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EFFECT OF 60° HEAD-UP TILT ON SYSTOLIC TIME INTERVALS IN HYPERTENSIVE PATIENTS

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Abstract : Time course of systolic time interval (STI) variations during 60° head-up tilt (HUT) was studied in 21 patients with essential hypertension and equal number of age-matched control subjects. ECG, Phonocardiogram and carotid pulse were recorded simultaneously on polygraph. Electromechanical systole (QS_2), left ventricular ejection time (LVET), pre ejection period (PEP), PEP/LVET ratio and ejection fraction (EF) were determined immediately after and at 1, 2, 3, 4 and 5 min after the tilt. In hypertensive patients, basal values of PEP and PEP/LVET ratio were insignificantly higher whereas LVET and EF were insignificantly lower as compared to the control subjects. 60° HUT produced significant decrease in LVET ($P<0.001$) and EF ($P<0.001$) and a significant increase in PEP/LVET ratio ($P<0.001$) in control subjects. The changes in hypertensive subjects were similar in pattern but statistically insignificant. It is concluded that tilt-induced changes in STIs are blunted in hypertensive patients.

Key words : head-up tilt hypertension systolic time intervals

INTRODUCTION

In continuation of our study on systolic time intervals (STIs) during head-up tilt (HUT) in normal young volunteers (1), we planned to study STIs in patients with essential hypertension. It has been suggested that STIs are sensitive indices of gravitational effects on left ventricular hemodynamic performance and promising predictors of blood pressure response to beta-blocking therapy in mild to moderate essential hypertension (2) and can be used to monitor the cardiac effect of anti-hypertensive treatment and also to estimate the cardiac changes associated with various types of hypertension (3, 4, 5). STIs are useful for non-invasive evaluation of left ventricular function in essential hypertension with angina pectoris (6). Previous studies have shown that as age advances, homeostasis remains active and physiological stresses produce usual autonomic responses although their efficiency is reduced (7). Baroreflexes are less active in old age. Age-related decline

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in heart rate response suggesting diminished β adrenergic receptor responsiveness (7) and enhanced plasma nor-epinephrine responses (8) has been reported earlier.

Esler et al (9) have found that noradrenaline levels are elevated in hypertensive patients under 60 years of age and there is an abnormally high level of sympathetic activity and increased vascular reactivity to sympathetic neurotransmitter release in patients with essential hypertension. It is known that ageing leads to a decline in autonomic nervous system function (7) and decline in cardiovascular responses to passive HUT (10). However, there are very few reports on the effect of HUT on STIs in elderly subjects and hypertensive patients. STIs are non-invasive and sensitive clinical tests for determining the functional state of the heart (11). Hence, we planned to study (i) the STI variations in patients with essential hypertension and age-matched normal healthy subjects and (ii) tilt-induced STI changes in the two groups.

METHODS

The present study was conducted on 21 male patients (age: 47.76 ± 1.54 y; weight: 69.3 ± 0.89 kg; height: 161.95 ± 0.99 cm) attending JIPMER staff clinic for treatment of essential hypertension. They were non-alcoholics and their general physical condition was good with no signs of heart failure or left ventricular dysfunction. They were under treatment with oral β-blocker (Atenolol). None of the patients had family history of hypertension. Minimum duration of hypertension was 5 y (range 5–20 y). 21 age-matched normal healthy male subjects (age: 46.09 ± 0.99 y; weight: 66.7 ± 1.21 kg; height: 162.9 ± 0.94 cm) were studied as control group. Anthropometrical data of the hypertensive and control subjects were comparable and there was no statistically significant difference between the two groups.

After explaining the experimental design, informed consent was obtained from them. On the day of the test, the subject was made to lie supine on the tilt table. Lead II ECG, Phonocardiogram and carotid pulse were recorded simultaneously on 8-channel polygraph (Nihon-Kohden, Japan). STIs were measured at a paper speed of 100 mm/s. Electromechanical systole (QS_2) was measured as the time duration (ms) from the onset of QRS complex of the ECG to the first high frequency vibration of second heart sound. Left ventricular ejection time (LVET) was measured as the time duration (ms) between the beginning of the upstroke to the dicrotic notch of the carotid pulse tracing. Pre ejection period (PEP) was calculated as the difference between QS_2 and LVET ($PEP = QS_2 - LVET$). Ejection fraction (EF) was calculated by using equation $EF = 1.125 - (1.25X\ PEP/LVET)$ devised by Garrad et al (12). Basal recordings were taken after 5 min supine rest on the tilt table. Response to 60° HUT was recorded immediately after and at 1, 2, 3, 4 and 5 min after the tilt.

The data was subjected to statistical analysis using students 't' test. P values of less than 0.05 were taken as statistically significant.

RESULTS

The basal value of QS_2 was similar in hypertensive and control subjects (Fig. 1). In hypertensive patients, the basal values of PEP, PEP/LVET ratio were insignificantly higher while the LVET and EF were insignificantly lower than the control subjects (Fig. 2 and 3).

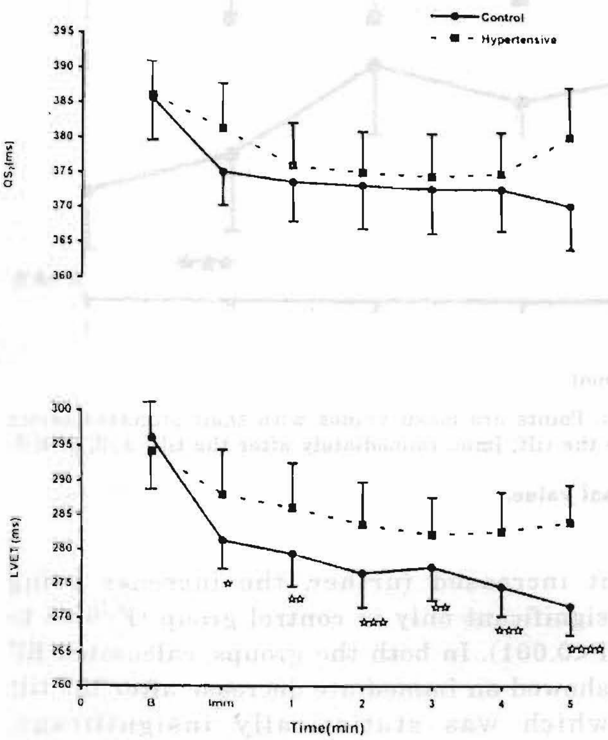

Fig. 1 : Effect of 60° head-up tilt on electromechanical systole (QS_2) and left ventricular ejection time (LVET). Points are mean values with their standard errors represented by vertical bars. B: basal values before the tilt; Imm: Immediately after the tilt; 1, 2, 3, 4, 5: minutes after the tilt.
*P<0.05; **P<0.02; ***P<0.01; ****P<.001 as compared to basal value.

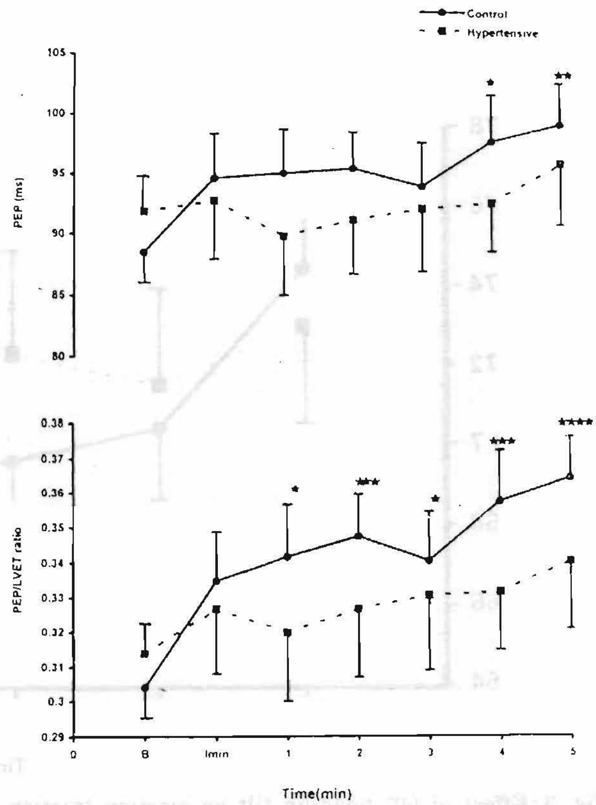

Fig. 2 : Effect of 60° head-up tilt on pre-ejection period (PEP) and PEP/LVET ratio. Points are mean values with their standard errors represented by vertical bars. B: basal values before the tilt; Imm: Immediately after the tilt; 1, 2, 3, 4, 5: minutes after the tilt.
*P<0.05; **P<0.02; ***P<0.01; ****P<.001 as compared to basal value.

After 60° HUT, QS_2 decreased immediately in both the groups, the decrease being less in hypertensive group than the control group. Its value decreased progressively throughout the tilt period in both the groups. However hypertensive group showed some recovery towards the end of the study period. These changes in QS_2 were not statistically significant.

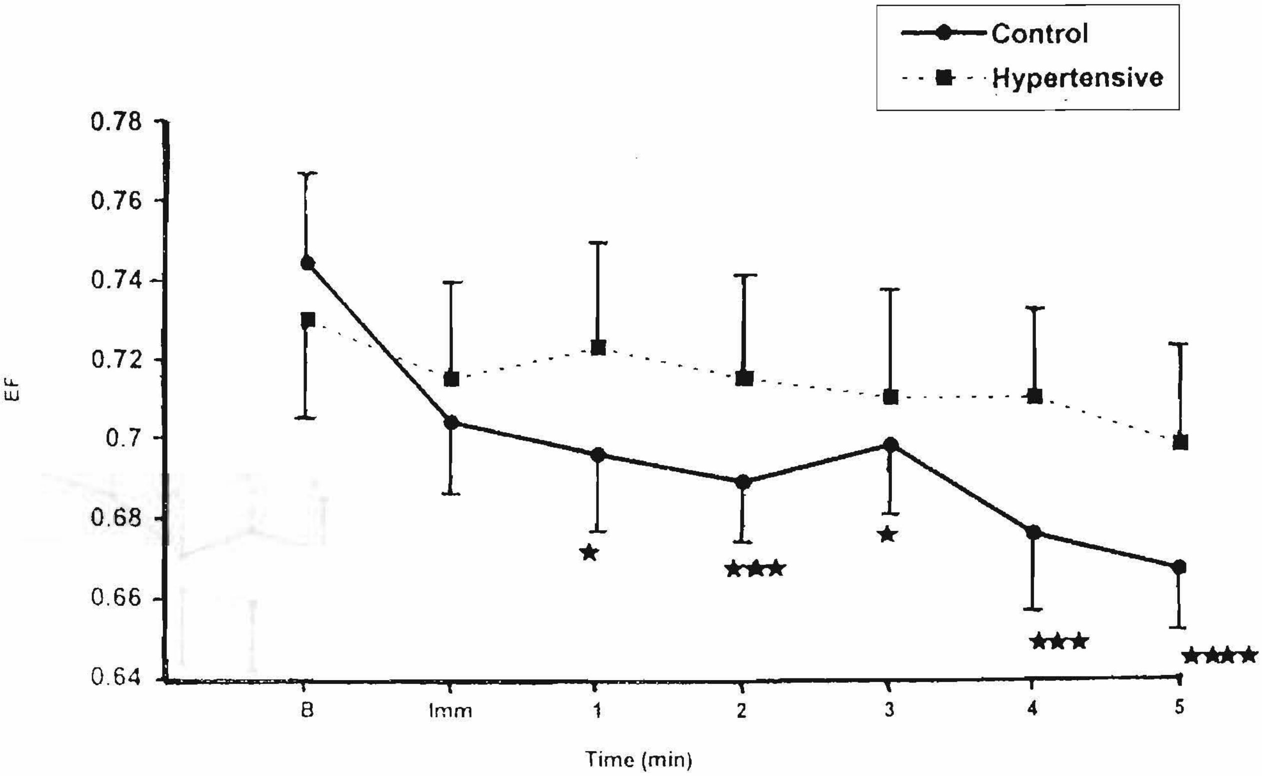

Fig. 3 : Effect of 60° head-up tilt on ejection fraction (EF). Points are mean values with their standard errors represented by vertical bars. B: basal values before the tilt; Imm: Immediately after the tilt; 1, 2, 3, 4, 5: minutes after the tilt.
*P<0.05; ***P<0.01; ****P<.001 as compared to basal value.

Immediately after the tilt LVET decreased from its respective basal value in both the groups. This decrease was statistically significant (P<0.05) only in case of control group. In the control group its value decreased further, the decrease being highly significant (P<0.001) at 5 minutes after the tilt. In the control group, PEP increased insignificantly immediately after the tilt. Its value increased further, the increase being significant at 4 minutes (P<0.05) and 5 minutes (P<0.02). In hypertensive patients, the changes in the PEP were statistically insignificant. Immediately after the tilt PEP/LVET ratio showed an insignificant increase in both the groups. Subsequently it increased further, the increase being significant only in control group (P<0.05 to P<0.001). In both the groups, calculated EF showed an immediate decrease after the tilt which was statistically insignificant. Subsequently its value decreased further in the control group, the decrease being significant (P<0.001).

DISCUSSION

In the present study, resting values of QS_2 were similar in the control and hypertensive subjects. This is in agreement with the findings of Rossi et al (13) who reported that QS_2 is only marginally (1.1%)

higher in hypertensive patients as compared to normal subjects. Our results are not in agreement with those of De Scalzi et al (3) who have reported that hypertensive patients have larger QS_2 values as compared to the normotensive subjects. Tilt-induced decrease in LVET was significant in our normotensive subjects, but not in the hypertensive patients. The decrease in QS_2 and LVET indicate improved inotropic state of the myocardium. Our study shows that the inotropic response to 60° HUT is blunted in hypertensive patients. Frey and Kenny (14) have reported that 70° HUT increases the duration of PEP. Our control subjects also showed a significant increase in PEP after 60° HUT. Prolongation of PEP after HUT implies a decrease in velocity of pressure rise in the left ventricle as a result of increased diastolic blood pressure and after load on the left ventricle. In our hypertensive patients, the tilt-induced increase in PEP was blunted. PEP provides an indirect measure of the maximal velocity of myocardial fiber shortening (contractility) which in turn is directly related to the rate of left ventricular pressure rise during isovolumetric contraction (15).

In control subjects, 60° HUT produced a progressive and significant increase in PEP/LVET ratio. This is in agreement with the findings of Stafford et al (11) who demonstrated an increase in the PEP/LVET ratio during assumption of upright posture and during peripheral pooling of blood with venous occlusion tourniquet. In our hypertensive patients, the resting value of PEP/LVET ratio was higher than that of the control group and the tilt-induced increase in the ratio was less marked as compared to the control group. Since PEP/LVET ratio is closely related to cardiac output and stroke volume, it has been used as a simplified semi quantitative measure of circulatory impairment in arteriosclerosis and hypertensive heart disease (16). Our findings of larger PEP/LVET ratio in hypertensive patients is in agreement with Rossi et al (13). Other workers have found a prolongation of PEP/LVET ratio in heart disease (15, 16, 17) and this indicates depression of left ventricular contractility.

In our hypertensive patients, the basal value of EF was insignificantly lower as compared to the control subjects. Tilt-induced response in EF was less marked in hypertensive patients as compared to the normotensive subjects. This shows that tilt-induced response of myocardium is blunted in hypertensive patients. Ahmed et al (17) also have reported that EF is depressed in patients with right or left ventricular overload. EF shows a significant correlation with PEP, LVET and PEP/LVET ratio (12). In our hypertensive patients, tilt-induced changes in all these parameters were less marked as compared to normotensive subjects. Our study shows that tilt-induced changes in STIs are blunted in hypertension. Our hypertensive patients had mild to moderate, uncomplicated hypertension. From the studies of Stafford et al (11) and Spodick et al (18) as well as the present work, it is clear that measurement of tilt-induced changes in STIs can be used as a sensitive and reliable test for assessing the status of cardiac function in patients suffering from hypertension.

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