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Cardiovascular changes in graded Head Up Tilt

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ABSTRACT

Background: Standing appears to be a simple act but it involves a lot of changes in the different systems of the body. Of all systems, the cardiovascular system is affected the most. Hence a study was conducted to observe the changes in the cardiovascular system on Head Up Tilt (HUT). **Methods**: The parameters which represent the cardiovascular autonomic function like, Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Arterial Pressure (MAP) and Pulse Pressure (PP) were recorded at supine, 30°, 60° and 80° Head Up Tilt in 30 subjects. **Results**: It was observed that there was a progressive increase in mean HR,DBP on HUT from supine to 30°, 60° and 80° .The mean resting systolic BP was reduced from 115.7 ± 6.0 to 110.8 ± 5.6, 107.2 ± 4.6 and 104.2 ± 66 from supine to 30°, 60° and 80° respectively. The MAP gradually increased and PP gradually decreased on progressive HUT. **Conclusions**: Systolic blood pressure decreased on changing from recumbent to upright position on the tilt table. There is 20-30% shift of venous blood from the central to the peripheral compartment due to the effect of gravity. 50% of change occurs within seconds resulting in decreased cardiac output and hence SBP decreased. This stimulated the baroreceptors,in turn the sympathetic system so HR and DBP are increased. And hence changes in MAP and PP were observed.

KEYWORDS

Head Up Tilt;
Autonomic nervous system.

INTRODUCTION

Head Up Tilt has long been considered as a convenient model to study reflex responses to gravitational stress[1]. During Head Up Tilt the changes occurring in the body are almost the same as those during standing like pooling of the blood in the lower part of the body and low pressure in the carotid sinus[2].

Orthostatic challenge (Head Up Tilt) induces marked shifts of blood from the cardiopulmonary into lower extremity vascular compartment causing central hypovolemia[3]. Hence counter regulating mechanism take place immediately including central and peripheral circulating responses and neurohumoral responses producing an increase in heart rate and a decrease in blood pressure[4,5]. This test is useful in assessment of cardiovascular reflex response of normal subjects who may be involved in specialized occupations such as flying. Head Up Tilt has also becomes an accepted diagnostic tool in the study of a poorly understood clinical entity often referred to as "Neurocardiogenic syncope"[6]. Most of the research works studied the changes in cardiovascular system to prolonged Head Up Tilt .Hence the present study was taken to study the immediate response in cardiovascular system to graded Head Up Tilt in normal subjects.

MATERIAL AND METHODS

The study was conducted on 30 healthy male subjects in the age group of 17-25 years. Selection of subjects was done on the basis of a detailed medical history and general physical examination. Subjects with past history of syncope and the presence of diabetes mellitus or any other illness known to affect the results were excluded. The subjects were explained about the procedure of test to eliminate fear and an informed consent was also taken.

A pretested structural proforma was used to collect the relevant information. The subjects were instructed not to take tea or coffee for at least 2 hours before the test. All the recording was done in the morning session between 11 AM to 1 PM.

A manually operated tilt table with foot plate support was used to do the test. Additional straps were applied at the level of knee, waist and shoulder. The metal arc is attached to the table with holes at various angles (30°, 60° and 80°). The table was locked at particular angle by the iron rod. Subjects were kept in each degree of tilt for 5 minutes. Before the change in the tilt, the subjects were brought to the supine position for 5 minutes rest. The systolic pressure, diastolic pressure and heart rate were recorded within 20 seconds after change in posture. Pulse pressure and mean arterial pressure were calculated. The subjects were asked for any symptoms such as nausea, palpitation, light headiness and fainting and no such thing was noted.

Results were presented as Mean ± SD. One way ANOVA was used for multiple group comparison followed by post hoc Tukey's test for group wise comparison. A "p" value of 0.05 or less was considered for statistical significance. SPSS (version 16) package was used for analysis.

RESULTS

For the purpose of analysis of data, the supine posture and 30°, 60°, 80° angles of Head Up Tilt were grouped as I, II, III, IV. The anthropometric data of the subjects were given in TABLE 1.

TABLE 1 : Anthropometric variables

Parameters	Subjects
Age (Years)	20.7 ±1.98
Height (cms)	168.19±19.9
Weight (kgs)	56.6±6.9
BMI	20.7 ±2.38

The mean heart rate (beats/min) in supine position was 71.8 ± 4.7. There was a progressive increase in heart rate on Head Up Tilt to 30°, 60°, and 80°. On comparing the mean values of HR in supine with 30°, 60°, and 80° Head Up Tilt the increase in heart rate was statistically significant ($P < 0.001$) (TABLE 2).

The mean resting systolic blood pressure (mm Hg) was 115.7 ± 6.0. With gradual Head Up Tilt to 30°, 60° and 80° the SBP were 110.8 ± 5.6, 107.2 ± 4.6 and 104.2 ± 4.6 .Statistical analysis was done to compare the mean SBP in supine with 30, 60° and 80° and this showed statistically significant value except between 60 to 80° (TABLE 2).

The mean diastolic blood pressure (mm Hg) increased on gradual Head Up Tilt. On comparing the DBP from supine to HUT in various degrees, it showed statistically a significant decreases $P < 0.001$ except between supine and 30°C which was not significant (TABLE 2).

The mean pulse pressure in (mm Hg) supine was 36.7 ± 4.5 on Head Up Tilt. The mean values were 29.2 ± 4.2, 23.0 ± 4.7 and 17.6 ± 4.0 at 30°, 60° and 80° respectively With Head Up Tilt the pulse pressure decreased and it was statistically significant also. $P < 0.001$ HS (TABLE 2). The mean arterial blood pressure (mm Hg) increased on gradual Head Up Tilt. On comparing the MAP from supine to HUT in various degrees, it was not statistically significant $P = 0.77$ (TABLE 2).

DISCUSSION

Orthostasis can be generally defined as any process that produces physiological responses similar to those induced by the upright, stationary posture[7]. One of the most commonly used technique for assumption of orthostatic stress is Head Up Tilt[8,9]. The most com-

TABLE 2 : Comparison of cardiovascular parameters between supine and various degrees of HUT

Parameters		supine(I)	30°(II)	60°(III)	80°(IV)	F* Value	P Value	Significant pairs**
HR	Mean	71.8	76.7	81.9	87.8	62.7	P<0.001 HS	I&II,I&III, I&IV, II&III,II&IV, III&IV
	SD	4.7	4.9	5.3	4.8			
SBP	Mean	115.7	110.8	107.2	104.2	28.4	P<0.001 HS	I&II,I&III, I&IV, II&III,II&IV
	SD	6.0	5.6	4.6	4.6			
DBP	Mean	79.0	81.6	84.2	86.6	9.7	P<0.001 HS	I&III,I&IV, II&IV
	SD	6.1	6.0	6.3	5.6			
PP	Mean	36.7	29.2	23.0	17.6	114.5	P<0.001 HS	I&II,I&III,I&IV, II&III,II&IV, III&IV
	SD	4.5	4.2	4.7	4.0			
MAP	Mean	91.2	91.3	91.9	92.5	0.4	P=0.77 NS	-
	SD	5.7	5.5	5.3	4.9			

***Oneway ANOVA test. **Tukey's post hoc test**

mon tilt table testing protocol is one that incorporates an angle of 30°, 60° and 80° Head Up Tilting and our objective was to study the immediate first (30 seconds) hemodynamic response of healthy adults to head up posture.

In our study on graded HUT, there was significant increase from baseline pulse rate. Similar findings have been documented by many workers[2,3,9,10]. During HUT there is a pooling of the blood in the lower parts of the body and low pressure in the carotid sinus. This removes stretch from baroreceptors leading to increase in heart rate, due to increase in sympathetic tone due to increase in sympathetic flow from the brain-stem centres. There is also a decrease in parasympathetic tone due to associated release of vagal tone. Some workers also reported an increase in plasma adrenaline levels in response to increase in the angle of tilt[1].

Smith et al. have also reported similar findings in their study and showed that immediate response in young adults is characterized by a prompt rise in heart rate which peaks at about 8 to 15 seconds and then tapers[11].

The mean value of baseline systolic blood pressure showed a significant decrease on HUT. When humans assume the upright posture, there is large gravitational shift of the blood away from the chest to the distensible venous capacitance system below the diaphragm[2]. In conditions where the muscle pump is inactive, a hydrostatic venous pooling of the blood in the lower extremities takes place. There is 20-30% shift of venous blood from central to the peripheral compartment. 50% of change occurs within seconds resulting in decreased cardiac filling and end diastolic volume[11]. The reduction in stroke volume may lead to a reduction in cardiac output and systolic blood pressure. Gabbett et al.and Konig EM et al. also reported a decrease in systolic blood pressure in Head Up Tilt[7,11].

In our study there was increase in the diastolic blood pressure with increasing angle of Head Up Tilt. During Head Up Tilt decrease in central blood volume and cardiac output cause reflex increase in heart rate and peripheral vascular resistance via activation of cardiopulmonary and arterial baroreflex pathways causing vasoconstriction. Total peripheral resistance increased in turn the diastolic blood pressure in an attempt to restore the arterial pressure towards a homoeostatic level in orthostatic stress[12,13].

In our study the pulse pressure decreased on 30°, 60° and 80° Head Up Tilting. Pulse pressure maintains the normal pulsatile flow of the blood and pulse pressure is the difference between systolic and diastolic blood pressure. In our study pulse pressure showed a decrease value because systolic pressure is decreased more compared to increased diastolic pressure. This finding is in consistency with the earlier work done by Gabbett et al.and Zaidi et al.[7,13].

Our study showed an increased in MAP from supine to 30°, 60° and 80° head up position. Even though MAP is increased the increase is only minimal. Reasons for this is despite decreased cardiac output a fall in the mean arterial pressure is prevented by a compensatory vasoconstriction of the resistance and capacitance vessels in the splanchnic, musculocutaneous and renal vascular beds within a minute. MAP is increased mainly by the reflex cardiovascular function in response to decrease distending carotid sinus pressure[7,13].

Another reason was MAP found to change very little since changes in systolic and diastolic blood pressure are opposite in direction.

CONCLUSION

In conclusion our study showed that during the graded Head Up Tilt in the first 30 seconds there was a significant increase in HR, DBP and MAP. Increase in HR may be due to increased sympathetic activity and decreased vagal tone and increase in the DBP was to increase peripheral resistance which occurs due to various cardiovascular reflexes. The SBP and PP recorded a fall mainly due to the venous pooling in the extremities and decrease stroke volume.

Limitations

This study also has some limitation because of time factor, this study could not be carried out in large sample size, and also it is studied only in young males. So the result of the study cannot be generalized for both sexes.

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