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Original Article

Physiology Section

The Cardiovascular Response to the Acute Physical and Mental Stress in Type-2 Diabetes Mellitus

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ABSTRACT

Background: Stress can either be physical or mental. Studies have shown that the cardiovascular response to the physical and mental stress is different in hypertensives .However ,no such study have been done in diabetic patients.

Aim and objective: The aim of this study was to assess the cardiovascular response during acute physical and mental stress in Type 2 Diabetes Mellitus.

Materials and Methodology: Twenty six type 2 diabetic Patients of the age group 35-50 years who had a normal BMI and were taking oral hypoglycaemic drugs and 24 age matched healthy controls were included in the study. The mental stress test and the isometric hand grip test were performed in all the fifty subjects .The blood pressure and the heart rate response were observed during the procedures.

Results: The blood pressure and the heart rate response to both the physical and the mental stress were more in the cases as compared to those in the controls. Contrary to the normal belief, the cardiovascular response to the physical stress was more in the diabetics and the controls as compared to the mental stress.

Key Words: Physical stress, Mental stress, Type 2 Diabetes mellitus

INTRODUCTION

Stress is considered as the most significant problem in the modern world, which leads to many systemic complications. It can be defined as a state where the organism's homeostasis is threatened [1]. The hyperresponsiveness to the stress stimulus may indicate a sympathetic hyperreactivity [2]. Though physical and mental stress are encountered at similar rates in the daily life [3], the mental stress is reported to be more associated with the silent ischaemic episodes than the physical stress [4]. This probably may be due to the differential cardiovascular responses to both these types of stress. Studies have been done to compare the cardiovascular response to the mental and the physical stress, with caffeine intake and in offsprings of hypertensive parents. To the best of our knowledge, so far, no studies have been done to compare the cardiovascular response to the acute physical and mental stress in type 2 Diabetes mellitus. Evaluating the cardiovascular response to the different types of stress may be helpful in identifying the type of stress that may lead to an exaggerated sympathetic activity in each individual. This in turn, may be useful for selectively choosing the type of exercise that is more concerned with the mental relaxation or the physical exertion . Hence, the aim of our study was to evaluate and to compare the cardiovascular response to the physical and the mental stress in type 2 Diabetes mellitus.

MATERIALS AND METHODS

The study population:

Twenty six type-2 diabetic patients, both males and females, of the age group of 35-50 years with a disease duration which ranged from 1-3 years, who were taking oral hypoglyacemic drugs without any long term complications of diabetes, were recruited from the Diabetology OPD of Sree Balaji Medical College and Hospital . Hypertensives , smokers and obese persons were excluded from the study .Twenty four normal age and sex matched subjects were recruited as the controls. A proper written permission was obtained from the Head of the Dept of Diabetology for recruiting the subjects.

The experimental protocol: The subjects were instructed to abstain themselves from caffeinated drinks for at least 16 hours before they were tested. They were explained about the procedure. After getting their written informed consents, the stress tests were Carried out in the morning between 8-11am, 2 hours after the subjects had a light meal, under standardized conditions in the Clinical Laboratory, Department of Physiology, Sree Balaji Medical College and Hospital. The subjects were asked to empty their bladders before they were tested. All the subjects were tested with them in a sitting posture. The heart rate and the blood pressure were recorded at rest and during physical stress (isometric hand grip exercise) and mental stress (mental arithmetic task) by using a Non Invasive Blood Pressure (NIBP) monitor (PLANET -50) in all the subjects.

The test procedure –The mental arithmetic task

The mental arithmetic task –The subjects were asked to perform a Sequential subtraction of one to two digit integers from three to four digit integers .This test was carried out for three rounds .Each round lasted for 2 minutes . The subject was asked to say the answer aloud [5] . At the end of the task, the difficulty index was marked on a Likert scale. It was ensured that there was uniformity in the difficulty index.

The isometric hand grip exercise- The maximum voluntary contraction was determined by asking the subject to press the hand grip dynamometer thrice with the maximum effort . The subjects were asked to maintain 30% of the maximum voluntary contraction(MVC) for 2 minutes [6]. They were instructed to count softly to avoid alterations in the respiratory pattern.

The data and statistical analysis

For all the 50 subjects, the heart rate and the blood pressure values at rest and during the physical exercise and the mental stress task were presented as mean ±SD. The differences in the blood pressure and the heart rate values during the physical exercise and the mental stress task from the rest were compared between the cases and the controls by using the paired t test for the independent samples and the p values which were < 0.05 were considered as significant.

RESULTS

Parameters	Diabetic (n=26)	Non –Diabetic (n=24)
Age (Years)	35.13±4.31	35.63±4.45
BMI(Kg/m2)	26.01±1.4	25.85±1.45
Resting heartrate(BPM)	89.12± 11.7	80.92±4.2***
Resting Systolic BP(mmHg)	121.31± 13.7	111.96±5.0***
Resting Diastolic BP(mmHg)	74.92±8	81.6±4***
Fasting (mg/dl)glucose	134.14± 50.7	128.37± 12.51
Post prandial (mg/dl)glucose	206.32± 59.38	176.43±16.74

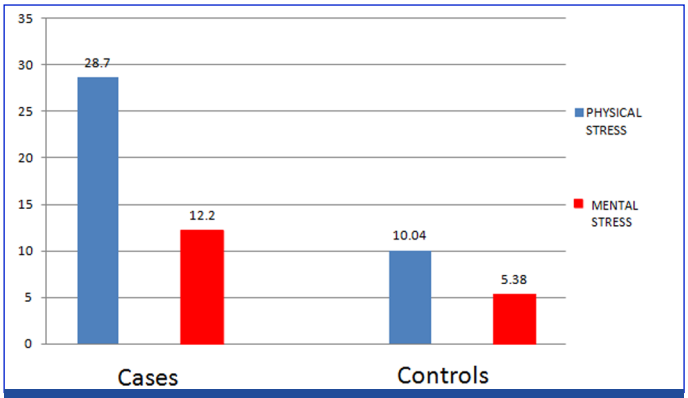
[Table/Fig-1]: Compares the base line characteristics and resting parameters between cases and controls

	Number of Subjects	Systolic Blood Pressure (Mmhg) Mean ±S.D	Diastolic Blood Pressure (Mmhg) Mean ±S.D	Heart Rate in Beats /Min
Cases	26	28.73±15.5	19.81±8.5	12.62±13.1
Controls	24	10.04±8.0	0.92±5.9	11.67±6.12
P-Value		0.000***	0.000***	0.749

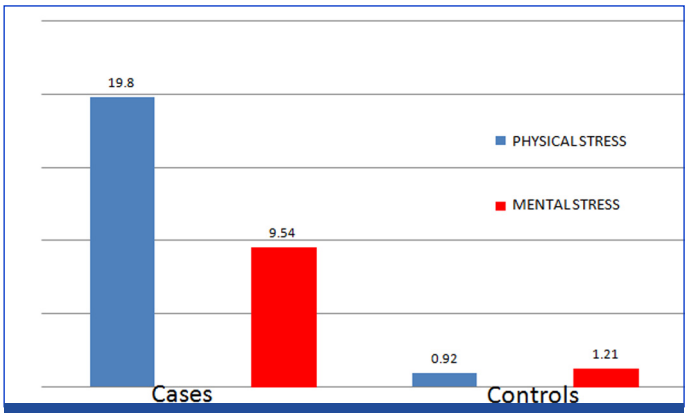
[Table/Fig-2]: Comparison of blood pressure and heart rate changes from the resting values during physical stress between cases and ontrols

	Number of Subjects	Systolic Blood Pressure (mmhg) Mean ±S.D	Diastolic Blood Pressure (mmhg) Mean ±S.D	Heart Rate in Beats /Min
Cases	26	12.2±11.6	9.54±5.6	6.73±10.4
Controls	24	5.38±9.3	1.21±8.6	3.13±5.1
P-Values		0.023*	0.000***	0.134

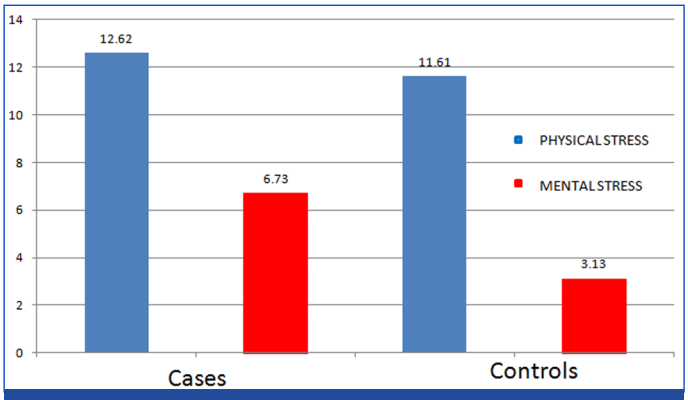
[Table/Fig-3]: Comparison of blood pressure and heart rate changes from rest during mental stress(mental arithmetic test) between cases and controls



[Table/Fig-4]: Comparison of mean of the rise in systolic blood pressure during physical and mental stress between cases and controls



[Table/Fig-5]: Comparison of mean of the rise in diastolic blood pressure changes during physical and mental stress between cases and controls



[Table/Fig-6]: Comparison of mean of the rise in heart rate changes during physical and mental stress between cases and controls

DISCUSSION

Type -2 diabetes mellitus commonly coexists with essential hypertension, which in turn multiplies the cardiovascular risk further because of the sympathetic hyperactivity [7,8].

Hypertensives were excluded from this study, as the main aim of this study was to evaluate the cardiovascular response to the physical and the mental stress in type -2 diabetes mellitus by excluding all the other confounding variables that could have affected the blood pressure. In the studies which have been done so far to evaluate the cardiovascular response,the blood pressure and the heart rate response to the stress tests were found to be increased and this increase was found to be more in the diabetic patients with a coexisting hypertension [9].

In this study, it was observed that at rest, the systolic blood pressure and the heart rate were more in diabetics as compared to those in the controls. The resting diastolic pressure was more in the controls as compared to that in the diabetic cases [Table/Fig-1].

An exaggerated pressor response to stress was observed in this study,as was shown by an increase in the systolic and the diastolic blood pressures and the heart rate to the physical and the mental stress in the cases as compared to those in the controls [Table/Fig-2 & 3]. Studies have shown that the exaggerated response to stress was a putative risk factor for hypertension

[10],cerebrovascular disease [11,12] and coronary artery disease [13,14]. Also, in a study which was done by Kamarck et al., it was stated that the responses to the experimentally induced mental and emotional stress correlated with the responses which were observed during the normal daily activities [15].This increase in the cardiovascular response, when it is experienced repeatedly for a longer time,may contribute to a vascular damage and morbidity [2].

So far, in the studies which had been done to assess the cardiovascular response to the isometric hand grip and the mental stress in type -2 diabetes mellitus as a part of the autonomic function testing , either there was an exaggerated or a diminished response to these tests. In this study, it was observed that there was a sympathetic overactivity, as was evidenced by an exAggerated cardiovascular response to stress.[Table/Fig-2& 3].Hyperinsulinemia may be the candidate mechanism for the sympathetic overactivity in diabetes [16]. However, a normal sympathetic activity has also been reported in patients with insulinoma [17,18]. Hence, it is possible that factors other than hyperinsulinaemia may contribute to the sympathetic overactivity. Studies have identified that insulin had a double mechanism of action in the form of central and peripheral effects for vasodilatation. The peripheral effects were mediated by NEFAs (Non –Esterified Fatty Acids) and the nitric oxide –L arginine pathway [19]. Studies have shown that in vivo, the insulin induced vasodilatation was abolished by a stereospecific inhibitor of NO synthase, L –NMMA (NG –monomethyl –L –arginine) and by the inhibition of tetrahydrobioterin, which was a cofactor which was necessary for the synthesis of NO [20,21]. A defect in the NO-synthesis and an increase in the plasma NEFAs may have important roles in inhibiting the vasodialator effect of insulin. A defect in the NO synthesis has also been reported in many insulin resistance states, which could contribute to the sympathetic overactivity [22].

Studies have been done to assess the cardiovascular response to stress in in hypertensives, with caffeine intake and in children of hypertensive parents [23,24]. However, to the best of our knowledge, so far , no study has been done to compare the cardiovascular reactivity to the acute physical and mental stress in diabetes .In most of the above mentioned studies, the cold pressor test was used as a type of physical stress, but this was a type of passive stress [23,24] .It has been stated that active coping leads to an enhanced β adrenergic stimulation as compared to the passive stress [25]. Hence, the isometric hand grip and the mental stress test were selected in this study to experimentally induce stress. In a study which was done by Chaney et al., they found that the treadmill tests caused greater mean heart rates and rate-pressure products, as well as more ST segment displacements, arrhythmias, and symptoms and signs than the isometric exercises .Hence, it was concluded in their study, that the isometric testing was easy and useful and, that if it was properly monitored, it caused lesser risk to the patient than the dynamic testing [26]. Because of their ease of administration and the relatively lesser risks which were involved, the isometric hand grip exercise and the mental stress were chosen as the methods to induce stress in this study.

In this study, it was observed that the rise in the systolic blood pressure and the heart rate from the resting values were much higher during the physical stress as compared to those in the Mental stress,both in the cases and the controls [Table/Fig-4&6]. The rise in the diastolic blood pressure was more during the physical stress than in the mental stress in the cases, whereas in the controls, the diastolic blood pressure was almost the same with both the types of stressors [Table/Fig-5].

The decreased response to the diastolic pressure during the mental stress which was observed in this study may be due to the fact that the mental activation is initiated from the central cortex and that it elicits a mixed pattern of the α and β adrenergic activities and also a parasympathetic response [25].

An augmented pressor response was observed in type 2 diabetes mellitus as compared to that in the controls. This pressor response was more during physical stress as compared to that during mental stress. Hence, we would like to conclude that unlike the findings of the studies which have been done so far in hypertensives and other conditions where an exaggerated cardiovascular response was observed during mental stress ,in diabetics , the physical stress was found to exaggerate the cardiovascular response.

The major limitation of this study was that the sample size was small and it has to be increased to generalize the results to the population. Also, measuring the fasting insulin and the nitric oxide levels and NEFA will definitely throw light on the pathogenesis of the sympathetic overactivity in diabetics.

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