ORIGINAL ARTICLE

HEART RATE AND BLOOD PRESSURE RESPONSES TO ORTHOSTATIC STRESS DURING HEAD-UP TILT TEST

Humaira Fayyaz Khan, Muhammad Amjad Hameed, Umar Ali Khan
Department of Physiology, Islamic International Medical College, Rawalpindi, Pakistan

Background: Orthostatic intolerance is the development of symptoms during upright posture. Upright posture is the most physiological orthostatic stressor as it imposes stress leading to gravitational pooling of blood in the splanchnic venous reservoir and leg veins. The most commonly used orthostatic stress test device is the Head-up tilt table (HUT). HUT testing reproduces symptoms of orthostatic intolerance in a setting where haemodynamic variables can be assessed. This study examined the cardiovascular response to orthostatic challenge, and the effect of gender on them. **Methods:** One hundred patients with complaints of orthostatic intolerance underwent HUT testing under quiet environment. The changes of heart rate and artery blood pressure were observed during tilt table tests. **Result:** Neurally mediated reflex syncope was the most common pattern constituting 65.07% of all the positive responses followed by Postural orthostatic tachycardia syndrome (POTS) which was seen in 25.3% of positive responses. Dysautonomic response was 4.79% and psychogenic response was the least common seen only in one patient. **Conclusions:** Neually mediated reflex response is the major haemodynamic pattern displayed by patients of orthostatic intolerance during the tilt table tests, but there are still other three abnormal haemodynamic patterns.

Keywords: Orthostatic intolerance, Postural orthostatic tachycardia syndrome (POTS), Vasovagal response, Neurally mediated syncope, Dysautonomic, Psychogenic, Head-up tilt test

INTRODUCTION

Orthostatic intolerance is a broad term used for several conditions characterised by symptoms of light headedness, dizziness and faintness on assuming upright posture.[1] The underlying mechanism of orthostatic intolerance is the inability of the autonomic nervous system to maintain adequate haemodynamic of the body during upright posture resulting in cerebral hypoperfusion which leads to its symptoms.[2]

Upright posture is the most physiological orthostatic stressor and it imposes stress leading to gravitational pooling of blood in the splanchnic venous reservoir and leg veins.[2,3] On standing 300 to 500 ml of blood is forced downward to the abdominal area and lower extremities.[2,3] A healthy subject is able to reach orthostatic stabilization in 60 seconds or less by an increase in sympathetic outflow resulting in vasoconstriction of capacitance and arteriolar vessels.[2,4] However, in patients with orthostatic intolerance this compensatory mechanism is disturbed and reflex mediated changes in autonomic nervous system leads to decreased vascular tone, heart rate and cardiac output with resultant acute cerebral hypoperfusion[5]. Normally a reproducible cardiovascular reactivity (CVR) pattern mediated via autonomic nervous system results in slight increase (10–15 bpm) in heart rate and blood pressure (10–15 mmHg) to balance the situation.[5] When autonomic nervous system is dysfunctional normal CVR pattern is altered so that blood pressure is not maintained at adequate levels during upright posture resulting in cerebral hypoperfusion and symptoms of orthostatic intolerance.[5]

Head-up tilt test allows simulation of upright posture in carefully monitored and controlled conditions.[6] The haemodynamic response to postural challenge during Head-up tilt table test has emerged as an index test for cardiovascular autonomic activity.[6,7] The autonomically mediated hypotension and bradycardia seen in these patients may be sufficiently profound to cause transient loss of consciousness as seen in neurally mediated reflex syncope.[8] Pharmacological provocative agents like isoprenaline or nitroglycerin can be employed to increase subject's susceptibility to orthostatic intolerance.[9,10]

The development of syncope and other symptoms like dizziness, fatigue, light headedness etc during Head-up tilt test are closely preceded by haemodynamic changes.[2,8,10] These changes are very complex but four definite patterns of haemodynamic changes have been identified which are :

- Neurally mediated reflex syncope(classical vasovagal response) is characterised by the sudden onset of hypotension with or without coexistent bradycardia.[11]
- Postural orthostatic tachycardia syndrome (POTS) is characterised by an increase in heart rate of at least 30 beats per minute (or a maximum heart rate of 120 bpm) within the first 10 minutes upright during the baseline tilt, this tachycardia is not associated with profound hypotension.[8,11]
- Dysautonomic response is characterised by gradual parallel decline in systolic and diastolic blood pressure, leading to loss of consciousness. [11]
- Psychogenic or psychosomatic response is when these patients experience syncope during tilt testing with no

ascertainable alteration in heart rate, blood pressure, electroencephalographic, or transcranial blood flow patterns.[10,12]

This study was conducted to evaluate the haemodynamic patterns preceding the development of the symptoms in tilt table testing. The effect of gender was also studied on these patterns.

SUBJECTS AND METHODS

The study was conducted at the Electrophysiology Department of Armed Forces Institute of Cardiology/ National Institute of Heart Diseases (AFIC/NIHD) Rawalpindi) from May 2006 to May 2007. A total of 100 patients with orthostatic intolerance who fulfilled the inclusion criteria of more than one episode of unexplained syncope, pre-syncope, dizziness, light headedness were included. Patients were taken from the OPD and wards. The data were collected on a structured proforma which was filled for every patient with informed consent.

Drugs disturbing the cardiovascular and autonomic nervous systems, and affecting intravascular volume, e.g., ACE inhibitors, calcium channel blockers, α-receptor blockers, tricyclic antidepressants, diuretics, nitrates, opiates etc. were discontinued for at least 24 hours before the test. The test was performed after 8 hours of fasting. Testing was conducted from 8:00 AM to 2:00 PM. The still position of the subjects before recording the test was ensured.

Stabilisation phase lasted for 5 minutes in which patients were placed and properly strapped in supine position to tilt table and asked to avoid movement of the lower limb musculature and joints in order to maximise venous pooling. They were monitored in this position to obtain baseline heart rate and blood pressure measurements.

Patients were rapidly tilted to 70° for orthostatic stress. If the patients remained asymptomatic the test was continued with the drug provocation phase. Patients who did not develop abnormal response at the end of passive tilt phase were administered 400 µg of nitroglycerine sublingually (2 puffs of nitroglycerine spray in the mouth). Continuous ECG monitoring during the test was done using electronic defibrillator monitor (Medtronic Lifepak 20). ECG strips of 20 seconds were taken every 2 minutes and during the appearance of symptoms. Blood pressure was measured by an automated sphygmomanometer (Adult/paediatric Vital Signs Monitor Model-845).

The patients remained in a supine position for 5 minutes after drug provocation in supine position. The haemodynamic changes were recorded. The change in heart rate and blood pressure was evaluated manually. Test was considered positive if patient developed syncope, pre-syncope or abnormal heart rate and/or blood pressure response.

Data were analysed using SPSS-12. Variables were expressed as percentages.

RESULTS

Total numbers of patients inducted in the study were 100. Patients who had positive Head-up tilt test were assigned a category based on heart rate and blood pressure response during the test. Haemodynamic responses and the number of patient in each category are summarised in Table-1. Sixty-three patients displayed positive response. In the 63 positive responses 41 (65.07%) responses were of Neurally mediated reflex type (NMR). When NMR response was analysed further, it was seen that there were 23 (56.09%) patients who had a vasodepressor response pattern. The other response pattern observed was that of mixed type which was seen in 9 patients. The third category of response seen in the NMR was cardioinhibitory and it was also observed in 9 patients.

The second type of response seen was POTS which was seen in 16 (25.3%) of the 63 patients. Dysautonomic response was seen in 5 patients, giving a percentage of 7.9%. The psychogenic response was the least common seen only in one patient and a percentage of 1.5 was obtained.

Table-1: Haemodynamic Response Patterns

Response pattern	Count (%)
Neurally mediated reflex syncope	41 (65.07)
Vasodepressor	23 (56.07)
Mixed	9 (21.9)
Cardio inhibitory	9 (21.9)
Postural orthostatic tachycardia syndrome	16 (25.3)
Dysautonomic	3 (4.76)
Psychogenic	1 (1.5)
Normal	37 (37)
Total	**100**

Table-2 shows comparison between gender and the haemodynamic response. There were 91 males and 9 females. In patients with POTS the females were 3 (18.75%).

Table-2: Haemodynamic response and gender comparison

Response Pattern	Male n (%)	Female n (%)	Total
NMS	39 (95.12)	2 (4.8)	41
POTS	13 (81.25)	3 (18.75)	16
Dysautonomic	4 (80)	1 (20)	5
Psychogenic	1 (1.5)	0	1
Normal	34 (91.89)	3 (8.10)	37
Total	**91 (91)**	**9 (9)**	**100**

DISCUSSION

The pattern of blood pressure and heart rate response to tilt preceding the symptoms may provide better understanding of the different mechanisms of orthostatic intolerance. Vasovagal Syncope International Study (VASIS) in 1992 classified the different types of vasovagal reaction observed during tilt-induced syncope.[8]

In this study, the patterns of the haemodynamic changes were studied by observing changes in blood pressure and heart rate. A clear change in behaviour of blood pressure and heart rate just prior to the onset of symptoms was identified. Our findings are comparable Qingyou[13] who conducted tilt table testing in 90 children of orthostatic intolerance.

In a study by Zhonghua[14] in 100 paediatric patients 50% children with unexplained syncope displayed the haemodynamic pattern of vasovagal response, among which 31% displayed the pattern of vasodepressor response, 7% cardioinhibitory response, and 12% mixed response. Thirty-three patients (33%) displayed POTS response, 2% OH response, and 15% normal haemodynamic response. Patterns of dysautonomic response and chronotropic incompetence were not observed in these children with orthostatic intolerance.[14] Our study had been conducted on a varied group of patients, so dysautonomic pattern which is a gradual and parallel decline in systolic and diastolic blood pressure leading to loss of consciousness were seen. In work published by Nowak[15] the responses to head-up tilt obtained were similar to the responses in this study. However, that study had been conducted on 40 patients. Wang *et al* reported response pattern having similar ratios of dysautonomics and POTS.[16]

The study was conducted in an armed forces institution so 77% patients had armed forces background and 91% were male. The number of females in the study were very few therefore reliable inference regarding the effect of gender on the results cannot be made but still this finding is verified by Baron-Esquivias *et al*[17] who performed 1,219 head-up tilt tests and found no statistically significant effect of gender on Head-up tilt test positivity. McGavigan *et al*[18] failed to find any effect of gender on Head-up tilt test positivity in 665 tests. There was a high percentage (18.75%) of females with POTS in our study. High incidence of females in POTS has been well documented by Thieben MJ *et al*[19] who identified 86.8% females out of 152 patients with POTS. Similarly Raj SR[20] in a review article on POTS mentioned female to male ratio of 4:1. Neurally mediated responses were the major haemodynamic pattern displayed by the patients during the tilt table tests, but there are still other three abnormal haemodynamic patterns that were also seen. There is no difference in different gender groups at the positive rate and the distribution of the model of haemodynamic response.

CONCLUSION

In patients with orthostatic intolerance, a variety of haemodynamic response patterns are observed during tilt testing, suggesting that different syndromes can be diagnosed by the test thereby helping to develop individualised therapeutic treatments.

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Address for Correspondence:

Dr. Humaira Fayyaz Khan, Department of Physiology, Islamic International Medical College, Rawalpindi, Pakistan. **Cell:** +92-300-5344159

Email: drhumairakamal@yahoo.com