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Gender comparison of cardiac autonomic functions as measured by heart rate variability in a tertiary care hospital

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Abstract

Introduction: Heart rate variability (HRV) has been proposed as an indicator of cardiovascular health. Compared to their male counterparts, women are at less risk of coronary heart disease, and of serious arrhythmias, with women lagging behind men in the incidenceof sudden death by 20 years since women have a lower cardiovascular risk, a hypothesis was generated that there exist gender differences in autonomic modulation.

Methods: We studied 100 subjects (50 males and 50 females). Anthropometric parameters like age; height; weight and BMI were measured. The baseline characteristics like resting heart rate; systolic blood pressure and diastolic blood pressure were recorded at supine rest for 5 minutes. Using HRV software, recording and analysis of HRV parameters like Total power; Low frequency; Low frequency normalized units; High frequency; High frequency normalized units and Low frequency / High frequency ratio were done.

Results: Frequency domain measures of HRV were compared in age-matched populations of 50 males and 50 females. The mean and standard deviation of the low-frequency spectral components of HRV analyzed as absolute units as well as normalised units were high in males as compared to females ($p<0.001$), as also the LF/ HF ratio ($p<0.001$). The present study showed that the measures of HRV Hfnu, $Hfms^2$ which are the markers of parasympathetic modulation are more in females relative to their age-matched male counterparts.

Conclusion: The results of the study indicate that gender differences exist in HRV. The finding that gender differences are due to differences in Low frequency/ High frequency ratio, Low frequency normalized units and these parameters are statistically significant higher in males compared to females. The parameter like High frequency normalized units which is a marker of parasympathetic modulation is significantly higher in females Thus heart rate variability can be used as a simple bedside procedure to assess cardiovascular autonomic regulation and also as a simple non invasive tool for research studies for the assessment of the neural control of heart rate and to find out the gender differences.

Keywords: Heart Rate Variability, Autonomic Nervous System, Cardiovascular disorders, Autonomic modulation, Gender differences

Introduction

One of the major systems involved in regulation of the cardiovascular system under both physiological and pathological conditions is the autonomic nervous system[1]. The heart rate (HR) and its fluctuations reflect changes in cardiac autonomic control. This neural link creates the basis of assessment of cardiac autonomic regulation through measurement of heart rate variability[2]. Beat- to- beat fluctuations of R-R interval is known as heart rate variability (HRV). Measurement of HRV is now used widely for assessing the autonomic input to the heart both in physiological and pathological conditions[3,4].

Decreased HRV is associated with various cardiovascular disorders like coronary arthrosclerosis, coronary artery disease and congestive cardiac failure. HRV is also a useful tool in detection of early diabetic autonomic neuropathy[5-7]. Differences in the autonomic system may be due to differences in central reflex transmission, in afferent receptor stimulation, in the efferent nervous system, and in postsynaptic signaling. At each of these potential sites of difference, there may be effects due to variations in receptors in size or number of neurons, differences in neurotransmitter content or metabolism, as well as functional differences in the various components of the reflex arc[8].

Previous studies have shown that heart rate variability could predict arrhythmic events and sudden death. Compared to their male counterparts, women are at less risk of coronary heart disease and of serious arrhythmias, with women lagging behind men in the incidence of sudden death by 20 years[9-12]. But the studies have found some conflicting results and there are very few studies conducted in this region on influence of gender on cardiac autonomic modulation. Hence the present study was conducted to evaluate the gender differences in cardiac autonomic functions as measured by heart rate variability.

Material and Methods

This was a cross sectional, descriptive study conducted at a tertiary care hospital in South India. The study was conducted from May 2013 to November 2014. The study was approved by Institutional ethics committee and informed consent was taken from all the Participants. Medical students of either sex aged between 18-25 years willing to provide informed consent were included in the study. Those who had

history of medical disorders such as hypertension, diabetes mellitus thyroid disorders, liver and kidney diseases, smokers and alcoholics, those who were on drugs which alter the heart rate such as beta blockers, calcium channel blockers were excluded from the study.

During first sitting anthropometric parameters, Body Mass Index (BMI), HR and BP in supine rest and ECG were recorded. The body weight of the subjects was measured using a pedestal type of weighing scale with a maximum capacity of 150 kg. The body weight was considered to the nearest of 0.1 kg. Height without footwear was measured using a vertical scale (Avery, India) and was rounded to the nearest 0.01 meters. The resting HR was recorded on a computerized ECG from lead II, at a speed of 30mm/sec.

Heart Rate variability analysis: Recording were standardized and instructions followed as per the guidelines of Task Force of The European Society of Cardiology and The North American Society of Pacing and Electrophysiology[13]. Heart rate variability was recorded using instrument Power lab 8/30 series with dual bio amplifier. (Manufactured by AD instruments, model No ML870). Heart rate variability analysis was done by total power, high frequency power, low frequency power, LF/HF. To quantify heart rate, the analog ECG signal was obtained using lead II to obtain a QRS complex of sufficient amplitude and stable base line. Heart rate variation during normal breathing for a period of 5 minutes was recorded, with subject in supine, awake and resting after giving adequate rest for 15 minutes. The data gathered was subjected to frequency domain analysis of HRV.

Statistical Analysis: The data collected was collected and analyzed using SPSS version 19.0 statistical software. Descriptive statistics has been carried out in the present study. Results are expressed in percentages; Mean and standard deviation were computed for all quantitative variables. Appropriate test of significance like unpaired 't' test was applied to study the gender differences. A 'P' <0.05 considered as statistically significant and 'P' value of <0.001 is considered as highly significant.

Results

50 males and 50 female subjects belonging aged between 18-25 years fulfilling the set criteria were included in the final analysis. Demographic data was recorded and the HRV was measured during 5 min supine rest in all these subjects. The data so obtained was tabulated with respect to HRV which were statistically treated and analyzed.

Table 1: **Anthropometric measurements in males and females**

Parameters	Male	Female	p-Value
Height	1.54±0.04	1.55±0.05	0.95
Weight	53.4±4.85	51.62±5.58	0.83
BMI	21.02±1.29	21.59±1.59	0.06
SBP	116.69±6.07	116.56±6.08	0.3
DBP	70.76±5.28	70.24±5.49	0.23

SD = Standard deviation, BMI = Body mass index, SBP = Systolic blood pressure,
DBP = Diastolic blood pressure

There was no statistically significant difference between males and females in anthropometric measurements **(P<0.001=highly Significant)**

Frequency domain measures of HRV were compared in age-matched populations of 50 males and 50 females. The mean and standard deviation of the low-frequency spectral components of HRV analyzed **(Table 2)** as absolute units as well as normalised units were high in males as compared to females (p<0.001), as also the LF/ HF ratio (p<0.001). The present study showed that the measures of HRV, Hfnu, Hfms² which are the markers of parasympathetic modulation are more in females relative to their age-matched male counterparts.

Table 2: Frequency domain measures of HRV in males and females

Parameters	Male	Female	p-Value
Resting heart rate	76.34±4.43	77.34±3.81	0.23
Total power (ms²)	1919.82±74.34	1917.49±73.81	0.87
Low frequency (ms²)	902.30±49.89	517.75±41.42	<0.001
Low frequency in normalized units (LFnu)	50.14±2.04	45.72±1.23	<0.001
High frequency (ms²)	596.92±64.55	597.72±65.23	0.95
High frequency in normalized units (HFnu)	47.28±1.27	49.95±1.05	<0.001
Low frequency to High frequency ratio (LF/HF)	1.06±0.03	0.91±0.02	<0.001

(P<0.001=highly Significant)

Discussion

Heart rate variability, a marker of cardiac autonomic function, is considered a parameter of cardiovascular health. Women live longer and develop cardiovascular illness at a later age than men, it was postulated that healthy women would have greater heart rate variability than healthy men[14]. Analysis of HRV from electrocardiographic recordings has become an important method for assessing cardiovascular autonomic regulation[15]. The integration between the

sympathetic and parasympathetic modulations determines HRV[16]. The influence of provocation on HRV (i.e., standing and fixed breathing) is more pronounced at younger ages[17]. In adults, an attenuation of respiratory sinus arrhythmia with advancing age usually predominates[18,19]. It was shown that compared to men, women are at lower risk of coronary heart disease[20].

In the present study the resting heart rate was higher in females (77.34±3.81) as compared to males (76.34±4.43) and it was statistically non significant. Similar results were observed in a study conducted by Shailaja Moodithaya et al[21]. The measures of HRV namely the frequency domain measures, the LF (Low Frequency); LFnu (Low Frequency normalized units); and the LF: HF ratio were higher in males compared to females and was statistically significant whereas HFnu is higher in females as compared to males and was statistically significant.

Total power has been interpreted as a selective index of cardiac parasympathetic tone[22,23]. In the present study total power was higher in males (1919.82±74.34) as compared to females (1917.49±73.81) but statistically non significant. Similar results are reported by other studies[24,25,26].

LF component is believed to be a marker of the sympathetic modulation. It has been proposed as an index for sympathetic modulation (especially when expressed in normalized units), because it increases during mental stress[27], postural tilt[28] and in experimental conditions that lead to tonic increases in sympathetic efferent activity[29]. In the present study when compared with the females (517.75±41.42) LF was higher in males (902.30±49.89) and it was statistically significant. This result is in accordance with other studies[14,21,30]. Higher low frequency power (in absolute values as well as in normalized units), and the higher low frequency/high frequency ratio which we have observed in our male population can be attributed to higher sympathetic activity in men[14].

High frequency power is mediated by vagal activity. High frequency power, which is related to respiration, is a marker of vagal modulation[14]. It was higher in females (597.72±65.23) as compared to males (596.92±64.55) but the difference was statistically non significant. This result is in accordance with other studies[14,21]. Low Frequency normalized units measure minimizes an effect of changes in very low frequency power and emphasizes changes in sympathetic regulation84. The measures of normalized units of LF component in the study showed statistically significant higher values in males. Identical findings was found in other studies[21,25].

High Frequency normalized units measure minimizes an effect of changes in very low frequency power and emphasizes changes in parasympathetic regulation84. As with the LFnu the measures of normalized units of HF component in this study showed statistically significant values in females (49.95±1.05) compared to males (47.28±1.27) with statistically significant (P<0.001). Identical findings were found in the study conducted by Shailaza et al and Sanhita Walawalkar[21,25]. Sinnreich et al[31] found higher HFnu values in females compared to males. The higher HF nu observed in the female subjects can be attributed to lower sympathetic activity in females which is reflected by lower LF in absolute and relative values in females[21].

Low Frequency /High Frequency (LF/HF): This measure indicates overall balance between sympathetic and parasympathetic systems[32]. In the present study the LF/HF ratio which is the ratio of the extent of fluctuations of the sympathetic tone to that of the parasympathetic tone was higher in males (1.06±0.03) as compared to females(0.91±0.02) which was statistically significant. Identical findings was found in other studies[21,30]. Low and high frequency components and their ratio (i.e., low frequency/high-frequency) would provide a model to evaluate, though quite broadly, the dynamic changes of the sympathovagal balance[15].

Limitations of the study

This present study was conducted in a only one centre and the sample size was small. Future studies should be multi-centric and include a large sample size.

Conclusion

This result of the study indicates that gender differences exist in HRV. The finding that gender differences are due to differences in Low frequency/High frequency ratio, Low frequency normalized units and these parameters are statistically significant higher in males compared to females. The parameter like High frequency normalized units which is a marker of parasympathetic modulation is significantly higher in females. With these differences in autonomic modulation by HRV conclude that females are protective compared to males. Lower sympathetic activity in females compared to males might provide an explanation for the protection against cardiovascular disease observed in females.

Conflict of interest: None

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