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Autonomic Dysfunction in Central Obesity

Archana Damodaran and Balasubramanian Kabali

Department of Physiology, Stanley Medical College, Chennai 600 061, India

Abstract: Background : Central Obesity, a major concern to the present population due to computer chips and potato chips, has lead to cardiovascular morbidity and mortality. Autonomic dysfunction, being a common cause for such cardiovascular death can be assessd by Heart Rate Variability (HRV). HRV is a non invasive tool to measure autonomic modulation of the heart.Waist circumference is considered a significant anthropometric measurement for central obesity.This study aimed to investigate cardiovascular autonomic function in adult Obese individuals with central obesity using Heart Rate Variability. After Ethical Committee approval, 30 obese individuals (O) were recruited, according to Indian guidelines for Obesity, based on waist circumference, from Master Health Check up OP Department, Stanley medical College & Hospital and compared with the age and gender matched healthy Non-Obese individuals (NO). After obtaining consent, Electroardiogram (ECG - lead II) recorded in supine rest for 20mins, using RMS polyrite 2.5.2 with 12 - 14 breath per minute and instantaneous RR intervals(interval between r wave of successive QRS complex) were acquired and analysed using Finland software 2.1 version. Waist circumference (in cm) and HRV measures - Resting Heart Rate (HR), Mean RR interval, Time Domain (SDNN - Standard Deviation of Normal to Normal Interval in millisecond) & Frequency domain (Low Frequency- LF in ms2, High Frequency HF in ms2, LF / HF ratio) measures were analysed using Students unpaired ‘t’ test. $p<0.05$ considered significant. Results revealed that in Central Obese individuals, Mean HR increased and Mean RR decreased. Parasympathetic measure, SDNN (NO- 59.14 ± 25.49; O- 46.19 ± 23.34) decreased significantly. LF in ms2 (NO - 35.15± 10.66; O - 43.1464± 10.93) increased, HF in ms2 (NO - 56.36 ±12.16; O-48.01± 12.12) decreased significantly. There was a significant increase in LF/HF (NO-0.70 ±0.39; O-.99± 0.40). In conclusion : There is autonomic imbalance in central obese with sympathetic overdrive and parasympathetic withdrawl.

Key words: Central Obesity % Heart Rate Variability % Waist Circumference % Sympathovagal Balance

INTRODUCTION

Central Obesity is an excess of abdominal adipose tissue accumulation, thereby resulting in increased waist circumference[1]. It is an important risk factor for developing chronic diseases like Hypertension, Diabetes Mellitus and Myocardial Infarction [2]. Central Obesity being a complex multifactorial chronic disease that develops from an interaction of genotype, behaviour and environment [3]. The increase in the prevalence of obesity is primarily due to the increasingly obesogenic environment rather than ‘pathology’ in metabolic defects or genetic mutations within individuals [4]. The central thermodynamic formulation for the origins of obesity, a mismatched energy balance equation, with an excess of dietary calorie intake over body energy expenditure, is a first step in the understanding of this phenomenon [5]. Autonomic Nervous system found to be one of the factors regulating the maintenance of the constant energy storage and utilisation. This excess of visceral fat, not only promotes clusters for cardiovascular risk factors, but is an independent risk factor for cardiovascular ailments. In our country urbanization and modernization has been associated with central obesity. Early prediction of cardiovascular risk in this central obesity is very essential.

Heart rate variability (HRV) is a result of the influence of the autonomic nervous system on the heart [6]. Beat to beat fluctuations in heart rate are mainly determined by

Corresponding Author: Archana Damodaran, Department of Physiology, Stanley Medical College, Chennai 600 061, India.

the activity of the cardiac sympathetic and parasympathetic systems. This variability in heart rate provides a non invasive tool to assess cardiac autonomic function. Reduced variability in heart rate, reflects autonomic imbalance. This imbalance has been shown to be a predictor of the morbidity and mortality in risk prone individuals [6]. Short term HRV analysis was done using Linear methods-Time Domain (SDNN- Standard Deviation of NNinterval in milliseconds(ms)) and Frequency Domain (Low Frequency -LF in ms^2, High Frequency -HF in ms^2, LF/HF.). Here, SDNN expresses parasympathetic activity. Power Spectral analysis was performed using the Fast Fourier transform algorithm (Welch's Periodogram) after passing it through the Hanning window [7]. In the frequency domain, the spectral components of low frequency (LF: 0.04-0.15 Hz) and high frequency (HF: 0.15- 0.40 Hz) in milliseconds squared(ms^2) were used. Here, LF represents both sympathetic and parasympathetic activity while HF represents mainly parasympathetic activity. The LF/HF ratio, which represents sympathovagal balance was also used.

Although many attempts have been made to study HRV in general obesity, very few studies are done in our population with central obesity. We hypothesize that there may be an impaired cardiovascular autonomic function in central obesity. The Aim of the study is to evaluate the impact of central obesity on cardiac autonomic function.

Aim and Objective: To study cardiovascular autonomic function in adult Obese individuals with central adiposity by comparing HRV at supine rest in centrally obese individuals with age and gender matched healthy non-obese individuals.

MATERIALS AND METHODS

The study was approved by the Institutional Ethical Committee, Stanley medical college, Chennai. 30 obese (17 female ; 13 male; age - 28.13 ± 5.45) and 30 non-obese (17 female ; 13 male, age - 26.33 ± 4.15) people, according to Indian Obesity of Guidelines [8] volunteered to participate in the study from Master Health check up Out Patient Department, Stanley Medical College. The study was conducted at the Neurophysiology Laboratory, Department of Physiology, Stanley Medical College, after an informed and written consent.

Prior to the recording, detailed history taking and clinical examination was done to exclude conditions interfering autonomic modulation like smoking, alcohol intake, caffeine intake, meals, Hypertension, Diabetes Mellitus and drug intake altering ANS function.

All these examination were carried out between 8.00 AM and 1.00 PM under comparable ambient conditions after having made participants comfortable and relaxed. After cleaning the skin surface with the spirit, ECG electrodes were placed properly and lead II ECG was recorded for five minutes after a resting period of 15 minutes at supine rest position with normal breath rate of 12 - 16 / minute, using RMS polyrite D Hardware 2.2 (India)[9]. The instantaneous RR intervals were plotted using Finland1.1version, University of Kuopio and Software for HRV analysis, with the interpolation frequency of 4Hz and smoothness prior method as per recommendations of Task Force Circulation [9].

Heart Rate Variability Analysis: HRV signal is generated from ECG by calculating the inter-beat intervals. It is a non-stationary signal that represents the autonomic activity of the nervous system and the way it influences the cardiovascular system[10]. HRV analysis was performed with linear methods in the domains of time and frequency. In the time domain, (SDNN) and in the frequency domain, the spectral components of low frequency (LF: 0.04-0.15 Hz) and high frequency (HF: 0.15-0.40 Hz) in milliseconds squared were used. The LF/HF ratio, which represents the relative value of each spectral component in relation to the total power minus the very low frequency component (VLF), was also used. Spectral analysis was performed using the Fast Fourier transform algorithm. The HRV analysis software Finland1.1v of Kuppio Lab was used

Statistical Analysis: The Data are expressed as mean ± Standard Deviation. The variation in parameters between the two groups were tested using student's independent t-test. P value less than 0.05 was considered significant.

RESULTS

Table1 showed an increased Mean HR and decreased Mean RR in centrally obese but not significant. Time Domain measures depicts a significant decrease in SDNN ($p<0.01$). Frequency measures showed an increase in

Table 1: Comparison Of Time Domain And FrequencyDomain Measures Between Obese And Non Obese

	Non Obese n=30		Obese n=30		
	Mean	SD	Mean	SD	Student Independent 't' test
MeanHR	75.10	8.66	79.00	9.97	p=0.11
MeanRR	0.810	0.098	0.772	0.109	p= 0.156
SDNN (ms)	59.14	25.49	46.19	23.34	p<0.01**
LF ms^2	35.15	10.66	43.14	10.93	p<0.01**
HF ms^2	56.36	12.16	48.01	12.12	p<0.01**
LF/ HF	0.70	0.39	0.99	0.40	p<0.01**

SD - Standard Deviation *p < 0.05 - significant ** p <0.01 - highly significant

LF(ms2)(p<0.01) and decrease in HF (ms2)(p<0.01). The sympathovagal ratio, LF/HF reveals a significant rise (p<0.01).

DISCUSSION

Obesity has been found to reduce life expectancy of individuals and it is one of the leading preventable causes of death worldwide[11],[6].We know that autonomic dysfunction lead to cardiovascular morbidities and mortalities. In Hugh R. Peterson *et al*, body fat and the activity of the autonomic nervous system was studied[12]. Therefore, Autonomic nervous status of centrally obese individuals was observed using Heart Rate Variability in our study.

Although cardiac automaticity is intrinsic to various pacemaker tissues, heart rate and rhythm are largely under the control of the autonomic nervous system [13]. This exerts its action through sympathetic and parasympathetic limbs. The parasympathetic influence is mediated via release of acetylcholine by the vagus nerve and decreases heart rate. The sympathetic influence is mediated by release of epinephrine and norepinephrine on sinus node and increases heart rate. Heart rate variability (HRV) describes the variations between consecutive heartbeats (RR or NN interval) [9]. This RR interval variations present during resting conditions represent a fine tuning of the beat-to-beat control mechanisms [14]. In our study, we observed insignificant decrease in mean RR interval in obese group. Decrease in the mean RR indicates there is increase in the mean resting heart rate.

Time Domain Measures: In our study SDNN which reflects parasympathetic activity is reduced in the obese group. This variation in heart interval which is largely dependent on vagal modulation is found to be decreased centrally obese individuals.There are very many mechanisms by which vagal dysfunction is connected to obesity but not very certain. But it is certain that reduced vagal activity is one of the underlying causes for developing cardiovascular risk. All the cyclic components are responsible for variability in the period of recording. Though SDNN encompasses shorter HF variations in 24 hour recording, SDNN estimates shorter and shorter cycle lengths in five minutes recording[9]. Thus SDNN reflecting parasympathetic activity is observed to be reduced in the obese individuals when compared to non obese. This increase in SDNN in non-obese is normally beneficial for the cardiovascular activity and hence, under resting conditions, normally vagal tone prevails.

Frequency Domain Measures: Power spectral density (PSD) analysis provides the basic information of how power (variance) distributes as a function of frequency. The modulatory effects of neural mechanisms on the sinus node have been enhanced by spectral analysis of HRV. The main advantage of spectral analysis of signals is the possibility to study their frequency-specific oscillations[9]. Thus not only the amount of variability but also the oscillation frequency (number of heart rate fluctuations per second) can be obtained. LF and HF power components are usually made in absolute values of power (milliseconds squared).

More controversial is the interpretation of the LF component, which is considered by some [16,17] as a marker of sympathetic and by others [14] as a parameter that includes both sympathetic and vagal influences. But in our study LF (ms^2) power taken as a marker of sympathetic modulation, found to be increased in obese compared to non obese. In obese, sympathetic stimulation leads to increase in heart rate and contractility, even under resting condition when there is no demand. Thereby results in increased energy consumption by heart and increased metabolism of cardiac tissues. This increases the metabolic waste products and injures the cardiac tissues, thereby acts as a risk factor of cardiac ailments. Also blood vessels which are normally maintained in sympathetic tone, undergoes vasoconstriction on increase in sympathetic activity, thereby resulting in Hypertension, most common consequence of Obesity.

Sympathovagal balance, the ratio of these periodicities, is taken to reflect the balance between the opposing neural mechanisms. Sympathovagal balance (in dimensionless units) is simply the ratio of absolute LF to absolute HF power, or LF/HF [9]. It acts as a balance indicating reciprocal relationship between sympathetic and parasympathetic neural output. In this study the balance tilts more towards sympathetic component for obese, indicating that under resting condition obese individuals tend to have greater propensity for increased work load on heart due to increased heart rate and peripheral resistance.

This excess sympathetic excitation is contributed mainly by leptin, an adipokine. Leptin is an adipocyte-derived protein hormone that carries out its primary task of regulating food intake and energy home ostasis [via increased sympathetic nervous system (SNS) outflow] by binding to specific leptin receptors in the hypothalamus [18, 19]. Also excess leptin increases noradrenalin activity [20]. This Obesity, a condition characterized by subclinical inflammation produces cytokines like IL-6, TNF á also increases sympathetic activity[21]. Our study depicts parasympathetic withdrawal and sympathetic predominance. This vagal dysfunction responsible for sudden death is suggested to be due to chronic mental stress and lack of physical activity.This visceral obesity has direct impact on cardiovascular system and nearby viscera being near by and thereby results in mortality and morbidity.

CONCLUSION

Our study indicates there is a reduction in SDNN and increase in LF / HF. Hence, cardiac autonomic function is impaired by increased sympathetic and decreased parasympathetic activity. The result suggested that there is a need for monitoring anthropometric measurement indicating obesity. This will avoid future complications.

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