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Effect of Lateral Positions of Body on Systemic Peripheral Resistance and Other Cardiovascular Parameters

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Abstract

Lateral positions of the body have some effect on autonomic nervous system. Systemic peripheral resistance is the main determinant of after load to the heart. It is regulated by the arterioles via sympathetic nerves and directly affects the diastolic blood pressure. One hundred asymptomatic healthy male subjects, aged 17-23 years, participated voluntarily in the present study, undertaken, to assess the effect of lateral positions of body on systemic peripheral resistance and other cardiovascular parameters. Cardiovascular parameters were recorded by mercury sphygmomanometer and Impedance Cardiovasograph (Nivomon) in three positions supine, left lateral and right lateral decubitus. Results showed significant increase in systemic peripheral resistance, systemic peripheral resistance index, and diastolic blood pressure in left lateral position. All the parameters were significant decreased in right lateral decubitus position in comparison to supine. Systemic peripheral resistance was maximum in left lateral position which indicates maximum sympathetic activity in left lateral position among the three positions supine, left lateral and right lateral decubitus. So, one should avoid left lateral decubitus position during rest to avoid extra load on the heart.

Keywords: Systemic Peripheral Resistance; Impedance Cardiovasograph; Lateral Decubitus.

Introduction

All the cardiovascular parameters in human body are controlled by autonomic nervous system. Autonomic nervous system has sympathetic and parasympathetic limbs which work synergistically but usually in opposite ways. It is well known fact that when a person changes position from supine to standing, there is venous pooling of blood leading to decreased venous return which further leads to decreased stroke volume and cardiac output. As a result systolic blood pressure decreases until this is not compensated by decreased baroreceptors discharge due to less stretching of baroreceptors caused by reduced cardiac output which ultimately increase the sympathetic activity to increase heart rate and blood pressure until it returns normal. So it is evident that change in posture directly affects the autonomic nervous system. Many researchers have shown that postural stress in the form of head –up-tilt produces sustained increase in heart rate and rate pressure product and tilting can be used for assessing the integrity of autonomic cardiovascular regulatory mechanisms in physiological as well as clinical situations [1]. Few studies have shown the acute effects of varying degree of head down tilt in form of increase in cardiopulmonary blood volume, decrease in forearm vascular resistance but little change in BP and HR with 15° and 30° head down tilt and assumed them to be associated with a reflex decrease in muscle sympathetic nerve activity [2-3]. Studies have shown that angle & duration of tilt also affect the cardiovascular parameters as acute 30° head down tilt (HDT) did not produce significant changes in BP and HR while 60–80° HDT for 5 min resulted in a significant increase in diastolic blood pressure, decrease in pulse pressure and insignificant change in systolic pressure, heart rate and rate pressure product. They hypothesized that decrease in pulse pressure is most likely due to a fall in stroke volume due to excessive preloading of the ventricles while increase in Diastolic blood pressure could be due to sympathoexcitation due to raised intracranial

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tension occurring with 60° and 80° HDT [4]. Decreased vagal activity has been observed in in various physiological and pathological conditions such as congestive heart failure and coronary artery disease. In patients with CHF, the time for the right lateral decubitus position was two-fold longer than that for the supine and left lateral decubitus positions. The increased cardiac sympathetic activity and decreased vagal tone in CHF patients were normalized in the right lateral decubitus position and concluded that right lateral decubitus position in patients with CHF may be a self-protecting mechanism of attenuating the imbalance of cardiac autonomic nervous activity [5,6]. Autonomic effect of various recumbent positions, namely the supine, left lateral decubitus and right lateral decubitus positions, in healthy subjects by using spectral heart rate variability analysis has also been studied and suggested that cardiac vagal activity is greatest when the right lateral decubitus position is adopted [7]. All these studies suggest that change in posture of the body affects the autonomic nervous system. Change in heart rate, stroke volume and systemic peripheral resistance can directly detect more precisely the magnitude of change in autonomic status. Measurement of systemic peripheral resistance is most important among cardiovascular parameters especially in hypertensive patients and their siblings, because increase in systemic peripheral resistance is more harmful for heart as heart need to do more work for pumping the same amount of blood which may lead to ventricular hypertrophy leading to further need of more blood supply to the increased muscle mass in myocardium and further deterioration of the condition. Therefore any posture which may increase the systemic peripheral resistance should be avoided especially in hypertensive and pre hypertensive. Therefore the present study was conducted to find out the direct effect of change in posture of the body on systemic peripheral resistance and other cardiovascular parameters.

Material and Methods

The present study was conducted in the department of physiology, Saraswathi Institute of Medical Sciences, Hapur. One hundred asymptomatic healthy male subjects, aged 17-23 years, participated voluntarily in the present study, undertaken, to assess the effect of lateral positions of body on systemic peripheral resistance and other cardiovascular parameters. Experiment procedures were in accordance with the ethical committee on human experimentation. Study was carried out at ambient temperature with minimal external or internal sound disturbances in the room. Subjects reported to laboratory 2 hours after light lunch. They were explained in detail about the experimental procedure. Informed consent was taken from all subjects. Subjects were asked to lie in supine position. The color coded 8 leads of NICO patient cable were connected at their respective locations on the body of subjects. Blood pressure was recorded by using mercury sphygmomanometer. Systemic peripheral resistance, heart rate, cardiac output, and other parameters were recorded using Impedance Cardiovasograph (Nivomon). After 10 minute of rest in supine position, all the parameters were recorded. Then subjects changed position to left lateral decubitus. Parameters were recorded again after 10 minutes of rest in left lateral decubitus position. Finally subjects changed the position to right lateral decubitus. Parameters were recorded again after 10 minutes of rest in right lateral decubitus position. All data were collected and statistical analysis was done by One-Way ANOVA and Tukey post Hoc tests using the window SPSS Statistics 17.0 version.

Result

Table 1 shows that, in comparison to supine

Table 1: Comparison of cardiovascular parameters in supine left lateral decubitus and right lateral decubitus positions

S. N.		Supine	Left Lateral Decubitus	Right Lateral Decubitus
1	Systolic blood pressure (SBP) (mm Hg)	119.82±4.5	121.2±3.2	110.2±5.5##
2	Diastolic blood pressure (DBP) (mm Hg)	77.92±3.2	83.32±4.5*	72.12±4.1#
3	Heart rate (HR) (per minute)	70.80±1.13	72.1±2.8	67.18±0.23##
4	Cardiac Output (CO) (L / min)	5.41±0.2	5.62±0.17	5.02±0.28##
5	Stroke volume (SV) (ml / beat)	74.04±0.82	76.28±2.5	70.24±0.26##
6	Systemic Peripheral Resistance (SPR) (dyne.sec / cm^5)	1360.1±17.4	1391.2±15.4*	1337.2±15.24#
7	Cardiac Index (CI) (L / min / m^2)	3.14±0.16	3.21±0.26	3.01±0.17##
8	Stroke volume Index (SI) (ml / beat / m^2)	44.81±0.12	45.46±0.18	42.02±0.22##
9	Systemic Vascular Resistance Index (SVRI) (dyne.sec / cm^5 / m^2)	777.5±11.5	791.5±13.1*	766.2±11.4#

Data presented are Mean±SD. *p<0.05, #p<0.05, ##p<0.01

*Comparison between parameters in supine ad left lateral decubitus

Comparison between parameters in supine ad right lateral decubitus

position, parameters in left lateral decubitus showed significant increase in systemic peripheral resistance, systemic peripheral resistance index, diastolic blood pressure ($p<0.05$) and insignificant increase in systolic blood pressure (SBP), heart rate (HR), cardiac output (CO), stroke volume (SV), cardiac index (CI) and stroke volume index (SI) ($p>0.05$). When compared to supine position, all the parameters in right lateral decubitus showed significant decrease. However decrease in parameters in right lateral decubitus was more significant in SBP, HR, CO, SV, CI, SI ($p<0.01$) and was less significant in DBP, SPR, SVRI ($p<0.05$).

Discussion

Blood pressure is regulated by autonomic nervous system. In hypertensive, sympathetic hyperactivity is one of the major causes of increase in blood pressure. Systemic peripheral resistance is mainly controlled by arterioles which have extensive sympathetic innervations. Sympathetic stimulation causes constriction of the arterioles and leads to increase in systemic peripheral resistance resulting in increase in diastolic blood pressure. Although systemic peripheral resistance also depend on other factors like temperature, viscosity of blood but these factors were remain unchanged in the present study. So it seems that change in autonomic activity is responsible for changes in parameters in the present study. Heart rate, stroke volume and systolic blood pressure decrease with decrease in sympathetic activity or increase in parasympathetic activity. Human S-A node receives its vagal innervations mainly from right vagus nerve. The right vagus nerve in the neck might be stimulated by periodic massage from the pulsation of the carotid artery in the right lateral decubitus position leading to higher parasympathetic activity. The position of the heart is lower in the left lateral decubitus than in the right lateral decubitus position. Gravity might exert an increased workload on cardiac function when the left lateral decubitus is assumed. A larger workload required in left lateral decubitus, as compared with the right lateral decubitus position, will produce more sympathetic and less vagal activity [8,9]. While reduction in this workload in right lateral decubitus position will lead to an enhancement of vagal activity. Because of right sided anatomical position of right atrium, the venous return from the venous system via inferior and superior vena cavae to the right atrium is more favorable when assuming the right lateral decubitus position, which may increase vagal activity. While in left lateral position, venous return is less in comparison to supine and right lateral decubitus. To compensate for decrease in venous return and cardiac output, sympathetic tone is enhanced and vagal tone is suppressed in left lateral position. Therefore there is possibility of, higher vagal activity and lower sympathetic activity in right lateral position with reversal of autonomic activity in left lateral position. Our results also indicate the increased parasympathetic activity in right lateral decubitus as shown by previous studies [10,11]. It can be also conclude from the present study that systemic peripheral resistance is significantly higher in left lateral decubitus so hypertensive as well as pre hypertensive people must avoid left lateral decubitus position during rest because it may be harmful for the heart while right lateral decubitus position should be preferred because it is associated with decreased peripheral resistance and increased parasympathetic activity.

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