International Journal of Medical Research & Health Sciences

www.ijmrhs.com Volume 3 Issue 1 (Jan- Mar) Coden: IJMRHS Copyright @2013 ISSN: 2319-5886

Received: 12th Dec 2013 Revised: 26th Dec 2013 Accepted: 29th Dec 2013

Research article

EFFECT OF 30°AND 60° HEAD UP TILT ON CARDIOVASCULAR RESPONSES IN NORMOTENSIVE AND HYPERTENSIVE INDIVIDUALS

*Badwe AN[1], Soodan KS[2], Kulkarni NB[3], Latti RG[4]

[1]Associate Professor, [3]Professor, [4]Professor & HOD, Department of Physiology, Rural Medical College, Pravara Institute of Medical Sciences, Loni, Rahata, Ahmednagar, Maharashtra, India

[2]Ex-Principal Rural Medical College, Pravara Institute of Medical Sciences, Loni, Rahata, Ahmednagar, Maharashtra, India

*Corresponding author email: anand.badwe@gmail.com, Mob: +91-9096035553

ABSTRACT

Since 50 years, head up tilt table testing is being used by physiologists and physicians for different purposes. Many investigators have studied the effect of head up tilt at a specific angle on cardiovascular and autonomic functions in healthy individuals and reported usefulness of HUT in assessing the integrity of cardiovascular and autonomic functions. In present study effect of 30° and 60° head up tilt is studied on cardiovascular parameters (systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse pressure (PP), mean arterial blood pressure (MAP), heart rate/min (HR), rate pressure product (RPP)) in normotensive and hypertensive individuals. **METHODS:** Effect of 30° and 60° head up tilt on cardiovascular parameters was studied in normotensive (n=50) and hypertensive individuals (n=50) aged 15-70 years. Blood pressure and heart rate were determined by using electronic blood pressure apparatus. **RESULTS:** 30° and 60° HUT produced decrease in SBP, PP, MAP and increase in DBP, HR, RPP in both groups. The results were significant at selected different time intervals. The changes produced by 60° HUT were more significant than 30° HUT. The changes produced in the hypertensive group were more prominent than normotensive group. In conclusion significant changes in HR and RPP in hypertensive individuals indicated more myocardial oxygen consumption and myocardial work at both angles of HUT.

Keywords: Hypertensive, head up tilt, cardiovascular parameters

INTRODUCTION

Since 50 years, head up tilt table testing is being used by physiologists and physicians for different purposes. This includes effect of head up tilt (HUT) on heart rate and blood pressure changes in posture, for modeling responses to haemorrhage, as a technique for evaluating orthostatic hypotension, as a method to study haemodynamic and neuroendocrine responses in congestive autonomic dysfunction and hypertension, as well as tool of drug research.[1-6]

Many investigators have studied the effect of head up tilt at a specific angle on cardiovascular and autonomic functions in healthy individuals and reported usefulness of HUT in assessing the integrity of cardiovascular and autonomic functions.[7,8]

From literature survey conducted, it is found that, there are few studies conducted to study the effect of head up tilt on cardiovascular responses in hypertensive individuals. The studies conducted so far, have studied the effect of head up tilt mainly on cardiovascular parameters such as Systolic blood pressure (SBP), Diastolic blood pressure (DBP), heart rate variability (HR), Cardiac output (CO).[9-10] Hence in the present study we decided to study the following objectives in selected hypertensive patients from the

Medicine department and the Family Medicine Department of Pravara Rural Hospital, Loni.

Objectives:1. To study the effect of 30° and 60° head up tilt on cardiovascular parameters

2. Comparison of investigated parameters in normotensive group and hypertensive group

MATERIALS AND MEHTODS

It was a case control study conducted in the department of Physiology at Rural Medical College, Pravara Institute of Medical Sciences. The male subjects selected for the study were between the age group of 20-70 years (n=100) and were grouped in two groups as:

1. Normotensive (control group n=50)
2. Hypertensive (Study group n=50)

Control group: Age matched normotensive healthy subjects were selected as control and were selected from clerical, teaching staff and students of our institute, who fulfilled following criteria, were included as control subjects in the study:

- No signs of cardiac, vascular or neurological involvement
- No history of diabetes mellitus, hypertension
- No history of drug treatment
- No history of systemic illness

Their normal blood pressure status was considered according to guidelines of, Seventh Report of the Joint National Committee (JNC7) [11] on Prevention, Detection, Evaluation and Treatment of high blood pressure and Indian Hypertension Guidelines II, 2007 with optimal value as <120/<80 mm Hg and further variations in systolic blood pressure was considered in the range of 120-139 mmHg.Diastolic blood pressure variation was considered in the range of 80-89 mmHg.

Study group (Hypertensive): Study group included the hypertensive patients attending to Medicine department and the Family Medicine Department of Rural Medical College on outpatient basis. Hypertensive subjects suffering from major illness such as severe diabetic condition, congestive heart failure, coronary artery disease, arrhythmias were excluded from the study.

Same type of exclusion criteria was used for inclusion of normotensive subjects in the proposed study. The study protocol was approved by the Institutional Research Ethical Committee.

In this group also patients were between the age group of 20-70 years with diagnosed hypertension (i.e., history of hypertension less than 1 year).Hypertensive subjects were considered as, having systolic blood pressure of 140-159 mmHg and diastolic blood pressure of 90-99 mm Hg (Grade I hypertension = According to Joint National committee VII and Indian Hypertension Guidelines II, 2007).[11-14]

These subjects were under treatment or on blood pressure lowering medication with controlled hypertension (target blood pressure value 140/90) at the time of study. Their hypertensive status was determined by consulting physician of Medicine department and Family Medicine department.

METHODS

All subjects were called by appointment in the laboratory, 2 hours after light brake fast in the morning (09.00am-12.00pm). Subjects were instructed not to consume caffeinated beverage and to avoid smoking before 12 hours of the test. Subjects were informed in detail about study protocol and written consent was obtained before the study.

Before beginning of the test, anthropometric characteristics such as height (cm), weight (Kg), body mass index (BMI, Kg/m^2), percent fat (%), fat mass (FM, kg), fat free mass (FFM, kg) were recorded in all subjects.

Percent fat (%), fat mass (FM, kg), fat free mass (FFM, kg) parameters were determined by method of measurements of girth as described by McArdle et al.[15]

Subjects were made to lie comfortably on tilt table for 20 minutes in the supine position. Three straps were applied at the level of knee, waist and head. After 20 minutes of rest baseline cardiovascular parameters (SBP, DBP, PP, MAP, HR/MIN, RPP) were recorded at 1,5,10 minutes of interval by using digital blood pressure monitor (Digicheck, Japan).

Thereafter subjects underwent gradual head up tilt at 30°, 60° angles of tilt with the speed of 5°/Sec. During head up tilt manoeuvre passive head up tilt protocol was followed only for 10 minutes. Tilt table with foot board was used in the study to support body weight. The following sequence of recording was followed.

1. Basal: 20 minutes of rest on tilt table in supine position
2. After 30° HUT
3. After 60° HUT

Cardiac parameters were recorded immediately after 1,5,10 minutes of HUT. Between each HUT the subject was tilted back to horizontal position and allowed to rest for 10 minutes.

Statistical analysis: For each parameter of both groups-mean and standard deviation (SD) were calculated. To find any significant change the data was analyzed for the same group by applying Student t –test and between two groups by applying unpaired t-test. The P values less than 0.05 (P<0.05) were considered as statistically significant.

RESULTS:

Table:1. Anthropometric characteristics of subjects

Parameter	Normotensive	Hypertensive
Age(yrs)	35.72±1.88	49.28±1.94
Height (cm)	163.86±1.01	164.74±1.10
Body weight kg	55.26±1.20	65.56±1.71
BMI (Kg/m^2)	20.81±0.48	24.21±0.57
% Fat	23.89±1.01	31.10±1.05
Fat Mass (Kg)	13.47±0.67	21.02±1.18
Fat Free Mass (Kg)	41.76±0.92	43.94±0.82

Values are Mean ± SE

Higher values of anthropometric characteristics were recorded in hypertensive individuals as compared to control group, which were non significant (Table: 1).

All results are presented graphically for better understanding of the effect produced by both angles of head up tilt in both study groups.

Table: 2. Effect of 30°, 60°head up tilt on cardiovascular parameters in normotensive

Parameter	Basal	30°HUT			60° HUT		
		1 Min	5 Min	10 Min	1 Min	5 Min	10 Min
SBP	121.4±1.66	117.44±1.80*‡‡‡	118.42±2.03‡‡‡	119.64±1.79‡‡‡	116.94±2.13*	121.84±1.78	117.66±2.14*
DBP	76.26±1.30	77.04±1.30‡‡‡	77.22±1.21‡‡‡	78.1±1.57	78.8±1.43	80.26±2.25	80.54±1.58*
PP	45.88±1.29	40.4±1.64***	41.2±1.70*	41.7±1.71*	38.34±1.66***	40.24±1.90*	37.4±1.67***
MAP	91.51±1.60	90.43±1.79	89.53±1.82	90.24±1.80	91.49±1.51‡‡‡	93.09±2.31‡‡‡	92.88±1.62‡‡‡
HR/MIN	75.6±1.60	78.14±1.79*†††	80.52±1.82***†††	79.6±1.80*†††	89.24±2.01***	91.56±1.93***	89.62±2.56***
RRP	9.0±2.74	9.09±2.30	9.48±2.59*	9.72±1.16**	10.43±0.31***†††	11.35±0.41***†††	10.64±0.33***†††

Values are Mean ± SE. Pressure values are in mmHg. Basal values are before tilt. SBP: systolic blood pressure, DBP: diastolic blood pressure, PP: pulse Pressure, MAP: mean arterial blood pressure, HR/MIN: heart rate/min RPP: rate pressure. (Paired t –test:*P<0.05significant, **P<0.01 highly significant ***P<0.001 very highly significant, Comparison between 30° and 60° head up tilt: †P<0.05significant, ††P<0.01 highly significant †††P<0.001 very highly significant, Unpaired t test: ‡P<0.05 significant, ‡‡P<0.01 highly significant ‡‡‡<0.001 very highly significant)

Normotensive: 30° HUT caused minimal and significant decrease in SBP after 1 min of HUT. After 1 minute of tilt, there was minimal decrease in SBP, which remained insignificantly lower than basal value for a total duration of 10 minutes of HUT.

DBP showed a marginal increase than basal value after 1 minute of HUT and remained almost constant throughout the 10 minutes duration of HUT.

PP registered very highly significant decrease (P<0.001) in its value than the basal value after 1 minute of tilt and showed a further significant decrease (P<0.05) at 5 and 10 minutes of HUT.

MAP (=DBP+1/3 PP) showed insignificant decrease after 1 minute of HUT and the same pattern was continued for 5 and 10 minutes of HUT.

HR also registered increase in its value, which was more than basal value. This change was significant after 1minute (P<0.05) and at 5 (P<0.001), 10 (P<0.05) minutes of HUT.

RPP showed a marginal insignificant increase in its value after 1 minute of HUT, however after 5 (P<0.01) and 10 (P<0.001) minutes of HUT, RPP registered a significant increase in its value.

<u>60° HUT</u>: 60° HUT produced more significant changes in cardiovascular parameters as compared to 30° HUT. SBP decreased significantly (P<0.05) after 1 and 10 minutes (P<0.05) of HUT. Insignificant increase was observed at 5 minutes of HUT, than basal value.

DBP registered a marginal insignificant increase at 1 and 5 minutes of HUT, however at 10 minutes of HUT significant (P<0.05) increase in DBP was recorded. PP registered significant decrease at 1(P<0.001), 5(P<0.05), 10(P<0.001), minutes of HUT. This decrease was lower than basal value. MAP showed insignificant decrease in its value after 1,5,10 minutes of HUT. HR registered very highly significant (P<0.001) increase as compared to basal values throughout the duration of 10 minutes of HUT. RPP also recorded very highly significant (P<0.001) increase in its value as compared to basal values throughout the duration of 10 minutes of HUT

Table: 3 Effect of 30° and 60°head up tilt on cardiovascular parameters in hypertensive

Parameter	Basal	30°HUT			60° HUT		
		1 Min	5 Min	10 Min	1 Min	5 Min	10 Min
SBP	140.4±3.59	141.72±2.48	142.48±2.70†	140.5±2.58†	137.4±3.04‡‡‡	136.58±3.83†‡‡‡	132.62±3.49†‡‡‡
DBP	93.84±1.99	93.92±2.54	96.36±1.99	96.48±1.84	95.58±1.74‡‡‡	95.00±1.92‡‡‡	94.14±1.70
PP	49.78±2.15	45.50±1.99	45.88±2.00*	43.9±2.56*	46.66±2.90	43.78±1.99**	40.68±1.96***
MAP	109.33±2.16	111.25±1.81	111.65±2.02	111.03±1.73	100.60±3.18*	109.56±2.11‡‡‡	107.71±1.78‡‡‡
HR/MIN	75.48±1.96	75.80±2.31	76.82±1.78††	79.82±1.95**	84.26±1.74***†††‡	83.72±1.85***†††‡	84.80±2.33***††‡
RRP	10.7±0.36	10.98±0.38†††	10.82±0.39	10.84±0.38	11.74±0.43***	11.58±0.40*	11.40±0.41*

Values are Mean ± SE .Pressure values are in mmHg. Basal values are before tilt.SBP: systolic blood pressure, DBP: diastolic blood pressure, PP: Pulse pressure, MAP: mean arterial blood pressure, HR/MIN: heart rate/min, RPP: rate pressure product. (Paired t –test:*P<0.05significant, **P<0.01 highly significant ***P<0.001 very highly significant, Comparison between 30^0 and 60^0 head up tilt : †P<0.05significant, ††P<0.01 highly significant †††P<0.001 very highly significant, Unpaired t test: ‡P<0.05 significant, ‡‡P<0.01 highly significant ‡‡‡<0.001 very highly significant)

Hypertensive: All cardiovascular parameters recorded in hypertensives registered increase its value, as compared with normotensives at 30°and 60° HUT at different time intervals.

30° HUT: SBP registered a marginal insignificant increase in its value than the basal value after 1and 5 minutes of HUT. After 10 minutes of HUT decline in SBP was observed and returned to baseline values.

DBP also registered a marginal insignificant increase in its value than basal value after 1 minute of HUT and this insignificant increase was followed for 5 and 10 minutes of HUT.

PP showed an insignificant increase after 1 minute of HUT and increase at 5 and 10 minutes of HUT, was found to be more significant (P<0.05) than basal value.

MAP recorded insignificant increase in its value after 1,5,10 minutes of HUT

HR recorded initially decrease in its value as compared to basal value, however at 10 minutes of HUT significant (P<0.01) increase in HR was observed. RPP recorded a marginal insignificant increase than basal value after 1,5,10 minutes of HUT.

60°HUT: HUT SBP decreased insignificantly and remained lower than basal value during 1, 5, 10 minutes of HUT.

DBP recorded a marginal increase in its value than basal value at 1,5,10 minutes of HUT

PP recorded insignificant decrease after 1 minute of HUT, however this decrease was significant at 1 minute (P<0.01) and 10 minutes (P<0.001) of HUT than initial basal value. MAP registered a significant increase in its value after 1minute (P<0.05) of HUT.MAP showed further a marginal decrease at 1 and 5 minutes of HUT, than basal value. HR recorded a highly significant increase (P<0.001) at 1,5,10 minutes of HUT. RPP also registered very highly significant (P<0.001) increase in its value after 1 minute of HUT and remained significant (P<0.05) increased at 5 and 10 minutes of HUT.

DISCUSSION

In the present study, we studied effect of 30° and 60° HUT on cardiovascular parameters in normotensive and hypertensive subjects.

Normotensive: SBP, PP and MAP parameters decreased, while DBP, HR/MIN, RPP increased gradually as the angle of HUT increased. At 30° HUT changes recorded in SBP, PP, HR/MIN, RPP were significant.

Similarly same pattern of decrease in SBP, PP, and MAP was observed in normotensive at 60° HUT and significant pattern of increase in DBP, HR/MIN, and RPP was observed. Except decrease in MAP other findings of our study agree with the study conducted by Vijayalaxmi et al[15].It is important to note that, autonomic functions vary with ageing [16] and parasympathetic [17] is also reduced, since our subjects were selected from different age group (20-70 yrs). In normotensive subjects, significant fluctuations were not observed, since, during the initial phase of HUT intact autonomic activity[18] stabilized the cardiovascular parameters during the total duration of HUT.

Hypertensive: In hypertensive individuals, SBP, PP, MAP showed decrease at 30^0 and 60^0 HUT. Similarly DBP, HR/MIN, RPP showed increase in their value at both angles of HUT. However, these changes were more significant at higher angle of 60° HUT, in both groups.

MAP is dependent on heart rate (HR), stroke volume (SV) and total peripheral resistance (TPR), which can be correlated as MAP=HR X SVX TPR. During HUT, changes like pooling of blood in lower parts of the body and low carotid pressure in the carotid sinus occur.[19]

These gravity induced changes produced decreases in venous return, stroke volume, pulse pressure, mean arterial pressure which cause tachycardia and vasoconstriction, due to baroreceptor reflex[20]. In this upright posture increase in heart rate and peripheral resistance regulate blood pressure. This mechanism is more effective in younger individuals than older ones in maintaining blood pressure in upright posture. [21]This was the major factor to cause a decrease in SBP, PP and MAP during HUT.

Increase in HR, as reported by other studies is tilt dependent, which remained elevated throughout the period of HUT. However, this increase in HR may be due to increase in sympathetic stimulation and withdrawal of vagal tone, which is the prominent finding in hypertensive.[22]

HUT 30° and 60° produced an increase in RPP in both groups, but this increase was more in the hypertensive group than normotensive group. HUT of 60° produced a more significant increase in its value throughout the duration of HUT. The increase in RPP was caused due to increase in SBP and HR.RPP (Robinson Index) was expressed as RPP= SBP X HR $X10^{-3.}$ [23]RPP indicates myocardial oxygen consumption and cardiac work in normal subjects as well as patients with heart diseases.[24] It also indicates onset of ischaemia in patients undergoing surgery or the onset of coronary pain during exercise.[25,26] Higher values of RPP recorded in hypertensive than normotensive indicate more oxygen consumption, coronary blood flow and more myocardial work.

CONCLUSION

The results of this study indicate a significant effect of HUT on cardiovascular parameters in hypertensive group. It is worth noting that, significant changes in HR and RPP in hypertensive individuals indicated more myocardial oxygen consumption and myocardial work at both angles of HUT. These are more prominent at higher angles of HUT than the lower angle of HUT.

REFERENCES

1. Severe K, Lefrandt, Nordby G, Os I. Autonomic function in hypertensive and normotensive subjects. Hypertension 2001; 37:1351-56
2. Chakko S, Muligtapang RF, Huikuri HV. Alterrations in heart rate variability and its circardian rhythm in hypertensive patients with left ventricular hypertrophy free of coronary artery diseases. American Heart Journal 1993;126:1364-72.
3. Guzzeti S, Piccgluger E, Casati R. Sympathetic predominance in essential hypertension: a study employing spectral analysis of heart rate variability. J Hypertens 1988;6:711-17.
4. Singh JP, Larson NG, Tuji H. Reduced heart rate variability and new onset hypertension: The Framingham heart study. Hypertension 1998:77:93-297.
5. Huikuri HV, Ylitalo A, Pikkujamsa SM. Heart rate variability in systemic hypertension. Am J Cardiol. 1996;77(12): 1073-1077.
6. Pikkujamsa SM, Huikuri HV, Airaksinen KE. Rate variability and baroreflex sensitivity in hypertensive subjects with and without metabolic

features of insulin resistance syndrome. Am J Hypertens 1998;11:523-31.
7. Vaz M, Kulkarni RN, Rodrigues D, Shetty PS. Immediate heart rate responses to head up tilt in healthy human subjects: response characteristics and variability. Indain J Physiol Phramacol 1993:37(4):323-27.
8. Jahan N, Deepak KK, Kaushal Navita, Paudel BH. Effect of graded head up tilt on parasympathetic reactivity. Indain J Physiol Phramacol 1996:40(4):309-17.
9. James MA, Robinson G T, Potter JF. The effect of systemic blood pressure on cardiovascular reflexes in elderly subjects.Clinical Physiology 2008:21(1):67-76.
10. Wahbha MMAE, Wilson , Hainsworth R. Cardiovascular response to upright tilting in hypertensive patients with and without renal impairment and before and following nisoldopine treatment. Br. J. Clin. Pharmac 1990;29:733-39.
11. Guidelines sub committee. 1993 Guidelines for the management of mild hypertension:memorandum from a World Health Organization/ International Society of Hypertension meeting.J Hypertens 1993;11:905-918.
12. Joint National Committee on prevention, detection and treatment of high blood pressure .The sixth report of the Joint Committee on prevention, detection and treatment of high blood pressure.(JNC VI). Arch Intern Med 1997;157: 2413-46.
13. Chobanian AV, Bakris GL, Black AR. Joint Committee on prevention, detection and treatment of high blood pressure. National Heart, Lung and Blood Institute, National high blood pressure programme coordinating committee. Seventh report of the Joint Committee on prevention, detection and treatment of high blood pressure. Hypertension 2003;42:1206-52.
14. Shah Siddharth, convenor. Practical guidelines for physicians: Indian hypertension guidelines 2007. Supported by unrestricted educational grant Pfizer, India. Website address
15. McArdle W, Katch F, Katch V. Body composition assessment. In Exercise Physioloy: energy, Nutrition and Human Performance.5th Ed,Lippincott Williams and Wilkins, Baltimore:2001:772-776.
16. Collins KJ, AN Exton-Smith. Functional changes in autonomic responses with ageing. Age and Ageing 1980:9:17-24.
17. Vita GP, Calabro R, Toscano. Cardiovascular reflex test: Assessment of age adjusted normal range. J. Neural Sci 1986;75:263-74.
18. Guyton AC, Hall JE. Nervous regulation of the circulation and rapid control of arterial pressure. In T.B of Medical Physiology.11th Ed ,Saunders, Philadelphia. 2006:204-14.
19. Neto JAN, Gallo L, Manco JC. Mechanism of tachycardia on standing: Studies in normal individuals and in chronic changes in heart patients. Cardiovas Res. 1980;14:541-50.
20. Florica V, Kem DC. Plasma norepinephrine, blood pressure and heart rate response to graded change in body position. Aviat Space Environ Med 1985;56:1166-71.
21. Luutonen S, Antila K, Errko M. Haemodynamic response to head up tilt in elderly hypertensive and diabetic. Age and ageing 1995;24(4):315-20.
22. Langewitz W, Ruddel H, Schachinger H. Reduced parasympathetic cardiac control in patients with hypertension at rest and mental stress. Am Hear J 1994;127:199-204.
23. Pepper MG, Crawley BE.Technical note: Calculation and display of the rate/pressure product during anaesthesia using binary rate multipliers. Med and Bio. Eng and Comput.1985;23:187-89.
24. Globel FL, Nordstrom LA, Nelson RR. The rate pressure –product as an index of myocardial oxygen consumption during exercise in patients with angina pectoris. Circulation 1978;57:549-56
25. Cokkinos DV, Vorodis ES. Constancy of pressure product in pacing induced angina pectoris. British Heart Journal 1976;38:39-42.
26. Robinson BF. Relation heart rate and systolic blood pressure to the onset of pain in angina pectoris. Circulation 1967;35:1073-80.