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Physiology

Evolution of Arterial Stiffness in Type 2 Diabetes Mellitus Patients in Western Rajasthan: A Case Control Study

Shilpa Solanki*, Dr. Raghuveer Choudhary

Department of Physiology, Dr. S.N. Medical College, Jodhpur, India

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***Corresponding author:** Shilpa Solanki

Abstract **Original Research Article**

People with diabetes are at increased risk of cardiovascular, peripheral vascular and cerebrovascular disease. A number of studies have investigated the effect of diabetes mellitus on arterial stiffness but very limited data on arterial stiffness is available in the Western Rajasthan and thus, we aim to investigate the type 2 diabetic related progression of arterial stiffness. This case-control study was carried out on 240 subjects were divided into two groups i.e. control 120 and diabetic 120 (60 male: 60 female) (25-60 years). To assess the arterial stiffness by Pulse Wave Analysis (PWA) and Aortic Pulse Wave Velocity (PWV). Our study concluded that the presence of diabetes is associated with increased arterial stiffness and it may contribute in part to increased cardiovascular risk in diabetic patients, when compare with control and statistically highly significant ($p<0.001$).

Keywords: PWA, PWV, AIx, PP, ASI, CF PWV, Br-Ank PWV, R Br ASI, L Br ASI, R Ank ASI, L Ank ASI, R Br Ank PWV, L Br Ank PWV.

INTRODUCTION

Type 2 diabetes mellitus (also known as non-insulin-dependent diabetes mellitus or adult-onset diabetes) is a metabolic disorder that is characterized by high blood glucose in the context of insulin resistance and relative insulin deficiency [1]. The incidence is increasing rapidly and by 2030, it would be doubled [2]. People with diabetes are at increased risk of cardiovascular, peripheral vascular and cerebrovascular disease. Arterial stiffness, a major contributor of atherosclerosis, has been shown to have positive relationship with systolic hypertension, coronary artery disease, stroke and heart failure [3,4]. The arterial stiffness is an independent marker of cardiovascular risk [5] that increases with age and elevation of BP. Elevated arterial stiffness is an independent marker of cardiovascular disease because it is closely associated with the presence of cardiovascular risk factors like hypertension, diabetes, smoking, hypercholestremia and family history, subclinical atherosclerosis and clinical cardiovascular diseases including angina, myocardial infarction, stroke and heart failure.

Pulse Wave Velocity (PWV), Augmentation Index (AIx) and Arterial Stiffness Index (ASI) are the markers of arterial stiffness which are widely accepted and recommended for measure of arterial stiffness [6,7]. Recent technical advancements have been made for non-invasive measurement of arterial stiffness by Pulse Wave Analysis (PWA) and Aortic Pulse Wave Velocity (PWV). Increased arterial stiffness may be considered as an important pathway linking diabetes to increased cardiovascular risk.

A number of studies have investigated the effect of diabetes mellitus on arterial stiffness but very limited data on arterial stiffness is available in the Western Rajasthan and thus, we aim to investigate the type 2 diabetic related progression of arterial stiffness.

MATERIAL AND METHODS

Study design and setting: A case-control study was carried out in the Physiology department of Dr. S.N. Medical College, Jodhpur (Rajasthan). Sample size calculation: Sample size was calculated by using OpenEpi software with power 80%, significance level alpha at 0.05. The total sample size required was 114 subjects. Participants and sample size: This case-control study was carried out on 240 subjects in Western Rajasthan population. The subjects were divided into two groups i.e. control and diabetic (25-60 years). In control group 120 (60 male: 60 female) and in diabetic group 120 subjects were taken. Subjects with history of smoking, renal diseases, coronary, arrhythmias, psychiatric disorders, thyroid disorders, arthritis and other chronic diseases like obstructive lung disease,

tuberculosis etc. and participants with type 1 diabetes were excluded. Subjects having type 2 diabetes was included. Both male and female subjects with age ranging from 25-60 years.

The informed consent of the subjects for the procedure and its consequences was taken prior to performing the test upon them.

For Arterial Stiffness

To assess the arterial stiffness PERISCOPE (RMS India) was used. This device is based on oscillometric method and records arterial pressure wave forms noninvasively. It calculates:

- Pulse Wave Velocity (PWV)
- Pulse pressure(PP)
- Arterial stiffness index (ASI)
- Carotid-femoral pulse wave velocity (CF PWV)
- Brachio-Ankel pulse wave velocity (Br-Ank PWV)

METHOD

Indices of Arterial Stiffness were assessed by PERISCOPE [RMS India]. PERISCOPE is a Computer based pulse waveform Analysis System that uses simultaneous noninvasive blood pressure measurements and pressure waveform from four limbs and Electro-cardiogram (ECG) waveforms to calculate important parameters like Pulse Wave Velocity [PWV], Arterial stiffness Index [ASI], Central Aortic Pressure Values and Augmentation Index (AIx) etc. Electrodes of electrocardiogram were placed on ventral surface of both wrists and medial side of ankles and BP cuffs were wrapped on both upper arm brachial artery and above tibial artery of ankles. The cuffs were connected to a plethysmographic sensor that determines volume pulse form and an oscillometric pressure sensor that measures blood pressure waveforms from the brachial and tibial arteries. All the pressure recordings were done for about 10 seconds and data was stored in the computer.We have collected the right and left ba PWV, cf PWV and their reference value for age, Right and left, brachial and ankle ASI, estimated augmentation index (AIx) actual and estimated 75 bpm heart rate from report generated by this device.

STATISTICAL ANALYSIS

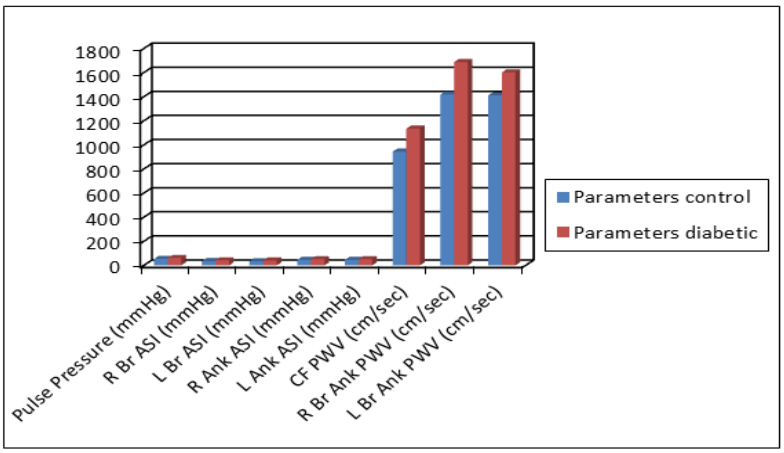
Results obtained in control and diabetic subjects were compared in these groups and was analysed statistically.All data were expressed as mean ± SD and were statistically analysed by using the Microsoft Excel and OpenEpi software (version 2.3.1). Student's t-test, One-way ANOVA and appropriate post-hoc tests (Bonferroni multiple comparisons procedure) was used to determine the statistical difference among parameters. p-values of less than 0.05($p<0.005$) was indicated as statistically significant.

Table-1: Comparison of Arterial Stiffness Parameters

Parameters	CONTROL (N=120)	DIABETIC (N=120)	p-value
	Mean±SD	Mean±SD	
Pulse Pressure (mmHg)	53.94±11.53	60.52±16.85	<0.001HS
R Br ASI (mmHg)	35.24±9.92	41.01±13.62	<0.001HS
L Br ASI (mmHg)	34.36±10.55	40.42±15.04	<0.001HS
R Ank ASI (mmHg)	45.49±12.12	50.46±16.50	<0.001HS
L Ank ASI (mmHg)	46.49±11.27	50.87±16.65	<0.001HS
CF PWV (cm/sec)	944.28±347.00	1134.52±378.51	>0.05NS
R Br Ank PWV (cm/sec)	1418.59±390.94	1686.98±552.94	<0.001 HS
L Br Ank PWV (cm/sec)	1410.99±472.88	1600.68±457.94	>0.05NS

Note: NS=Not Significant, S= Significant, HS=Highly Significant

CHART-1



RESULT

Table 1 and chart 1 are showing the comparison of arterial stiffness parameters between the control and diabetic subjects. The results showed that PP, R Br ASI, L Br ASI, R Ank ASI, L Ank ASI and R Br Ank PWV are highly significantly increased in diabetes. The statistical analysis was done by Student's t- test.

DISSCUSSION

Diabetes is associated with increased cardiovascular disease, including peripheral arterial disease, coronary heart disease and cerebrovascular disease. The vascular nature of the chronic complications of diabetes is not surprising, thus forms the basis for defining diabetes based on circulating glucose levels. Arterial stiffness, as measured by PWV, is increased among type II diabetic patients with no evidence of overt atherosclerotic cardiovascular disease. Table 1 and chart 1 are showing the comparison of arterial stiffness parameters between the control and diabetic subjects.Our results showed that the presence of diabetes is associated with increased arterial stiffness and it may contribute in part to increased cardiovascular risk in diabetic patients. Arterial stiffness indices PP, R Br ASI, L Br ASI, R Ank ASI, L Ank ASI, R Br Ank PWV shows highly significant increase in diabetes. Alvim ORD *et al*. [8] reported that diabetic individuals had higher frequencies of increased arterial stiffness and hypertension. They also had higher values of PWV, body mass index, total cholesterol, triglycerides, systolic and diastolic blood pressures compared to non-diabetic individuals ($p < 0.01$). Zakaria E *et al.* [9] reported that PWV was significantly higher among diabetics versus control.

We have found that the pulse wave velocity was significantly increased in diabetic patients compared to control group. These findings could be explained by the fact that hyperglycaemia promotes the non- enzymatic glycation of LDL forming oxidatively modified LDL that may signal many of the initial events of atherogenesis. The pathophysiological mechanism underlying these associations has not been fully elucidated. However, arterial stiffness may be one important pathway linking diabetes to increased CV risk. The association between diabetes and increased arterial stiffness is well established. Increased atherosclerotic plaque deposition, exacerbated by the increased inflammatory (i.e. immune) response characteristic of the diabetic state, is one mechanism which leads to increased arterial stiffness. In addition to factors leading to increased atherosclerotic plaque deposition, diabetes is also associated with increased arterial calcification, further increasing the arterial stiffness.

Parameters	Pulse Pressure (mmHg)	R Br ASI (mmHg)	L Br ASI (mmHg)	R Ank ASI (mmHg)	L Ank ASI (mmHg)	CF PWV (cm/sec)	R Br Ank PWV (cm/sec)	L Br Ank PWV (cm/sec)
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Present study	(C)53.94±11.53 (D)60.52±16.85 <0.001 HS	35.24±9.92 41.01±13.62 <0.001 HS	34.36±10.55 40.42±15.04 <0.001 HS	45.49±12.12 50.46±16.50 <0.001 HS	46.49±11.27 50.87±16.65 <0.001 HS	944.28±347.00 1134.52±378.51 >0.05 NS	1418.59±390.94 1686.98±552.94 <0.001 HS	1410.99±472.88 1600.68±457.94 >0.05 NS

Parameters	PWV(m/s) Mean±SD
Alvim ORD *et al.* 2013 [8]	(C)9.3 ± 2.1 (D)11.6 ± 2.7 <0.001
Zakaria E *et al*. 2013[9]	(cm/sec.) (C)867.9±188.5 (D)1278.9±517.8 0.001.
Bagherzadeh A *et al*. 2016 [10]	(C)8.00 ± 1.61 (D)10.11 ± 2.45 <0.001
Elias MF *et al.* 2017 [11]	(C)10.4 ± 0.12 (D)12.5 ± 0.36

CONCLUSION

Our study concluded that the presence of diabetes is associated with increased arterial stiffness and it may contribute in part to increased cardiovascular risk in diabetic patients. The results from our study confirm that diabetes increase risk for increased arterial stiffness and that having this condition led to even higher predicted PWV levels. In the control group, the absence of significant association with risk for increased arterial stiffness.

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