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A Study Of Variation In Heart Rate Variability With Change In Posture In Young Adult Indian Males

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ABSTRACT:

Heart rate variability is predominantly dependent on the extrinsic regulation of the heart rate. The HRV response to postural change is a sensitive measure of the shift in autonomic balance from parasympathetic to sympathetic predominance that, when attenuated or absent, has been correlated with prevalent disease in patient populations..

Key-words: *Heart rate variability,Autonomic nervous system , Young adult Indian males, Change in posture, Supine-sitting-standing*

AIMS:

1. To study the effect of change in posture on HRV in young adult Indian males.
2. To compare HRV parameters in different postures in males.

KEY MESSAGES:

Heart Rate Variability parameters such as mean R-R interval, mean LF and mean HF showed significant difference with variation in posture from supine to sitting to standing in young adult males. This correlates with decrease of parasympathetic tone and increase of sympathetic influence with postural changes from lying to sitting and to standing positions.

SETTINGS AND DESIGN:

The study was conducted on 50 young adult males.

INTRODUCTION:

Measures of heart rate variability (HRV) are a reliable reflection of many physiological factors modulating the normal rhythm of the heart. [1] A growing number of studies indicate that increased variability in the heart's interbeat interval is physiologically desirable.[2]A depressed heart rate variability level usually indicates the presence of pathological conditions such as coronary artery disease, heart failure, diabetes and hypertension. HRV is also a predictor of left ventricular dysfunction following myocardial infarction and is a risk factor for morbidity and mortality. [1] HRV is important because it provides a window to observe the heart's ability to respond to normal regulatory impulses that affect its rhythm. At rest, both sympathetic and parasympathetic systems are active with moderate parasympathetic dominance. The actual balance between them is constantly changing, maintaining an optimum body function.

In addition to the autonomic nervous system, the external factors, like body posture also change the spectral characteristics of HRV. In the supine position, the parasympathetic modulation is dominant, and causes stronger high-frequency heartbeat fluctuations. In contrast, decreased parasympathetic function occurs in the standing position.[3]The HRV response to postural change is a sensitive measure of the shift in autonomic balance from parasympathetic to sympathetic predominance that, when attenuated or absent, has been correlated with prevalent disease in patient populations.[4]

The observations on the effects of posture on the pulse-rate deal mainly with the different rates in the lying, sitting, and standing positions. So far as explanations have been offered of postural effects on pulse rate and blood pressure, these have been attributed to hydrostatic influences affecting the amount of blood in the splanchnic area and the blood pressure in the head, in addition to the different amounts of static muscular contraction needed to maintain the different postures.

The present study was aimed to evaluate the difference in HRV parameters due to postural changes in young adult males. One of the best ways to assess the autonomic function is to analyze minute changes in heart rate, which are caused by many factors including regulatory influence of the autonomic nervous system.

HRV can be assessed by time domain or frequency domain indices.

Frequency domain measures of HRV provide information on the frequency distribution of the components of HRV using power spectral density analysis.

The high frequency (HF) component (0.15Hz -0.40 Hz) measures the influence of the vagus nerve in modulating the Sinuatrial node and the inspiratory inhibition of the vagal tone.

The low frequency (LF) component (0.04Hz-0.15 Hz) influenced baroreceptor-mediated regulation of blood pressure and reflects predominantly sympathetic activity.

The very low frequency (VLF) component (0.003Hz -0.04 Hz) reflects the influence of several factors on the heart, including chemo receptors, thermo receptors, the Renin-angiotensin system, and other non-regular factors. The purpose of the present study was to systematically investigate the effect of change in posture (lying to sitting to standing) on HRV and compare various components of HRV in the three postures in healthy young adult males in India.

SUBJECTS AND METHODS:

A total of 50 healthy young adult male volunteers were included in this study with age range from 18 to 25 years.

The study was conducted in the Department of Physiology at a Medical College.

The non smoker, non alcoholic, non diabetic, having normal pulse rate, blood pressure, normal heart sounds and having no evidence of illness and having perfect physical, mental and psychological well being were included in the study.

A brief history was taken and general physical examination of all the volunteers was done with main emphasis on cardiovascular diseases, renal diseases. None of the subjects took any medication at the time of study. All the tests were carried out between 11 am to 4 pm. The procedure was explained and informed consent was obtained after the subjects had read a description of the experimental protocol, which was approved by the ethical committee of the college. The height, weight and blood pressure of the subject was measured with measuring tape, weighing machine and sphygmomanometer respectively. On auscultation, the heart sounds were found to be normal.

The experiment consisted of 3 recordings and each performed in a sequence: lying position, sitting position and standing position. During the data collection, the volunteers were instructed not to speak or move. To evaluate the autonomic HR modulation response in relation to the supine, standing and sitting postures, data were recorded for a 5-minute period at rest for each condition respectively, with spontaneous breathing. Initially the subject was asked to lie down over a bench in horizontal supine position and relax. The probe of pulse oxymeter was clipped to the subject's index finger and care was taken that subject did not move his hand. The probe was connected to the Anu-photo-rheograph which was in turn connected to personal computer with application software (Variability Analyzer 2008). Record in lying position was taken.

After the first record, the subject was asked to get up and sit in a chair with hands placed on the bench at the level of her thorax and the probe of pulse oxymeter was attached to the index finger. Subject was asked to relax and record in sitting position was taken. At last the subject was asked to stand up with hands by the side of the body and the record was taken in standing position.

The recorded HRV raw data was analyzed in the frequency domain to get HRV graph and FFT power spectrum. Very low frequency (VLF), low frequency (LF), high frequency (HF) spectral powers were determined by integrating power spectrum between 0.00-0.04 Hz, 0.04-0.15 Hz and 0.15-0.4 Hz respectively and expressed in normalized units (nu). Total power was calculated between 0.00-0.5 Hz and expressed in absolute unit of millisecond squared.

The statistical analysis of the significance on the data was done using independent t-test. The statistical significance level was established at 5% ($p < 0.05$) and 1% ($p < 0.01$).

RESULTS:

Table1. Physical Characteristics of Male Subjects

Physical Characteristics				
Gender	Statistics	Parameter		
Male		Age	Height	Weight
	Mean	20.08	165.36	63.94
	Std. Deviation	2.89	7.29	7.13

Table2. Descriptive Statistics and One Way Anova

Parameter	Posture	Mean	Standard Deviation	F-stat	DF	P value
Mean RR Interval	Lying	0.82	0.15	14.748	2,147	0.00*
	Sitting	0.78	0.12			
	Standing	0.69	0.10			
Total Power	Lying	2264.80	2381.18	0.519	2,147	0.596
	Sitting	2253.74	2385.17			
	Standing	1891.84	1285.78			
Very Low Frequency	Lying	19.04	11.16	0.187	2,147	0.83
	Sitting	19.32	9.20			
	Standing	20.18	8.72			
Low Frequency	Lying	27.76	8.40	6.894	2,147	0.001#
	Sitting	34.28	9.08			
	Standing	30.73	8.87			
High Frequency	Lying	20..00	11.30	7.66	2,147	0.001#
	Sitting	14.20	8.76			
	Standing	13.32	7.31			

#: Statistically significant at 5%level of significance i.e. P-value < 0.05

*: Statistically significant at 1%level of significance i.e. P-value < 0.01

Table3. Multiple Comparisons (Tucky's HSD)

Parameter	Posture	Posture	Mean Difference	P- value
Mean RR Interval	Lying	Sitting	0.04840	0.131
		Standing	0.13380	0.000*
	Sitting	Lying	-0.0480	0.131
		Standing	0.08540	0.002*
	Standing	Lying	-0.13380	0.000*
		Sitting	-0.08540	0.002*
Total Power	Lying	Sitting	11.06000	1.000
		Standing	372.96000	0.644
	Sitting	Lying	11.06000-	1.000
		Standing	361.90000	0.661
	Standing	Lying	-372.96000	0.644
		Sitting	-361.90000	0.661
Very Low Frequency	Lying	Sitting	-0.28188	0.989
		Standing	-1.14480	0.827
	Sitting	Lying	0.28188	0.989
		Standing	-0.86292	0.898
	Standing	Lying	1.14480	0.827
		Sitting	0.86292	0.898
Low Frequency	Lying	Sitting	-6.51986	0.001*
		Standing	-2.97252	0.212
	Sitting	Lying	6.51986	0.001*
		Standing	3.54734	0.112
	Standing	Lying	-2.97252	0.212
		Sitting	-3.54734	0.112
	Lying	Sitting	5.79444	0.006*

High Frequency		Standing	6.68042	0.001*
	Sitting	Lying	-5.79444	0.006*
		Standing	0.88598	0.882
	Standing	Lying	-6.68042	0.001*
		Sitting	-0.88598	0.882

#: Statistically significant at 5%level of significance i.e. P-value < 0.05

*: Statistically significant at 1%level of significance i.e. P-value <0.01

The mean RR Interval for males in lying, sitting and standing was 0.82 ± 0.15, 0.78 ± 0.12 and 0.69 ± 0.10 respectively. It is significantly different in three postures (P = 0.000).

The mean LF for males in lying, sitting and standing was 27.76 ± 8.40, 34.28± 9.08 and 30.73 ± 8.87 respectively. It is significantly different in three postures (P= 0.001).

The mean HF for males in lying, sitting and standing was 20.00± 11.30, 14.20 ± 8.76 and 13.32 ± 7.31respectively. It is significantly different in three postures. (P = 0.000).

The mean TP for males in lying, sitting and standing was 2264.80 ± 2381.18, 2253.74 ± 2385.17 and 1891.84 ± 1285.78 respectively. It is not significantly different (P > 0.05).

The mean VLF for males in lying, sitting and standing was 19.04± 11.16, 19.32 ± 9.20 and 20.18 ± 8.72 respectively. It is not significantly different (P > 0.05).

The mean difference in RR Interval for males between lying and standing and sitting and standing was 0.13380 and 0.08540{significantly different (P = 0.000 and 0.002 respectively.)}. The mean difference in RR Interval for males between lying and sitting was 0.04840{not significantly different (P > 0.05)}.

The mean difference in LF for males between sitting and lying was 6.51986{significantly different (P = 0.001)}. The mean difference in LF for males between lying and standing and sitting and standing was {-2.97252 and 3.54734 respectively. It is not significantly different (p > 0.05)}.

The mean difference in HF for males between lying and sitting and lying and standing was 5.79444 and 6.68042 respectively {significantly different (P =0.006 and 0.001 respectively)}.The mean difference in HF for males between sitting and standing was 0.88598{not significantly different (P > 0.05)}.

Discussion:

The HRV response to postural change is a sensitive measure of the shift in autonomic balance from parasympathetic to sympathetic predominance that, when attenuated or absent, has been correlated with prevalent disease in patient population. [4]The heart rate (HR) at rest is influenced by different factors, such as: genetic characteristics, anthropometrics (body mass and height), age, gender, hormonal and emotional factors, level of physical fitness and state of health, among others. The influence of these factors can be analyzed through postural tests. [5]It is well-known that orthostatic challenge test is one of the most informative methods used to detect subtle changes in cardiovascular function and specifically its regulatory mechanisms.[6] It helps to assess the ability of both sympathetic and parasympathetic nervous systems to adequately respond to regulatory challenge caused by gravitational shift in the body's blood mass. When body's position is changed from supine or sitting to standing, specific changes in heart rate and blood pressure happen as a compensatory reaction of the body. This standup maneuver as well as keeping a standing posture for several minutes does not cause any significant physical exertion to a healthy individual. However if body's regulatory mechanisms do not have adequate functional capacity or there is subtle cardiovascular deficiency then this maneuver becomes a significant stressor to the body.[6] In present study, mean RR interval decreases with change in posture in males (Table 2). A decrease of RR interval with change in posture from lying to sitting is not significant statistically. But when posture changes from sitting to standing, decrease of RR interval is significant. It has been reported in the literature that adjustments in HR modulation from the supine posture to the sitting and standing postures are due to hydrostatic deviations caused by the displacement of blood from the central region to the lower regions, thereby reducing the cardiac output, systemic arterial pressure and activation of the arterial and cardiopulmonary receptors. Similar results were obtained in a study by Zuttin R. S. et al. [5] Their results of analysis of RR interval showed that heart rate was greater in the sitting posture than in the supine posture.

The results of HRV analysis showed that the total power for males in three postures was not significantly different. Total power reflects overall influence of parasympathetic and sympathetic effect on cardiac function. [6]

In males, VLF slightly increased with changes in posture but difference in VLF in three positions was not significant statistically.VLF component of HRV analysis reflects the influence of several factors on the heart, including chemoreceptors, thermoreceptors, the renin-angiotensin system, and other non-regular factors.[8] The physiological meaning of this band is most disputable. With longer recordings, it is considered to represent sympathetic tone as well as slower hormonal and thermoregulatory effects. There are some findings indicating that in shorter recordings VLF has fair representation of various mental stress factors (negative emotions, worries, rumination etc.). In present study no significant difference in VLF component could be observed with change in posture in males. The factors described above influence the cardiac function as long-term regulatory mechanisms. So, this study which consists of three recordings of 5 minutes each (total 15 minutes) hence does not reflect the influence of above mentioned factors.

In the present study, in males, mean LF increased significantly with change in posture from lying to sitting. Then when posture changed from sitting to standing, LFdecreased but it was not significant statistically. Males demonstrated higher LF in standing position than in lying and difference is significant statistically. The results of the present study are matching with results of study by Zuttin R. S. et al.[5] They observed that for the supine posture in relation to the sitting posture, the HF (units) was greater, the LF (units) was lower and the LF/HF ratio was lower. In another study by Pomeranz B. et al it was found that low-frequency fluctuations (below 0.12Hz) are increased by standing and are jointly mediated by the sympathetic and parasympathetic nervous systems. Higher-frequency fluctuations are decreased by standing and are mediated solely by the parasympathetic system. [9]

Changing a body posture from lying to sitting or standing leads to blood mass rush down to lower extremities due to gravitational pull. This causes an increase in arterial and venous pressure in the lower body and decrease in blood mass returned to the heart. Therefore the central venous pressure drops causing decrease in stroke volume and cardiac output. In response to decreased blood pressure in large arteries, an internal regulatory mechanism turns on to avoid dizziness or even passing out due to a limited blood supply of the brain.[6] The sitting-lying difference is due to hydrostatic influence acting mainly, if not wholly, through the carotid sinus reflex. [10] Once mean pressure drops due to standing up, stimulation of baroreceptors increases, so they begin sending signals to vasomotor center located in the brainstem. Increased stimulation of this center causes immediate drop in parasympathetic tone and rapid increase in sympathetic tone. [6]

A combination of decreased parasympathetic tone and increased sympathetic tone causes rapid increase in heart rate, contractility of the heart muscle and peripheral arterial vasoconstriction. This all leads to increase in the stroke volume, cardiac output and mean arterial pressure. Thus the body achieves compensation of the cardiovascular deficiency caused by standup maneuver. [6] Analysis of results of present study shows that, with a change of posture from lying to sitting, there is an increase of sympathetic effect on HRV hence LF which is associated with sympathetic tone increases. In the present study, the posture change from sitting to standing is characterized by decreasing influence of sympathetic tone. Once the compensation has been achieved, the body begins a recovery process trying to find a balance in a new standing condition. The organism tries to gradually find a new equilibrium, lowering heart rate, stroke volume and arterial blood pressure without compromising on adequate blood supply to the vital organs. The decreased level of mean arterial pressure lowers stimulation of baroreceptors, which reduces stimulation of vasomotor center in the brainstem and causes decrease in sympathetic activity. This finally leads to gradual decrease of heart rate and contractility, which reduces stroke volume, cardiac output and mean arterial pressure to the level adequate to new body condition. [6] In males, mean HF also decreases with change in posture from lying to sitting but decrease is not significant. Decrease of mean HF in males from sitting to standing is significant statistically. (Table 3)

Various combinations of vagal and sympathetic activation are characteristic for different body postures. Cacioppo et al. have suggested that vagal activity is the highest and sympathetic activity is the lowest in the supine posture. The reverse occurs in the standing posture, and a combination is characteristic for the sitting posture. [11]

To summarize, with changes in posture (supine-sitting-standing), decrease of mean RR interval was observed. The result shows that the mean RR interval for males in three postures was significantly different (P = 0.00). Sitting-standing difference of mean RR interval showed significant decrease. This finding is explained by increase in sympathetic tone with posture change from sitting to standing.

The mean LF for males in three postures was significantly different (P < 0.01). There was a significant increase of LF with change in posture from lying to sitting. But with change of posture from sitting to standing, LF decreased not significantly. These findings can be explained by increase of sympathetic tone with lying-sitting change in posture. And decrease of sympathetic influence with sitting-standing change in posture could be related to recovery process trying to find a balance in a new standing condition. With changes in posture (supine-sitting-standing), decrease of HF was observed. The mean HF for males in three postures was significantly different (P = 0.00). When postures were changing from lying to sitting and to standing, HF decreased. This correlates with decrease of parasympathetic tone and increase of sympathetic influence with postural changes from lying to sitting and to standing positions.TP component of HRV decreased with postural changes but not significantly. In our study no significant difference in VLF component could be observed with change in posture. The mean difference in TP and VLF were not significantly different for males between various positions. VLF component of HRV indicates influence of long-term regulatory mechanisms. So, our study which consisted of short time recordings does not reflect the influence of such mechanisms.

CONCLUSIONS:

Our study shows that HRV components - mean RR interval, mean LF and mean HF are significantly different with posture change from supine to sitting to standing in young adult males. These findings correlate with decreased parasympathetic and increased sympathetic influence with postural changes from lying to sitting to standing.

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