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Original Article

Physiotherapy Section

Evaluation of Autonomic Dysfunction in Obese and Non-Obese Hypertensive Subjects

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ABSTRACT

Introduction: Obesity and more specifically, visceral obesity, has been consistently associated with hypertension and increased cardiovascular risk. Epidemiological studies indicate that at least two-third of the prevalence of hypertension can be directly attributed to obesity. Studies also suggest that hypertensive patients have impaired cardiac autonomic function.

Aim: The objective of the study was to examine any added effects of obesity on cardiac autonomic dysfunction in hypertensive patients.

Materials and Methods: Hypertensive subjects (n=45) between 35-60 years of age were divided into two groups; Group A (n=30) consisted of non-obese hypertensive subjects and Group B (n=15) consisted of obese (BMI≥30kg/m^2) hypertensive subjects. Cardiac autonomic function was assessed using four tests – Heart rate response to immediate standing (30:15 ratio), standing to lying ratio (S/L ratio), Blood pressure response to immediate standing and Cold Pressor Test (CPT).

Results: There were no significant differences for autonomic function tests between obese and non-obese hypertensive subjects (p >0.05).

Conclusion: The results showed that there are no significant differences in the cardiac autonomic function responses between obese and non-obese hypertensive subjects.

Keywords: Cardiovascular function, Heart rate variability, Hypertension, Obesity, Sympathovagal imbalance

INTRODUCTION

Hypertension is the most common condition seen in primary care and leads to myocardial infarction, stroke, end stage-renal disease and death if not detected early and treated appropriately [1]. The worldwide epidemiology of hypertension in 2000 was 26.4% of the adult population, wherein 26.6% men and 26.1% women were found to be hypertensive. This number is projected to grow to 29.2% by 2025, constituting 29.0% of men and 29.5% of women population [2]. The autonomic nervous system plays a very crucial role in the pathogenesis of hypertension and several studies suggest that hypertensive patients have impaired cardiac autonomic function [3].

Studies have found an association between cardiac autonomic function and the development of hypertension that can be determined by Heart Rate Variability (HRV) [4]. There is also evidence of reduced vagal function and sympatho-vagal imbalance with developing hypertension [4]. It is also proved sympathetic activation is a peculiar feature of essential hypertension, particularly in its early stages [5]. The adrenergic activation to characterize hypertension may be attributed to factors such as humoral, metabolic, reflex and central mechanisms, which may also contribute to the development and progression of the cardiac and vascular alterations resulting in hypertension-related morbidity and mortality [5-8]. Obesity is one of the most important health problems worldwide. In India, obesity is emerging as an important health problem particularly in urban areas, with a prevalence of 30-65% for urban adults. The rising prevalence of overweight and obesity in India has a direct correlation with obesity-related co-morbidities; hypertension, the metabolic syndrome, dyslipidemia, type 2 diabetes mellitus, and cardiovascular disease (CVD) [9]. The rising prevalence of obesity is increasingly recognized as one of the most important risk factors for the development of hypertension [10]. Obesity and more specifically, visceral obesity has been consistently associated with hypertension and increased cardiovascular risk [11]. Epidemiological studies indicate that at least two-thirds of the prevalence of hypertension can be directly attributed to obesity [11]. Compared to the year 2000, the number of adults with hypertension is predicted to increase [12] by 60% to a total of 1.56 billion by the year 2025. Recent research has shown that sympathetic activation plays a major role in obesity-related hypertension. In obesity-related hypertension, long sympatho-activation leads to raised arterial pressure by causing peripheral vasoconstriction and increasing renal tubular sodium reabsorption [13]. Obesity is intimately associated with hypertension, causing activation of sympathetic nervous system and renin-angiotensin system [14]. Obesity is also associated with endothelial dysfunction, and renal functional abnormalities that may play a role in the development of hypertension [15,16]. The purpose of this study was to examine the effect of obesity on hypertensive subjects with respect to autonomic function, so that these abnormalities can be promptly detected and corrected and further cardiovascular complications may be avoided by pharmacological intereventions, lifestyle modification and aerobic exercise.

MATERIALS AND METHODS

Fifty subjects who were medically diagnosed with hypertension for more than a year or with BP >140/90 mm Hg, were recruited from Hakim Abdul Hamid Centenary Hospital, of which 5 were unable to complete the test and thus excluded from the study. The remaining 45 patients were further divided into two groups: Group A (n=30) consisted of non-obese hypertensive subjects (age 49.27±8.013 years) and Group B (n=15) consisted of obese (BMI≥30kg/m^2) hypertensive subjects (age 51.27±8.013 years). Cardiac autonomic function was assessed using four tests – Heart rate response to immediate standing (30:15 ratio), standing to lying ratio (S/L ratio), Blood pressure response to immediate standing and Cold Pressor Test (CPT). Ethical approval for the study was obtained from the institutional ethical committee. Subjects were informed in detail about the type and nature of the study, the consent for the same was obtained prior to participation.

Autonomic Function Assessment [17,18]:

a) **Heart rate response to immediate standing (30:15) –** The subject was given a rest of 15 minutes in the supine position and

the ECG leads (12 channel ECG recorder, Medicaid systems) were positioned. After the rest period ECG recording was started and the patient was asked to stand up from the supine position without displacing the leads. A ratio of 30:15 was calculated by taking ratio of the longest R-R interval around beat 30 and the shortest R-R interval around beat 15 after standing up.

b) **Standing to lying ratio (S/L ratio) –** The limb leads were positioned with the subject standing and ECG was recorded for 20 beats. Following this, the patient was asked to lie down as quickly as possible with the leads attached. The recording continued for 60 more beats in the lying position. The point at which subject started to lie down was marked. S/L ratio was calculated as the longest R-R interval during 5 beats before lying down to the shortest R-R interval 10 beats after lying down. A S/L ratio of >1 was taken as normal and <1 as abnormal.

c) **Blood pressure response to standing -** The test started with the subject in supine position and blood pressure was recorded. The subject was then asked to stand up immediately and remain motionless and blood pressure was noted at 30 second intervals for 2 minutes. Differences between the readings of systolic blood pressure and diastolic blood pressure in lying and immediate standing were calculated. A fall of more than 20 mm Hg in blood pressure was taken as abnormal.

d) **Cold pressor test -** The subject was comfortably seated in a chair and the resting blood pressure was recorded. The subject was then asked to immerse his/her hand in cold water maintained at 4-6°C, upto the wrist joint. Blood pressure was measured from the contralateral arm at pain threshold time. The maximum increase in blood pressure was recorded. A rise of diastolic blood pressure >15mm Hg was taken as normal and less than this was considered as abnormal.

STATISTICAL ANALYSIS

Data was analysed using SPSS (version 17.0). The data were tested for normality of distribution using Shapiro-Wilk test and independent t-tests were employed to determine the differences in autonomic function responses in obese hypertensive and non-obese hypertensive subjects. The level of significance was set at $p<0.05$.

RESULTS

There were no significant differences between the two groups for sympathetic tests i.e. the systolic and diastolic blood pressure responses to immediate standing (p=0.56 and 0.18, respectively) and cold pressor test (p=0.96 and 0.48, respectively). The parasympathetic tests i.e. the heart rate response to immediate standing (30:15 ratio) (p=0.9) and standing to lying ratio (S/L ratio) (p=0.06) also yielded non-significant differences between obese and non-obese hypertensive patients [Table/Fig-1].

Variables	Group A n=30 Mean ± SD	Group B n=15 Mean ± SD	p-value	t-value
Systolic BP response to standing (S1)	0.53 ± 12.5	1.53 ± 8.2	0.56	0.579
Diastolic BP response to standing (D_1)	5.77 ± 10.9	1.27 ± 9.6	0.183	1.353
Systolic BP response to cold pressor test (S_2)	5.13 ± 17.0	5.40 ±11.0	0.956	0.55
Diastolic BP response to cold pressor test (D_2)	3.33 ± 10.5	0.53 ±15.6	0.480	0.713
30:15 ratio (R_1)	1.014 ± 0.1	1.017 ± 0.1	0.904	0.121
Standing to lying ratio (R_2)	1.0788± 0.1	1.0127±0.1	0.065	1.893

[Table/Fig-1]: Comparison of autonomic responses in non-obese (Group A) and obese (Group B) subjects.
BP: blood pressure. *level of significance at p <0.05

DISCUSSION

In the present study, autonomic function evaluation was conducted on obese and non-obese hypertensive patients. As per our observation, there is scarcity in the knowledge regarding effects of obesity in hypertensive subjects. The aim of this study was to evaluate any differences in autonomic regulation between obese hypertensive and non-obese hypertensive subjects, so that an early intervention could decrease mortality, morbidity and the health risks related to hypertension and obesity. Previous studies by Rossi et al., and Grewal et al., have reported that there is marked decrease in autonomic function in obese and non-obese patients for the parasympathetic as well as sympathetic division [17,18]. In hypertension, autonomic dysfunction occurs mainly in sympathetic division [19]. Clinically the present study also showed that there is cardiac autonomic dysfunction, but there is no significant alteration with increasing BMI. Furthermore, significant differences between hypertension and obesity on cardiac autonomic dysfunction could not be found. Although, studies have reported that in obesity the cardiac autonomic function may vary markedly from person to person, Nagai reported that this variation might be due to the level and duration of obesity [20], physical activity of the person and level of hypertension, its medication and gender also [21]. According to Rossi et al., there was no significant difference between the groups indicative of sympathetic function between the obese and control group [17]. In the present study, no significant differences between the groups were found. This might be due to an inadequate sample size of obese subjects. Also, the obesity level was not defined, as we took only 32.41±2.05 on BMI scale. Thus, a very small range of obesity level was included in the study. Grassi et al., reported that the central obesity showed significantly greater autonomic dysfunction than peripheral obesity, because of the small number of obese subjects we cannot make any differences between the patterns of obesity [22]. Young reported that effects of obesity in human beings are less clear and also the exact mechanism of the autonomic dysfunction in human obesity is not clear [23]. One possible reason for the non-significant differences in the present study could be the small number of obese hypertensive patients who were included and moreover, the pattern of obesity that was not differentiated. The limited ranges of obesity or BMI could also be the responsible factors for altered results as low grades of obesity do not have many effects on the autonomic function. As per our knowledge, there is lack of data on Indian population about the effect of obesity on the autonomic function in hypertensive subjects. We may also speculate that demographic factors could play an important role. Some clinical studies showed that weight loss is effective in lowering blood pressure in most hypertensive patients, and some population studies showed that excess weight gain is one of the best predictors for development of hypertension [24-29], but this study showed that there is no added effect of obesity in hypertensive patients on autonomic function tests. It may be because the dysfunction was present in both the groups in obesity and hypertension and both lead to dysfunction. However, clinically 11 subjects out of 15, i.e. 73% in obese population had an abnormal response and the rest 4 showed normal responses. In non-obese hypertensive subjects 15 subjects showed normal and 15 subjects showed abnormal response out of the total of 30 subjects.

LIMITATIONS

The present study was conducted on limited resources available, newer technique might be used to measure the dysfunction like HRV, and a control group should be used to examine autonomic differences. The present study did not consider the type of obesity (peripheral, abdominal), the duration of obesity, hypertension and physical activity. The study was conducted on a small number of obese patients so that the result cannot be generalized.

CONCLUSION

The results of the present study indicate that there was no difference in autonomic dysfunction between obese hypertensive and non-obese hypertensive subjects. This could be due to numerous factors like duration of obesity, pattern of obesity, the small number of test subjects, physical activity of the obese persons, severity of hypertension and the medication used. As obesity and hypertension both cause dysfunction, a healthy control group might be used to distinguish any differences in autonomic function.

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