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Assessment of Pulse Wave Velocity in Obese Adults using ECG and Finger Tip Photo Pulse Plethysmography

M. Jahnavi[1], Sharan. B. Singh M[2], Uma B.V.[3], K.N. Maruthy[4]

[1]MBBS, [2]Professor at SVIMS-SPMC(W), [3]Associate Professor, [4]Professor & Hod, Department of Physiology, Narayana Medical College, Nellore

Abstract

Introduction : The World Health Organization has recently defined obesity as a disease. Obesity is the result of imbalance between food intake and energy expenditure. Obese individuals with excess fat deposition in the abdominal region are at risk for CHD, hence this study was taken up to see if any association is there between obesity and PWV.

Aim : 1. To measure the pulse wave velocity (PWV) in obese individuals.

2. To compare if there is any correlation between pulse pressure, PWV and BMI.

Material and Method: 68 obese adults were included for the study , 45 males and 23 females. The study was started after getting clearance from IEC. Informed oral consent was obtained from the subjects. Height and weight of the subjects were recorded. All of them were in the age group of 27 to 62 years and had BMI > 30.

Resting blood pressure was recorded, then Lead II ECG was recorded along with left forefinger tip photo pulse for a period of 15 secs. Distance between the R wave and the foot of the finger pulse was measured in msec. The arm span was measured from the left lateral border of sternum to tip of left forefinger which was taken as distance(D) travelled by the pulse. Using $V=\Delta T/D$, PWV was calculated.

Results : The mean BP in male and female was 106 ±9 & 94.7 ±4.4 mmHg respectively where as the PWV was 5.8 ± 0.7 mts/sec in male and 5 ± 0.5mts/sec in females which is in normal limits. Analysis of data was done by applying Pearson's Correlation and paired Student T test which revealed there was positive correlation between mean BP versus PWV $r = 0.21$ & BMI versus mean BP $r = 0.26$. P value were highly significant which was < 0.001

PWV is influenced by tethering of vessel and stiffening of the arterial wall, so increase in velocity may not be a good index to assess risk factor in all cardiac conditions.

Conclusion : PWV is influenced by tethering of vessel and stiffening of the arterial wall, so increase in velocity may not be a good index to assess risk factor in all cardiac conditions unless it is corrected with respect to age and Blood pressure .

Keywords – *pulse wave velocity , obesity, photo pulse plethysmography*

Corresponding author:
Dr. Mundlapudi Jahnavi
MBBS, Narayana Medical College,
Chinthareddypalem, Nellore – 524 003
Mobile: 8106105516, E mail ID: jan.rdy@gmail.com

Introduction

Obesity is a fast growing global health, social and economical problem. It is also called as disease of 21st century. It develops due to imbalance of energy intake and energy expenditure. Obesity is defined by WHO

as "A Medical condition in which excess body fat has accumulated to the extent that it may have adverse effects on health consequences". The BMI is an attempt to quantify the amount of fatty mass in an individual, and then categorize as underweight, normal weight, overweight, or obese, based on BMI value.[1]

Arterial stiffness is a general term for the elasticity (or compliance) of the arteries. Structural and cellular changes results in hardening or stiffening of the arteries which is called arteriosclerosis. Arterial stiffening is a marker for increased cardiovascular disease risk such as Coronary Heart Diseases. The stiffness of arteries indicates how hard the heart has to work to pump blood through the body.

Obesity is a world-wide epidemic with massive socioeconomic consequences; in particular, it increases the likelihood of associated pathologies including cardiovascular disease, type 2 diabetes, dyslipidemia, and sleep apnea. Early vascular aging and therefore elevated arterial stiffness, an independent marker of cardiovascular events and mortality, has been found to be associated with all these pathologies. Therefore, obesity could be expected to be directly related to increased arterial stiffness. However, conflicting results have been reported in adults, some studies found a positive relationship between obesity and arterial stiffness. Whereas others found no such relationship or even a negative relationship. A recent review indicated that only 13% of the relevant publications reported a positive association between body mass index (BMI) and PWV. [2]

Vascular stiffness, increases the load on the ventricles, decreases cardiac ejection. Blood ejecting into a stiffer arterial system , generates high end-systolic pressure for the same net stroke volume using greater energy. Chronic ejection into a stiffer vasculature induces cardiac hypertrophy.

Vascular stiffening also changes the manner by which the heart is perfused. Isolated systolic hypertension (defined as systolic blood pressure > 140 and diastolic blood pressure < 90 mm Hg) and elevated pulse pressure are two clinical manifestations of decreased vascular distensibility (Increases vascular stiffness).

Pulse wave velocity helps in assessment of arterial stiffness. It increases in certain diseases that are associated with increased cardiovascular risk .[3]

Photoplethysmography (PPG) is a non invasive method for the measurement of arterial blood volume changes at a peripheral site where the blood vessels are close to the skin. It is an instrument mainly used to determine and register the variations in blood volume or blood flow in the body which occur with each heartbeat. Here infrared light rays are transmitted through index finger to measure pulse wave.

The plethysmogram waveform represents pulsatile peripheral blood flow, which reflects both peripheral and central hemodynamic. [4]

Aim

1. To measure the pulse wave velocity (PWV) in obese individuals.

2. To compare if there is any correlation between pulse pressure, PWV and BMI.

Materials and Method

After getting clearance from ethics committee, informed consent was taken from all the participants and detailed clinical examination was done as per study protocol. All experiments were performed in the Department of Physiology, Narayana medical College, Nellore.

Participants:

68 Apparently healthy volunteers were recruited after obtaining Institutional ethical clearance - 45 subjects were males & 23 subjects were females.

Inclusion criteria

Age between 25 - 60 years, Male and female (irrespective of menstrual phase) adults with BMI >30 [kg/m^2] without past history of diabetes , hypertension, any cardio vascular conditions.

Exclusion criteria

Age less than 25 or more than 60 years male and female adults, BMI < 30[kg/m^2] , with

past history of diabetes, hypertension, any cardiovascular conditions.

Parameters recorded - Height, Weight, BMI, Arm span, SBP, DBP & PWV

Procedure

The data was collected in the morning hours between 7- 8 am. Informed written consent was taken. Subjects were asked to take rest for 15 minutes after which blood pressure was recorded.

Weight & Height were measured, Body mass index (BMI) was calculated .Standard ECG electrodes were connected to record Lead II ECG and simultaneously Left fore finger Photo pulse was recorded using Audacity software (freeware)by using computers sound card as analog to digital converter.

Results

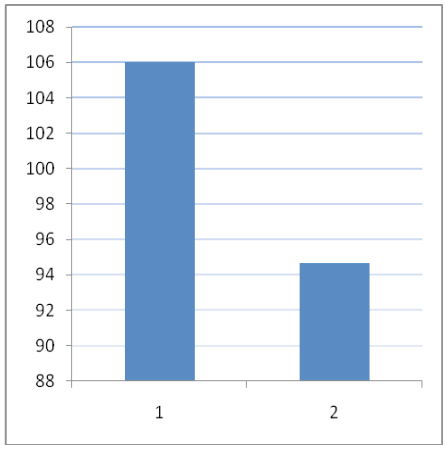
Table - 1 General characteristics of the subjects

Parameters Mean ± SD	Males [n = 45]	Female [n = 23]
Age (yrs)	44 ± 7.4	42.2 ± 10.13
Height (cms)	165.9 ± 6.7	155.7 ± 5.3
Weight (Kgs)	84.95 ±10.44	73.92 ± 10.18
BMI	30.78 ± 2.95	30.68 ±3.19
Arm span	83.2 ± 4.38	76.66 ±3.44

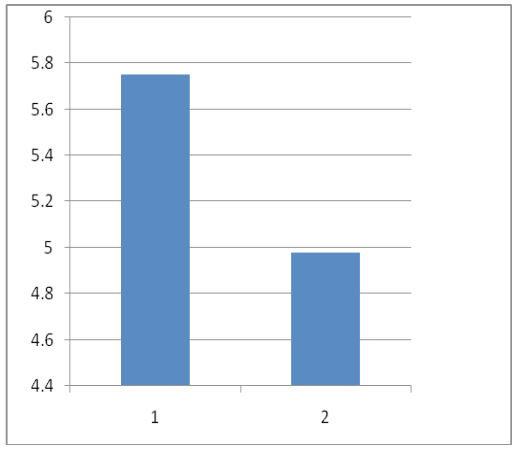
Table - 2 Cardiovascular parameters of smokers

Parameters Mean ±SD	Males [n = 45]	Female [n = 23]
SBP (mmHg)	129.48 ± 13.8	113.65 ± 5.03
DBP (mmHg)	94.2 ± 7.7	85.21 ± 5.69
Mean B.P	105.99 ± 9.03	94.69 ± 4.37
PWV (mt/sec)	5.75 ± 0.65	4.98 ± 0.53

Graph – 1 Analysis of data was done by applying Pearson's Correlation and paired Student T test



Mean B.P(mm Hg). Male & Female



Mean PWV (mts./sec) Male & Female

Normal pulse wave velocity = 5 - 6 mts./ sec

There was Positive correlation between mean B.P with PWV, BMI and Age which were statistically significant.

Discussion

Arterial stiffening reflects the changes of arterial wall degeneration. It has become clear that, the arterial stiffness is not only determined by structural elements with in vessel wall and distending pressure, but also by functional regulation by the sympathetic nervous system and endothelium of the vessel wall. Increase in arterial stiffness may results in higher systolic blood pressure; lower diastolic blood pressure and wide pulse pressure all conferring greater cardiovascular and total mortality risk. Increased arterial stiffness through an elevation of SBP enhances the left ventricular load and favors cardiac

hypertrophy and through reduction of DBP, results in a decrease in the perfusion pressure of the coronary arteries, thus contributing to myocardial ischemia.

Conclusion

Endothelial dysfunction is an important risk factor for hypertension because it leads not only to functional alterations, represented by the impaired control of the vascular tonus, but also to structural changes, such as thickening of the intima and media of the vessel wall. The association between endothelial dysfunction and increased blood pressure in obesity comes from studies showing that obese individuals display blunted vasodilatation in response to classical endothelium dependent vasodilators such as acetylcholine in resistance arteries, as well as reduced capillary recruitment in response to reactive hyperemia and shear stress and that the severity of endothelial dysfunction correlates with the degree of visceral adiposity

Measuring arterial stiffness provides good data on the endothelial condition. In our study we have seen increase in PWV which is a early marker of arterial stiffness. Therefore complete understanding the effects of obesity on vascular endothelium is useful in treatment and in preventing deleterious complications.

Over the next few years measurement of arterial stiffness might become an important part of risk assessment. It will become necessary for physicians both in primary care and hospital practice to understand the importance of arterial stiffness and different techniques are available for its clinical assessment.

Conflict of Interest :- Nil

Source of Funding:- Self

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