overall stress rate of 28.9% among Saudi medical students and 30.9% among Egyptian medical students.^[11,12]

Although some degree of stress can be a stimulator for some individuals, not all students find stress helpful. Stress stimulates feelings of fright, lack of ability, not being beneficial, anger, and culpability and can be associated with both psychological and physical morbidity in many students.^[6]

Excessive stress results in psychological problems such as depression, anxiety, substance abuse, poor decision-making, and suicide ideation.^[13] It is emotionally and physiologically challenging.

Stress disrupts the physiological functions of the body by affecting the brain.^[14] Cardiovascular system is also affected by stress.^[15] Stress and arrhythmias are linked with each other.^[16] Mental and physical stress is known to play an important role in ventricular arrhythmias and sudden cardiac death, and it causes ischemia which may precipitate ventricular tachycardia and ventricular fibrillation.^[17]

Electrocardiogram (ECG) is commonly used to study cardiovascular disorders. It is recorded. When the cardiac impulse passes through the heart, electrical current also spreads from the heart into the adjacent tissues surrounding the heart. A small portion of the current spreads all the way to the surface of the body. If electrodes are placed on the skin on opposite sides of the heart, electrical potentials generated by the current. Normal ECG is composed of a P wave, QRS complex, T wave, PR, and QT interval. The QRS complex is often but not always, three separate waves: Q, R, and S wave. Any alterations in this waves lead to arrhythmia.^[18]

Acute stress is now one of the major causes, leading to fatal ventricular arrhythmia. The mechanisms by which acute stress causes arrhythmias are not completely understood.^[19]

In this study, an attempt has been made to study the heart rate and ECG changes during acute mental stress in first MBBS students.

MATERIALS AND METHODS

The study was carried out in the department of physiology. It is an analytical study done on 50 healthy first MBBS students of Sambhram Institute of Medical Sciences, K.G.F, Kolar, Karnataka. This study was approved by the institutional ethics committee. Informed consent and detailed history were obtained from all the study subjects. Convenience sampling technique was used.

Inclusion Criteria

Selection of subjects: All male students of first MBBS were included in the study.

Exclusion Criteria

- Documented evidence of heart diseases such as cardiac failure, cardiomyopathy, valvular heart disease, congenital heart disease, myocarditis, hypertension, and arrhythmias.
- Chronic obstructive pulmonary disease.
- Alcoholics and smokers.
- Chronic medication, psychiatric illness.
- Features of hypothyroidism, anemia.
- Practicing any known stress relieving or relaxation technique.

General and clinical examination was carried to rule out any underlying disease. All the ECGs were recorded at a speed of 25 mm/s with electrocardiography C3i ECG machine (manufactured by Philips Medical Systems). ECG was recorded at rest in supine position on the 1st day. Students were subjected to acute mental stress by a number of mental tasks and challenging situations (public speaking, type A interviews, seminars, mental arithmetic problems, and viva).^[17] ECG was recorded in them immediately. ECGs were analyzed for heart rate, PR interval, QRS duration, QT interval, QTc interval, and P duration.

The Spielberger's State and Trait Anxiety Inventory (STAI) was administered to all the students and the individual scores were calculated. Stressed students were identified based on their STAI scores.^[20,21]

Analysis and Statistical Methods

Data were coded and entered into Microsoft Excel data sheet. Quantitative data will be represented as mean, confidence interval, and standard deviation. Paired *t*-test statistical analysis was carried out using SPSS software. $P \leq 0.05$ will be considered as statistically significant.

RESULTS

ECG findings were observed and tabulated.

Table 1 shows the mean age, BMI, and systolic and diastolic blood pressure of the study population 18.27 ± 1.28 , 22.82 ± 4.44 , 114.9 ± 9.80 , and 70.82 ± 6.72 .

Table 2 shows that the heart rate (100.37 ± 16.49), P duration (100.24 ± 15.61), and QT_c (418.31 ± 16.93) were increased after acute mental stress when compared to that of rest 79.98 ± 13.07 , 93.71 ± 11.37 , 418.31 ± 16.93 and decreased QT interval (324.57 ± 25.69 versus 353.08 ± 21.57) was seen, respectively, and all of them mentioned above were statistically significant. QRS complex (85.73 ± 8.20) was decreased after mental stress when compared to that of rest 87.47 ± 6.87 and it was statistically not significant and there was a decrease in QRS axis (63.41 ± 34.61) and PR interval (137.71 ± 18.78) during acute stress when compared to that of rest 61.82 ± 19.89 and 140.69 ± 22.79 which were statistically not significant.

DISCUSSION

During acute mental stress, there was an increased heart rate due to increased activation of sympathetic nervous system and vagal withdrawal. Strokes, cardiac failures, and mortality rates are high during increased heart rate. QT and PR interval were reduced due to increased heart rate which is a major determinant of QT interval and PR interval. If heart rate increases, there will be gradual decrease in QT and PR interval. Similar findings were reported by Krishna *et al*, Magri and Lampert *et al.*^[17,22,23]

Mental stress could lead to augmentation of sympathetic system, catecholamine release which can lead to increase in the velocity of conduction in atria and influences on intraventricular conduction time by changing autonomic balance, which can lead to reduced QRS duration. Similar finding was reported by Krishna and Bhide *et al.*^[17,24] In our study, we also found that there was a prolonged P wave during acute stress. This wave duration is a marker of atrial conduction. Prolonged P wave duration signifies conduction delay between the right and left atrium due to impulse slowing or blockage has been suggested to be an easily measurable risk factor for underlying subclinical heart disease. In fact, it has been associated with atrial fibrillation, diabetes, cardiovascular disease, and stroke mortality among population. Similar findings for the cause of P wave were reported by Vepsalainen *et al.* and Magnani *et al.*^[25,26]

We also found a prolonged QTc interval during acute stress condition when compared to that of rest and it was statistically significant. Similar findings were reported by Krishna and Andrassy *et al.*^[17,27] This may be due to autonomically induced repolarization changes. Mental stress could lead to ANS imbalance, adrenergic release, and increased sympathetic tone, which can lead to ventricular depolarization heterogeneity, leading to prolonged QTc interval.^[24] Evidence suggested that lateralization of cerebral activity during emotional stress may stimulate the heart asymmetrically and produce areas of inhomogeneous repolarization that creates electrical instability and facilitate cardiac arrhythmias.^[28]

Acute emotional stress can cause adverse effects on heart such as left ventricular contractile dysfunction, myocardial ischemia, and disturbances in cardiac rhythm which may lead to fatal sometimes. These heart-brain interactions help to explain sudden cardiac events related to acute stress and provide insights into newer therapies in future to prevent sudden deaths.^[29]

Lacunae of the Study

Stress has been common in our day-to-day life, it has increased more in the medical students due to time pressures, workload, multiple roles, and emotional issues.^[20]

There is a paucity of literature in assessing the effect of academic stress on heart rate variability and ECG changes.

The outcome of the study will provide the basis for enhancing the general adoption of a new, positive approach to student life, thereby, ensuring academic success.

Limitations

Sample size is less due to lack of students because it's a new medical college sample collection was done only on first MBBS male students. Our study included only students

Table 1: The blood pressure and BMI in study group

Variables	Study group
	Mean±SD
SBP mmHg	114.49±9.80
DBP mmHg	70.82±6.72
BMI	22.82±4.44

BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SD: Standard deviation

Table 2: The heart rate and ECG changes during acute mental stressed and normal

Variables	Acute mental stress	Resting state	P value
	Mean±SD	Mean±SD	
Heart rate (beats/min)	100.37±16.49	79.98±13.07	<0.00*
P Duration (ms)	100.24±15.61	93.71±11.37	<0.02*
PR Interval (ms)	137.71±18.78	140.69±22.79	0.48
QRS Complex (ms)	87.47±6.87	85.73±8.20	0.26
QT Interval (ms)	324.57±25.69	353.08±21.57	<0.00*
QTC Interval (ms)	418.31±16.93	396.78±21.18	<0.00*

ECG: Electrocardiogram, SD: Standard deviation, *0.05 statistically significant

of one medical college. The inclusion of different medical colleges will result in a broader picture of the levels of perceived stress and emotional distress in medical students.

CONCLUSION

Atrial and ventricular arrhythmias can be triggered by stress. Stress is an inevitable part of life, especially among students. It is one of the most prevalent and common problem faced by majority of population, especially students that too in medical profession. Stress among medical students can be due to various causes such as examination schedule, too much portions to be covered, communication gap between students due to problem in local languages, or inferiority complex of not knowing to talk English properly. Stress among medical students can also be due to problems in living conditions in hostel, lack of social support system, and improper social environment in the hostels. To improve the quality of life among medical students, institutions can focus to make changes in medical curriculum or examination schedule. Management should provide proper infrastructure and basic facilities in the hostel. Parents also should communicate with their children on regular basis, motivate, and support them morally. Awareness creation about the adverse effect of substance use, academic counseling in the first 3 years of the courses, and stress reduction interventions were recommended. As a part of course curriculum, some techniques to reduce the stress should also be included in medical colleges such as meditation, yoga, body scanning, deep breathing, and self-massage. All these improvements can result in better academic performance and skill development among medical students and thus produce high-quality medical doctors.

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