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Original Article

Cardiovascular autonomic responses to passive head uptilt in males and females

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A R T I C L E I N F O

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A B S T R A C T

AIMS: Orthostatic stress is commonly utilized to evaluate the cardiovascular autonomic function. This is done by Head Up Tilt (HUT).. Tilt table test is a standardized, physiological, clinically relevant stimulus that challenges the cardiovascular regulation. By the performance of head up tilt, it is possible to assess the dynamic capacity of regulatory system. Human responses to head up tilt are a window on Central Nervous System (CNS). MATERIALS AND METHOD: 100 healthy males and females between age group of 15-45 years were selected. A pretested structured proforma was used. Manually operated tilt table was used which is locked at30°,60° and 80°. ECG recordings were observed over monitor for 5 minutes in each position .Blood Pressure (BP) and Heart Rate (HR) were recorded within 20 seconds of change of posture. A repeated measure ANNOVA was used for analysis at different tilts. RESULTS: HR and Diastolic Blood Pressure (DBP), Mean arterial Pressure (MAP) increased on HUT in both males and females. The increase in heart rate in females was less than males. CONCLUSION: During HUT there is increase in sympathetic activity resulting in increase in HR and DPB. The gender differences need to be further investigated. Postural stress test is useful for medical students, physiologist and clinicians to understand cardiovascular reflex response in healthy individuals

1. Introduction

Baroreflexes are an important mechanism by which the Central Nervous System controls blood pressure in response to acute challenges [1]. Imbalance between sympathetic activation of heart and the vasculature has been described in heart failure patients and postural tachycardia patients. There are many factors which will influence the baroreflex function. Variation in blood pressure with age and gender has also been reported. The postural hypotension is the most disabling feature of autonomic dysfunction. The autonomic tests are helpful when the history and physical examination findings are inconclusive [2].

Postural stress test was used for assessment of cardio-vascular reflex response in normal subjects by Dikshit MB. Various degrees of tilt ranging from30°-90° have been used, but 70° head up had shown the most common cardio-vascular effects produced using this angle are similar to those produced with 90° HUT. It was observed that on HUT there was a reflex increase in HR and DBP[3]. Abdel Rehman studied the sympathetic and hemodynamic responses to postural stress in males and females. It indicated that HR increased more in the females than it did in the males and MAP increased more in the males than in the females at 60° HUT. Pulse pressure at 60° HUT was greater in males than in females [4].

Leonelli FM studied the effects of various degrees of tilt in normal control subject. His study suggested that a protocol of 60° or 70° tilt testing for not more than 10 min would provide reasonable specificity for assessing syncope even with 60 °or 70° HUT for less than 10 min .30%-40% of patients with other wise unexplained syncope had a negative HUT response [5]. A study was conducted by Zaidi in which the hemodynamic effects of increasing angle of HUT were studied. They observed that every hemodynamic variable at each angle was significantly different from supine values. HUT produced progressive increase in HR and DBP with increasing tilt angle. However although 450 produced significantly less hemodynamic effect. There were no significant

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differences for angles between 60^0 and 90^0. Cardiac output fell on HUT by 17-20% and stroke volume by 28-34% but, increasing tilt angle produced no significant additional reduction in cardiac output and stroke volume because of increase in HR. They concluded that angles less than 60^0 produce significantly less hemodynamic effects than steeper angles. Increasing tilt angle beyond 60^0 produces no apparent additional effect on cardiac output or sympathetic tone. 60^0 of tilt is a more practical angle for support of a syncopal patient and is recommended [6]. This study is undertaken to study the cardiovascular response to passive tilting in males and females.

2. Materials and Methods

100 healthy male and females between age group of 15-45were are selected from general population randomly. Consent was taken. The study was conducted after lunch between 12 noon to 2 pm.

Exclusion criteria:

- Obese
- Alcoholics
- Smokers
- Hypertensive
- Age below15 and above 45yrs
- Subjects taking any medications
- Diabetic individuals

Preparation for tilt table test (TTT)

Generally there was no eating or drinking 4-6 hrs prior to test to limit the symptoms of nausea and vomiting .Manually operated tilt table with footplate support is used .The table is locked at particular angles. The angles used were 30°, 60°and 80°.ECG leads were fixed at right arm ,left arm, left foot and right foot. When normal lead II ECG was obtained these recordings were saved for a duration of 5 min. In supine position BP was recorded by using sphygmomanometer. BP was recorded within 20 sec after change in position . Heart rate is recorded by 5 min ECG. The table is tilted to 30°, 60° and80 °HUT position .Before the change in the tilt angle the subject was brought to the supine position for 5 min rest. Statistical analysis was done

3. Results

In our study as the tilt angle increased i-e 30 , 600 and 800 ,the DBP , HR and MAP increased progressively in both males and females [Table 1,3]. The SBP and PP decreased with increasing head up tilt in both males and females . [Table 1,3].The increase in the heart rate was more in males as compared to females [fig 1]. On comparing the blood pressure in supine and 30^0 , 60^0 and 80^0 , there was progressive increase in DBP , HR and MAP and in contrast to this there was decrease in SBP and PP[Table 2,4]

TABLE – 1 : Cardiovascular responses to HUT in males

Parameters	Supine		30 Deg		60 Deg		80 Deg	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
RR (min)	16.4	3.4	17.3	2.8	18.6	2.8	20.3	2.6
HR (bts/min)	73.3	4.9	75.4	5.0	76.5	4.9	79.1	5.9
SBP(mm of Hg)	113.7	6.0	109.7	7.6	107.0	6.5	105.5	6.0
DBP(mm of Hg)	78.2	8.3	78.7	9.0	79.4	8.2	80.3	7.6
PP(mm of Hg)	34.8	8.9	30.5	12.8	27.5	10.5	24.6	8.7
MAP(mm of Hg)	88.1	2.2	89.3	2.6	90.1	2.6	92.3	2.1

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

Parameters	Supine	30 Deg	60 Deg	80 Deg	p* Value	Significant Pairs**
HR (bts/min	73.3	75.4	76.5	79.1	p < 0.001 HS	I&II, I&III, I&IV, II&IV, III&IV
SBP(mm of Hg	113.7	109.7	107.0	105.5	p < 0.001 HS	I&II, I&III, I&IV, II&III, II&IV
DBP(mm of Hg)	78.2	78.7	79.4	80.3	p < 0.001 HS	–
PP(mm of Hg)	34.8	30.5	27.5	24.6	p < 0.001 HS	I&II, I&III, I&IV, II& III, II&IV
MAP(mm of Hg)	88.1	89.3	90.1	92.3	p < 0.001 HS	I&II, I&III, I&IV, II& III, II&IV
RR (/min)	16.4	17.3	18.6	20.3	p < 0.001 HS	I&II, I&III, I&IV, II&III, II&IV, III&IV

***Repeated measures ANNOVA test**
****Tukey's test**
HS – Highly significant , NS – Not significant

TABLE – 3 : Cardiovascular responses to HUT in females

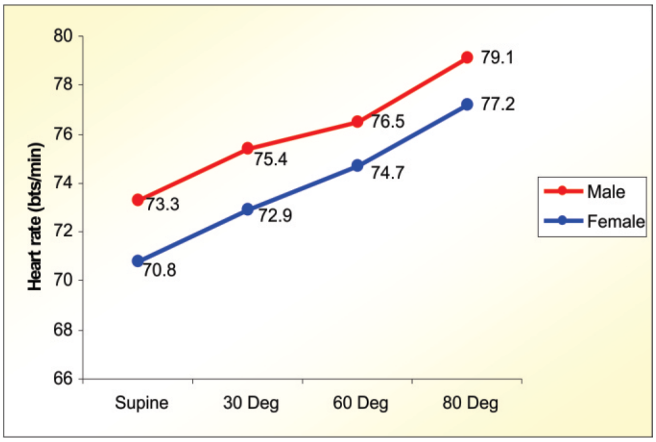
Parameters	Supine		30 Deg		60 Deg		80 Deg
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**
RR (min)	15.0	2.4	16.4	2.2	18.3	2.3	SD
HR (bts/min)	70.8	3.3	72.9	3.4	74.7	3.4	1.9
SBP(mm of Hg)	112.3	5.4	110.2	5.2	108.6	5.7	3.0
DBP(mm of Hg)	78.2	6.6	80.1	6.2	83.5	5.9	5.6
PP(mm of Hg)	34.5	7.0	30.0	6.8	25.0	7.7	5.5
MAP(mm of Hg)	89.1	9.8	89.9	5.0	91.7	4.6	6.8
							4.4

TABLE – 4 : Comparison of cardiovascular parameters between supine and various degrees of HUT in females

Parameters	Supine	30 Deg	60 Deg	80 Deg	p* Value	Significant Pairs**
HR (bts/min	70.8	72.9	74.7	77.2	p < 0.001 HS	I&II, I&III, I&IV, II&IV, III&IV
SBP(mm of Hg	112.3	110.2	108.6	106.2	p < 0.001 HS	I&II, I&III, I&IV, II&III, II&IV
DBP(mm of Hg)	78.2	80.1	83.5	85.2	p < 0.001 HS	–
PP(mm of Hg)	34.5	30.0	25.0	21.0	p < 0.001 HS	I&II, I&III, I&IV, II& III, II&IV
MAP(mm of Hg)	89.1	89.9	91.7	92.2	p < 0.001 HS	I&II, I&III, I&IV, II& III, II&IV

***Repeated measures ANNOVA test**
****Tukey's test**
HS – Highly significant , NS – Not significant

Fig 1: Comparison of heart rate with HUT in males and females



4. Discussion

Orthostatic stress is commonly utilized to evaluate cardiovascular autonomic function. This typically involves the passive movement from a supine to HUT. The most common tilt table testing protocol is one that incorporates an angle of 30°, 60°and 80° head up tilting .In our study heart rate increased linearly with increasing angle of HUT. The increase in heart rate was statistically significant ($p\leq 0.00$.). Light was thrown by Shoemaker JK over the gender related differences in the baroreceptor reflex control of HR in normotensive humans. Average age and BP were similar in both sexes, but females had a significantly higher HR. A major difference existed between the two sexes when the BP was elevated by intravenous administration of phenylephrine. Females had a significantly smaller baroreflex sensitivity, which inferred a gender-related difference in baroreceptor reflex control of HR. However, a positive correlation existed between basal HR and baroreflex sensitivity. It was important to investigate whether this difference was related to the significantly lower basal HR in female [7].

Six healthy subjects aged 30-58 years and 6 patients with orthostatic hypotension were choosen. Arterial pressure and HR were recorded. In healthy subjects HUT induced gradual circulatory adjustments. After 2 min upright, stroke volume and cardiac output had decreased by 39 9% and 26 10% respectively. Little change in mean BP at heart level indicated that systemic vascular resistance had increased by 39 24%. The gradual responses upon HUT contrasted with the pronounced and rapid circulatory responses upon tilt back. In the patients a progressive fall in BP on HUT was observed [8].

In 2006,the study was conducted by Vijaylakshmi in 20 healthy male aged 18-20yrs. HR and BP was recorded in 30°,60°,80 °degrees HUT . In this study 30 degree HUT there was no significant change in BP and HR, with 60° and 80° HUT there was a significant graded increase in DBP and decrease in pulse pressure[9].

During up-right posture there is pooling of 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 through withdrawal of vagal tone initially followed by increased sympathetic activity which leads to sustained tachycardia. Our findings were consistent with Tuckman [10] Zaidi A [11] and Bouddi BM [12].

In the present study the mean systolic blood pressure decreased from supine to head up tilt. On HUT the systolic blood pressure decreased on changing from supine to up right position. There is 20-30% shift of venous blood from the central to peripheral compartment,50% of change occurs within seconds and results in decreased cardiac filling pressure. The stroke volume is also decreased by 40%.This decreased afferent activity from the sensory baroreceptors and heart rate rises are due to increasing sympathetic activity .Similar findings were seen in the study by Tuckman J [10] Bouhaddi BM [12] and Roa [13]

In our study there was increase in diastolic blood pressure with increasing angle of HUT mean value showed a statistical significance ($p\leq 0.001$). On HUT there is increase in sympathetic activity, increase in vascular tone and increase in peripheral resistance which leads to an increased diastolic blood pressure. Our findings were consistent with Zaidi A [11] Bouhaddi BM

In the present study the mean arterial pressure increased on up right posture. On HUT increase in the diastolic blood pressure and decrease in systolic blood pressure resulted in increase in the mean arterial pressure. The hydrostatic gradients with HUT reduces the distending pressure in carotid sinus resulting in a sympatho-excitatory stimulus. This reduction in carotid sinus distending pressure would partially be corrected by increase in mean arterial pressure. Similar findings were observed by Ramsey [14].

5. Conclusion:

During the gradual head up tilt angles the heart rate , systolic blood pressure and diastolic blood pressure varied. The heart rate increased with gradual increase in head up tilt activity which could be due to sympathetic stimulation .The systolic blood pressure decreased mainly due to decrease in cardiac output. The diastolic blood pressure increased on HUT due to variations in vascular tone and peripheral resistance. The change in values of systolic and diastolic blood pressure resulted a change in pulse pressure.

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