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Original Research Article

# Type 2 Diabetes Mellitus is associated with Arterial Stiffness in adult men of Western Rajasthan

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**Abstract:** Arterial stiffness and type 2 diabetes Mellitus (T2DM) are associated with increased risk for cardiovascular disease (CVD) and mortality. By assessing the arterial stiffness in diabetics, the risk of CVD could be quantified in T2DM. Aim of this cross sectional study to assess the association of arterial stiffness and T2DM. 25 normal and 60 atleast 1year history of T2DM males, aged 25 to 65 years of western Rajasthan were examined for arterial stiffness. Anthropometric data such as weight and height were taken to derive Body Mass Index (BMI). Right and left brachial ankle Pulse Wave Velocities (Br Ank PWV) and carotid to femoral Pulse Wave Velocity (cf PWV) were taken as indices of regional and central arterial stiffness respectively. On other hand right and left, brachial and ankle Arterial Stiffness Indexes (ASI) are taken as indices for corresponding local arterial stiffness. These were measured by an automated device Periscope (developed by genesis medical system, Hyderabad) based on oscillometric technique. Results were compared by Student't' Test by Data Analysis ToolPak in Microsoft Excel, considering p value $<0.05$ as significant. PWVs (in cm/sec) were elevated in T2DM as compare to Normal Control significantly ($p<0.01$) as Rt Br Ank PWV (1821.25±646.23 vs 1358.31±246.30), Lt Br Ank PWV (1479.72±277.55 vs 1001.94±260.67), cf PWV (1136.10±348.54 vs 750.08±191.36) but difference between all recorded ASI were not significant statistically ($p>0.05$). Our study concluded that central arterial stiffness, but not local peripheral arterial stiffness, were significantly associated with atleast 1 Year old T2DM in young to early aged overweight to obese male population of western Rajasthan.
**Keywords:** arterial stiffness, type 2 Diabetes, Pulse Wave Velocity, Periscope, Arterial Stiffness Index, T2DM.

## INTRODUCTION

Cardiovascular diseases (CVDs) are emerging as one of the leading causes of morbidity and mortality globally. CVDs have assumed epidemic proportions in India as well. According to the World Health Report 2002, CVDs will be the largest cause of death and disability in India by 2020. According to the World Health Report of 2002, deaths due to coronary heart disease in India rose from 1.17 million in 1991 to 1.59 million in 2000 and 2.03 million in 2010 [1]. The major risk factor contributing to CVDs are Diabetes mellitus (DM), Hypertension, smoking, hypercholesterolemia and family history of CAD.[2] DM and especially T2DM is one the most important risk factor for development of CAD. Up to 80% T2DM patients die from cardiovascular complications and average life expectantly is reduced approximately to 10 years [3,4].

Diabetes is increasing rapidly in every part of world, to the extent that now it has been assumed epidemic proportions [5]. In India, prevalence of type 2 Diabetes mellitus in urban and rural area is 18.67% and 9.21% respectively [6]. Over 30 million have now been diagnosed with diabetes in India. The estimate of actual number of diabetic in India is 40 million. This means that India actually has the highest number of diabetics of any one of country in the entire world [7]. An abnormal metabolic state associated with DM promotes a number of alterations in arterial tree and subsequent vascular impairment may represent a pathophysiologic link between diabetes mellitus and cardiovascular

disease. The two metabolic abnormalities that characterize T2DM are hyperglycemia and insulin resistance and two main pathophysiologic processes in vascular wall that can elicit cardiovascular events are atherosclerosis and arterial stiffness. Arterial stiffness reflects changes in extracellular matrix in media layer are distinct from atherosclerosis, caused by lipid accumulation in inflammatory cells infiltration in vascular endothelium and foam cell development. Indian patient with diabetes show both atherosclerosis and arterial stiffness [8].

Measurement of arterial stiffness in an important tool to assess cardiovascular risk.[10] Pulse wave velocity (PWV), Augmentation Index (AIx) and arterial stiffness index (ASI) are markers of arterial stiffness which are widely accepted and recommended from measure of arterial stiffness [9, 10]. Various non invasive methods have developed to measure these parameters to detect arterial stiffness and quantify the risk of development of CVDs.

PWV is a measure of regional arterial stiffness. Cf PWV indicates the arterial stiffness in central arteries (thoracic and abdominal aorta). An elevation in PWV indicates an increase in arterial stiffness or decrease in vascular compliance. ASI is a measure of local arterial stiffness [10]. Toshiaki Kakiba *et al*. [11] suggested in Japan that diabetic nephropathy is associated with Br Ank PWV. Ebtissam Zakaria *et al*. [12] suggest in their study in Egypt that PWV increased evidently earlier than clinical evident of atherosclerosis in diabetics. Namrata BK *et al*. [13] in India have also suggested that diabetics have increased PWV than non diabetic individuals. In this study we compared PWV and ASI between diabetics and non-diabetics in adult male population of western Rajasthan, India.

## METARIAL & METHOD

### Study design

In this cross sectional study, 25 normal and 60 T2DM (total 85) Male Participants of age group 25 to 65 Years (49.6±10), natives and residents of Western Rajasthan, India were examined for Arterial Stiffness. Cases of T2DM were selected as WHO recommendations [14]. Smokers and individual with history of any Vascular diseases such as peripheral arterial disease, Cardiovascular disorders, cerebro-vascular disorders, Renal Disease were excluded from study. This study was approved by the institutional ethical committee. Written informed consent was obtained from all the participants.

### Anthropometric measures

BMI was calculated by dividing the participant's weight in kilograms by the square of his height in meters. Weight and Height of participants were measured by calibrated electrical weighing Scale and Calibrated Stadiometer respectively.

### Biochemical measures

Blood Glucose level is measured by Robonik automatic biochemical analyser in biochemical laboratory. Participants with Fasting Blood Glucose level more than 126mg/dl with history of atleast 1 year of detection of type 2 DM classified in Diabetic group. And participant with no history of prior higher glucose level and spot Fasting Glucose level less than 125mg/dl were kept in non- Diabetic group. Only blood glucose level more than 126mg/dl or only history of Type 2 DM but not spot fasting glucose level more than 126mg/dl was not included in study.

### Measurement of arterial stiffness

Indices of Arterial Stiffness is measured by Periscope (developed by Genesis Medical Systems, Hyderabad, India) based on Oscillometeric Method in morning in fasting condition with 8 to 10 hours over night sound sleep. Periscope records arterial Blood pressure (BP), arterial pressure Waveform non-invasively through Cuffs Wrapped on all four limbs. Simultaneously it records Electrocardiogram (ECG) by 4 leads applied to four limbs. Time taken by pressure wave to reach limbs is calculated by time point recording of R Wave of ECG and foot of arterial pressure Waveform. The system software of this device supports sophisticated digital signal-processing algorithm to calculate all the results. It calculates right and left brachial ankle PWV (R Br Ank PWV & L Br Ank PWV), carotid to femoral PWV (cf PWV), Arterial Stiffness Index (ASI), Ankle Brachial Index (ABI) & Augmentation Index (AIx). Participants were asked to refrain from drinking caffeine containing beverages 12 hrs before the test. They were also informed not to speak or sleep during the procedure. All subjects were explained about the procedure to be undertaken and written consent was obtained from all the subjects prior to the study. Br Ank PWV and cf PWV were measure of central arterial stiffness. Brachial and ankle ASI were measure of peripheral local arterial stiffness [10].

**Statistics**

Results obtained from the Participants were then compared in both groups. Results were statistically analyzed using Data Analysis ToolPak in Microsoft Excel. All the arterial stiffness parameters were expressed as mean and standard deviation (SD). Comparison of data between diabetic and non diabetic was done using student-'t' test. The p value of less than 0.05 was considered as statistically significant.

**RESULT & DISCUSSION**

Table 1 gives the mean and standard deviation of the comparable parameters, Age and BMI, and the markers of arterial stiffness, PWV and ASI of the both study groups.

**Table-1: Comparisons of Mean and Standard Deviations (SD) of the parametric variables in the both study groups**

| Parameters | Non Diabetic (n=25) | | Diabetic (n=60) | | P Value* |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| **Age** (years) | 47.76 | 12.16 | 50.38 | 9.08 | 0.28 (NS) |
| **BMI** (kg/ $m^2$) | 29.94 | 5.06 | 28.11 | 5.02 | 0.131 (NS) |
| **R Br Ank PWV** (cm/sec) | 1358.31 | 246.30 | 1821.25 | 646.23 | 0.0008 (S) |
| **L Br Ank PWV** (cm/sec) | 1001.94 | 260.67 | 1479.72 | 277.55 | <0.0001 (S) |
| **c-f PWV** (cm/sec) | 750.08 | 191.36 | 1136.10 | 348.54 | <0.0001 (S) |
| **R Br ASI** (mm Hg) | 30.45 | 9.07 | 34.13 | 10.89 | 0.141 (NS) |
| **L Br ASI** (mm Hg) | 29.76 | 7.24 | 33.50 | 11.28 | 0.13 (NS) |
| **R Ank ASI** (mm Hg) | 42.20 | 10.63 | 45.90 | 11.20 | 0.162 (NS) |
| **L Ank ASI** (mm Hg) | 40.45 | 11.49 | 42.55 | 15.72 | 0.548 (NS) |

n = Number of participants

* = p value by students't' test

S = Significant, NS = Not significant considering α 0.05

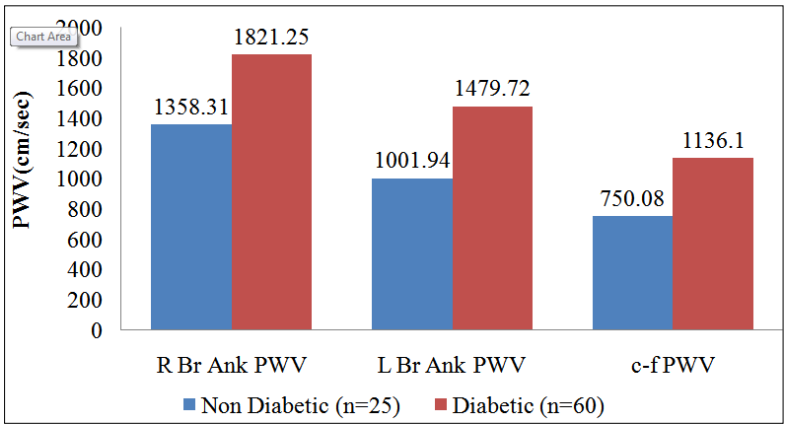


**Fig-1: Comparisons of various PWV between normal control and T2DM**

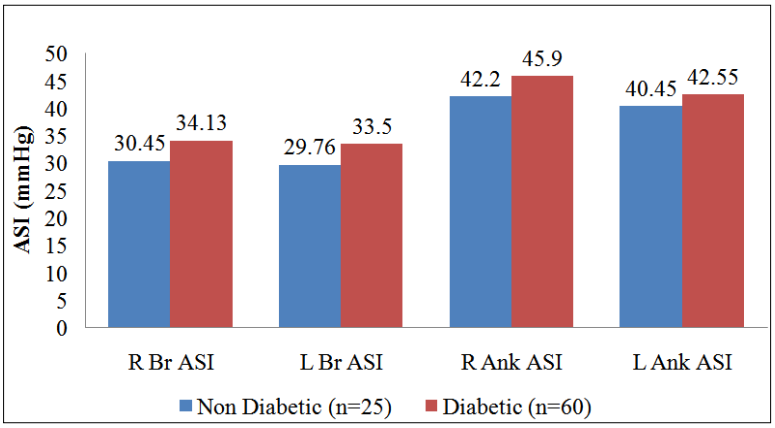


**Fig-2: Comparisons of various ASI between normal control and T2DM**

Table 1 shows Comparisons of Age, BMI, various pulse wave velocities and arterial stiffness index (parameter for measuring arterial stiffness) in diabetic cases and non diabetic controls. Fig. 1 & 2 showing the same in graphical presentation. Mean differences of age was not significant so the age was controlled in the study. BMI was also not significantly different between groups. Some studies [12,15] suggested the there is significant association between BMI and Type 2 DM. Some others studies [13,16] concluded no relation between BMI and being Diabetic. Helen C. Looken *et al*. [17] suggested that before the diagnosis of diabetes there was a steady gain in weight but after diagnosis the weight gain declined. It may be because of use of drugs.

Mean and SD of Right Brachial Ankle pulse wave velocity in diabetic cases was 1821.25±646.23 cm/sec and in non diabetic controls 1358.31±246.30 cm/sec. Mean and SD of Left Brachial Ankle pulse wave velocity in diabetic cases was 1479.72±277.55 cm/sec and in non diabetic control was 1001.94±260.67 cm/sec. Mean and SD of Carotid Femoral pulse wave velocity in diabetic cases was 1136.10±348.54 cm/sec and non diabetic control was 750.08±191.36 cm/sec. It was observed that mean differences of all pulse wave velocities in diabetic cases and non diabetic controls was statistically highly significant (p value <0.01). PWVs are higher in diabetic group as compare to non diabetics. Whereas mean differences of Right Brachial ASI, Left Brachial ASI, Right Ankle ASI and Left Ankle ASI in diabetic cases and non diabetic controls was not significant different statistically (p value >0.05). These PWVs are the measure of regional arterial stiffness and different ASI are measures of local arterial stiffness [10]. So our study suggested that T2DM was associated with increased central arterial stiffness but not with local brachial and ankle arterial stiffness.

Many studies have suggested the same result in context of PWV that, brachial ankle and carotid femoral PWV are significantly associated with Type2 DM [12-14, 18-21] it is because of supra physiological level of insulin in insulin resistant type2 DM cases. So the growth promoting activity of insulin in the diabetic individuals elevated and causes smooth muscle cell proliferation in vasculature [22]. Impaired glucose tolerance also enhances nonenzymatic glycation of proteins with covalent cross-linking of collagen and alters the mechanical properties of interstitial tissue of the arterial wall [23]. As Increased arterial stiffness is an important determinant of cardiovascular disease risk [24]. Early detection of type 2 DM can reduce the cardiovascular disease incidence as well as regularly measuring the PWV CVD risk can be quantified and monitored.

## CONCLUSION

Overweight and obese, young to early old aged male population of Western Rajasthan whose having type 2 Diabetes mellitus for atleast 1 year have increased arterial stiffness than same BMI and same age group non-diabetic male population of same region. Whereas stiffness of Peripheral arteries did not show significant association with type 2 DM in these male population of western Rajasthan.

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