Effect of visceral fat on nighttime blood pressure

Priyadarshni D.[1], Ambarish V.[2,*]

[1]Junior Resoident, [2]Associate Professor, Dept. of Physiology, Ramaiah Medical College, Bangalore, Karnataka, India

***Corresponding Author:**
Email: ambarish.vijayaraghava@gmail.com

Abstract

Introduction: Nighttime blood pressure is lower compared to that of daytime. Reduction in this blood pressure is a physiological phenomenon. Nighttime blood pressure is a better predictor of outcome than daytime pressure with respect to cardiovascular events. Visceral fat has been shown to be associated with various aspects of blood pressure.
Aim: To assess the effect of visceral fat on nighttime blood pressure in normal individuals.
Materials and Methods: This study included 20 subjects. Visceral fat was measured and ambulatory blood pressure was recorded from 10 pm to 2 hours after waking up for a minimum of 8 hours. Data was analyzed using SPSS Version 17. Pearson's correlation was used to find the correlation between visceral fat and other parameters. p value < 0.05 was considered as statistically significant.
Results: There were 20 subjects, 15 females, 5 males. Pearson's correlation shows a significant positive correlation between visceral fat and average nighttime systolic blood pressure (r=0.747, p=<0.001), visceral fat and average diastolic blood pressure (r=0.598, p =<0.005), visceral fat and average mean arterial pressure (r=0.673, p = <0.001).
Conclusion: This study showed that visceral fat is significantly associated with nighttime blood pressure which has a prognostic significance.

Keywords: Visceral fat, Night-time blood pressure.

Received: 10th October, 2017 **Accepted:** 28th December, 2017

Introduction

Ambulatory blood pressure has become an important tool in the management of hypertensive disorders. The mean 24 hour blood pressure is a better predictor of morbidity and mortality than the office BP.[1] The ABP measurements give information about the daytime and night-time values of BP of the individual and therefore are used to analyze the diurnal variation of the BP of the individual. The daytime and night-time blood pressure both have a prognostic significance. The daytime blood pressure is however a less reliable predictor as it is subjected to a number of confounding factors in the individual in relation to his daily activities. Hence, the night-time blood pressure holds a better prognostic value. The night-time blood pressure is a better predictor of cardiovascular risk and mortality than the daytime blood pressure. Failure of the physiological phenomenon of blood pressure reduction in the night-time is associated with higher cardiovascular mortality and morbidity.

There is a rising prevalence of obesity worldwide especially in the developing countries. Excess fat correlates with increased mortality and risk for diabetes, hyperlipidemia, hypertension and atherosclerosis of coronary, cerebral and peripheral vessels. Body mass index is no longer considered as a significant parameter is assessing the body fat of an individual. The body fat distribution is therefore more relevant is assessing the health status. Body fat is distributed primarily in two compartments, the subcutaneous and the visceral compartments. Visceral fat is a direct link in various facets of the metabolic syndrome: glucose intolerance, hypertension, dyslipidemia, and insulin resistance. Abdominal obesity, the accumulation of fat around the abdomen has been identified as an important risk factor for the development of cardiovascular and metabolic disorders. The intraabdominal fat depots appear to mediate the detrimental influence of abdominal obesity on metabolic processes.

Ambulatory blood pressure monitoring (ABPM) estimates the true mean blood pressure. Since ABPM recordings yield multiple readings throughout the day and night, they provide a more comprehensive picture regarding the blood pressure. This mean BP has shown to have a better correlation with end-organ damage and cardiovascular outcomes when compared with traditional office or clinic BP measurements. ABPM not only estimates the mean BP level but also its diurnal rhythm and its variability. The fluctuation of BP in a specific time interval serves as an indicator in target organ damage as well as in the prognosis of hypertensive patients.[2] Although ABPM records both average daytime and night-time BP, it is the nocturnal blood pressure that has emerged as a better predictor of mortality and morbidity related to BP, independent of the mean and the daytime levels. Nocturnal blood pressure is defined as the average of the BP reading recorded during the period coinciding with sleep between 11 pm and 7 am.[3] Management of abnormal nocturnal BP can have a positive impact on cardiovascular and cerebrovascular outcomes. Sleep blood pressure measured by ABPM has a better prognostic significance that office BP or clinic BP measurements.[4] Sleep systolic blood pressure is better associated with target organ damage independent of morning and evening systolic BP measurements. Reduction in the night-time blood pressure by night-time administration of antihypertensive medication can reduce morbidity and mortality in patients' risk of cardiovascular events.[5] Long term elevated nocturnal BP results in endothelial dysfunction causing remodeling of arteries as a result of target organ damage. This has a prognosis on hypertensive patients.

With the development of body composition measurement techniques, the assessment of body fat composition has become possible. Individuals with higher truncal fat and lower leg fat show a higher risk of metabolic syndrome. This is because fat in the body is distributed broadly into two compartments, the subcutaneous compartment and the visceral compartment. The fat in the visceral compartment reflects in truncal fat, otherwise referred to as abdominal fat or visceral fat. Excess fat in the upper body has a positive correlation with mortality and risk for diabetes, dyslipidemia, hypertension and atherosclerosis of coronary, cerebral and peripheral vessels. Of particular importance is the intraabdominal fat depots which are responsible for the detrimental effect obesity has on metabolic processes. An increase in visceral adipose tissue mass of 1 kg is associated with an increase in mean blood pressure of 10 mmHg.[6] Visceral adiposity is necessary in the assessment of cardiometabolic risk independent of age, race or BMI. It is a marker and target of therapy in cardiometabolic disease.[7] A higher visceral adiposity index is positively associated with both prehypertension and hypertension in both males and females.[8]

Objective

To assess the effect of visceral fat on average nighttime blood pressure

Materials and Methods

Methods

Ethical clearance was obtained from ethical committee of MS Ramaiah Institute of Medical Science. 20 subjects were taken from Ramaiah Indic Speciality Ayurveda Institute for the study. The study period was between January 2015 and April 2016.

Inclusion Criteria

1. 20 – 45 years of age
2. Blood pressure reading of SBP <140mm Hg, DBP <90mm Hg, as per the JNC criteria of WHO
3. Not having past or present history of any drug intake
4. Non-smokers
5. Non-alcoholics

Exclusion Criteria

1. History of hypertension
2. History of antihypertensive drug use
3. History of known sleep disorders
4. History of cardiovascular disease
5. Presence of any acute infections
6. History of any past/present chronic illness

Methodology

Blood pressure measurement: The basal blood pressure measurement was taken with an automated digital blood pressure monitor Schiller BR-102 Plus device at the venue. The subject was seated comfortably on a stool. The adult size BP cuff was tied around the right arm with the arm placed at the level of the heart. The blood pressure was recorded two times with a gap of 5 minutes between the readings. The basal blood pressure was taken as the average of the two readings. After the basal blood pressure was recorded, the cuff was tied again to record the nocturnal blood pressure with the same automated ABPM device. The ambulatory blood pressure measurement was recorded between 10 pm and 7 am.

The BR-102 plus is a menu guided programmable unit enabling long term blood pressure measurements to be taken at preset intervals. The recorded data was stored in an internal memory. Individual measurements could also be taken. It employs the auscultatory method of measurement with an oscillometric method as a back-up. When a clear measurement could not be obtained with the auscultatory method, the oscillometric value was used. When the measurement could not be taken by either method, the BP measurement was retaken.

The microphone in the cuff was placed over the brachial artery of the left upper arm and the cuff was secured. The cuff was wrapped in the upper arm in such a way that the subject could still bend the arm. The device was set to record the blood pressure at hourly intervals between 10 pm and 6 am.

Body Fat Measurement

The body composition was measured using OMRON HBF – 362 Karada Scan device. The information of the subject such as age, sex, height and weight were entered. The weight, BMI, body fat percentage, resting metabolism, body age and visceral fat were recorded. The fat and skeletal muscle distribution in the whole body, trunk, legs and arms were also recorded.

The subject stood on the main unit and placed the feet on the foot electrodes with the weight evenly distributed. The arms are kept extended at a 90 degree angle to the body and composition was measured.

The HBF-362 estimates the body fat percentage by bioelectrical impedance method. Muscles or blood vessels are body tissues with a high water content that conducts electricity easily. Body fat is tissue that has low electrical conductivity. An extremely low electrical current of 50 kHz and less than 500 µA is sent through the body to determine the amount of fat tissue. This weak electrical current is not felt by the subject. This method combines the electrical resistance with the distance of the electricity conducted. Correct posture of the subject and consistent measuring conditions were maintained. In order to determine body composition, the electrical impedance method is used along with the height, weight, age and gender information to generate results based on OMRON's data of body composition. The data is based on an algorithm by which the HBF-362 works based on research using exhalation and MRI analysis

Statistical Analysis

All the quantitative parameters such as Systolic Blood Pressure, Diastolic Blood Pressure, Mean Arterial Pressure and Visceral Fat were analyzed and expressed in terms of Mean and Standard Deviation. Pearson correlation was used to analyze the correlation between the visceral fat and the blood pressure measurements.

Results

20 normal subjects participated in the study. The mean age of the subjects was 35±8.69. There were 15 females and 5 males in the study. The age and gender distribution of the subjects is shown in Tables I and II. The mean visceral fat was 11.20±5.68. The mean and standard deviation values for visceral fat was 11.20±5.68. The mean and standard deviation values for nighttime systolic, nighttime diastolic and mean arterial blood pressure were 116.89±14.67, 68.62±10.07 and 84.71±11.39 in mm Hg respectively.

Visceral fat and systolic blood pressure: There was a strong positive correlation between visceral fat and average nighttime systolic blood pressure ($r = 0.747$) and it was statistically significant ($p < 0.001$). The correlation is shown in Fig. 1.

Table I: **Age distribution of subjects**

Age in years	No. of patients	%
20-30	7	35.0
31-40	5	25.0
41-50	8	40.0
Total	20	100.0

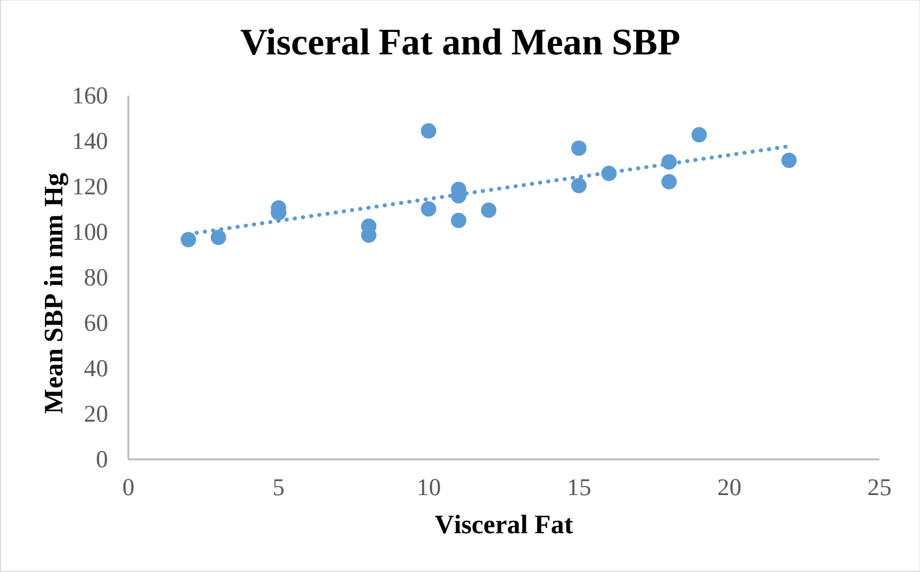

Fig. 1: Correlation between visceral fat and mean SBP

Visceral fat and diastolic blood pressure: There was also a positive correlation between visceral fat and diastolic blood pressure (r = 0.598, p<0.005). The correlation is shown in Figure 2.

Table II: Gender distribution of the subjects

Gender	No. of patients	%
Female	15	75.0
Male	5	25.0
Total	20	100.0

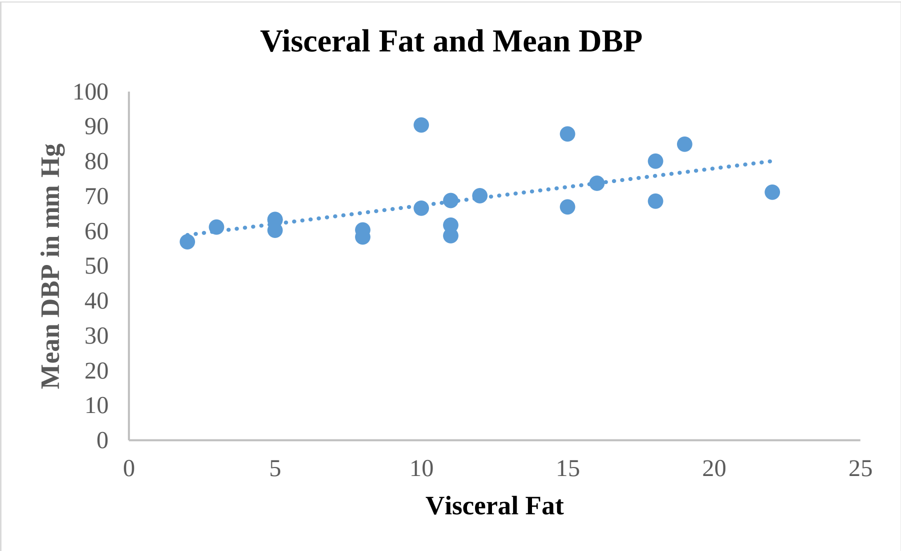

Fig. 2: Correlation between visceral fat and mean DBP

Visceral fat and mean arterial pressure: Mean arterial pressure also showed a strong positive correlation with visceral fat (r = 0.673. p<0.001). It is shown in Figure 3.

Table III: "p" and "r" values

Parameter	r value	p value
Visceral fat and SBP	0.747	<0.001
Visceral fat and DBP	0.598	<0.005
Visceral fat and MAP	0.673	<0.001

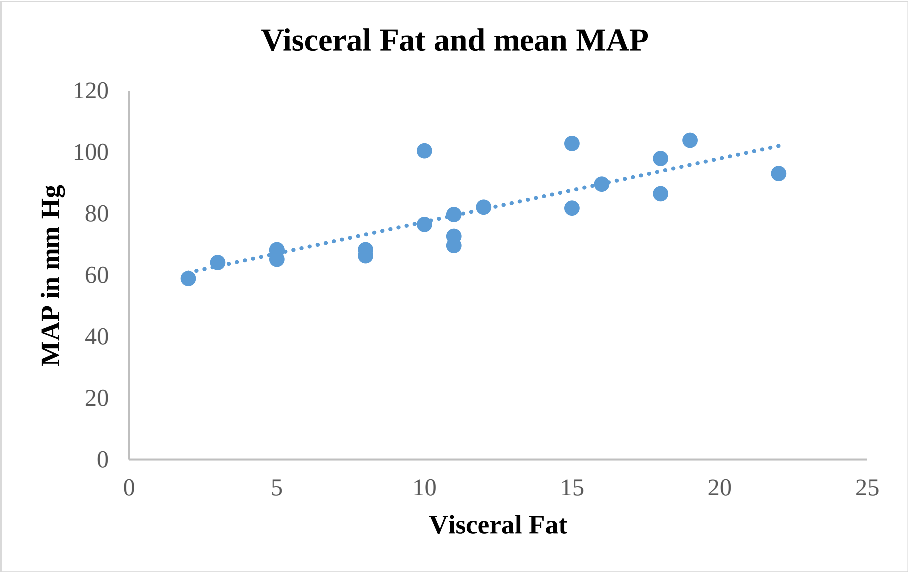

Fig. 3: Correlation between visceral fat and mean MAP

Discussion

Obesity has gained interest in the past few decades due to its rising increase in prevalence worldwide. Obesity is a dangerous non-communicable disease which increases the risk of developing other diseases such as diabetes, cancer and cardiovascular disease. Central obesity is one of the main risk factors of metabolic syndrome. The fat is distributed in the subcutaneous and visceral compartments. The visceral fat has a prognostic significance. Higher the visceral fat area, higher is the risk of metabolic syndrome. Visceral fat is better associated with greater cardiometabolic risk as compared to subcutaneous fat and other measurement of obesity including BMI. It acts by playing an important role in insulin resistance, dyslipidemia, hyperglycemia and especially hypertension.

In the present study, visceral fat was compared with nighttime values of systolic, diastolic and mean arterial pressure.

The results of this study showed that visceral fat was positively and significantly associated with all the parameters of blood pressure namely, systolic, diastolic and mean arterial pressure. This positive correlation between visceral fat and nighttime blood pressure values suggests that visceral fat contributes to the pattern of nighttime blood pressure. As the measurement of nocturnal blood pressure has shown more significance than daytime blood pressure values, management of nocturnal blood pressure can be considered as an important factor in the management of cardiovascular diseases. The nighttime systolic blood pressure in particular is associated better with target organ damage than morning orevening blood pressure values. In this study, the systolic blood pressure had a strong correlation and significance with the visceral fat. The diastolic and mean arterial pressure also showed a positive correlation with visceral fat.

Hence visceral fat needs to be looked upon as an important link between developments of cardiovascular events due to increased blood pressure. Reducing the visceral fat may be useful in reducing the nighttime blood pressure and thereby its consequences of cardiovascular disease.

Limitations of the Study

Measurement of daytime values could not be assessed in this study.

Scope for future Study

Reducing visceral fat can be a method of management of hypertensive patients in addition to drug therapy.

Conclusion

This study shows that visceral fat is significantly associated with all parameters of nighttime blood pressure; systolic, diastolic and mean arterial pressures. These are all independent markers of cardiovascular events. Nighttime blood pressure is known to have a much more prognostic significance than daytime blood pressure. Reducing visceral fat can be looked into an as additive measure in the management of blood pressure regulation, especially the nighttime blood pressure. Targeting visceral fat and thereby regulating nighttime blood pressure may have an important role in the prevention and management of cardiovascular disorders.

Acknowledgment
We are thankful to the whole Department of Physiology, Dr. Medha Rao, Principal and Dean, Mrs. Radhika Kunnavil, Lecturer cum Statistician in the Department of Community Medicine for their valuable inputs.

References

1. Fagard RH, Celis H, Thijs L, Staessen JA, Clement DL, De Buyzere ML, et al. Daytime and nighttime blood pressure as predictors of death and cause-specific cardiovascular events in hypertension. Hypertension. 2008;51(1):55–61.
2. Qin X, Zhang Q, Yang S, Sun Z, Chen X, Huang H. Blood pressure variability and morning blood pressure surge in elderly Chinese hypertensive patients. J Clin Hypertens (Greenwich). 2014;16(7):511–7.
3. Xu T, Zhang Y-Q, Tan X-R. The dilemma of nocturnal blood pressure. J Clin Hypertens (Greenwich). 2012;14(11):787–91.
4. Kario K, Hoshide S, Haimoto H, Yamagiwa K, Uchiba K, Nagasaka S, et al. Sleep Blood Pressure Self-Measured at Home as a Novel Determinant of Organ Damage: Japan Morning Surge Home Blood Pressure (J-HOP) Study. J Clin Hypertens (Greenwich). 2015;17(5):340–8.
5. Hjortkjær H, Jensen T, Kofoed KF, Mogensen UM, Sigvardsen PE, Køber L, et al. Nocturnal antihypertensive treatment in patients with type 1 diabetes with autonomic neuropathy and non-dipping: a randomised, placebo-controlled, double-blind cross-over trial. BMJ Open. 2016 5;6(12):e012307.
6. Sironi AM, Gastaldelli A, Mari A, Ciociaro D, Postano V, Buzzigoli E, et al. Visceral Fat in Hypertension. Hypertension. 2004 1;44(2):127–33.
7. Shah RV, Murthy VL, Abbasi SA, Blankstein R, Kwong RY, Goldfine AB, et al. Visceral adiposity and the risk of metabolic syndrome across body mass index: the MESA Study. JACC Cardiovasc Imaging. 2014;7(12):1221–35.
8. Ding Y, Gu D, Zhang Y, Han W, Liu H, Qu Q. Significantly increased visceral adiposity index in prehypertension. PLoS ONE. 2015;10(4):e0123414.