Original Research Article

Relationship between Aortic Root Diameter and Type 2 Diabetes in Hypertensive Patients

Abstract

Background: Diabetes mellitus (DM) involves a series of metabolic conditions associated with hyperglycemia which is caused by defects in insulin secretion and./or insulin action. The aim of this work was assessment of the relationship between AOR diameter and T2DM in HTN cases.

Methods: This prospective case control study was carried out on 80 HTN cases. Cases were divided in to three groups: Group A (30 HTN cases) with type 2 DM with good metabolic control (Hb AIC $\leq$ 7.0), group B: (30 HTN cases) with type 2 DM with poor metabolic control (Hb AIC > 7.0) and C (Control group) 20 HTN, non-DM subjects of the same age and sex group with no other comorbid conditions.

Results: FS had a significant decline in group A (P2 = 0.001) and in group B (P3 <0.001) than C. EF had a significant difference among all groups (P <0.001). Early wave DT had a significant decline in group A (P2 = 0.049) and in group B (P3= 0.023) than C. Tissue doppler early velocity wave had a significant difference among all groups (P = 0.004). Tissue doppler early velocity wave had a significant decline in group A and B than C. (P2 = 0.038. P3 = 0.003).

Conclusions: AOR in HTN cases had a significant decline in DM cases compared with non-DM cases. In our results, glycemic control didn't play a significant role in aortic root.

Keywords: Aortic Root Diameter, Type 2 Diabetes, HTN Cases,

Introduction:

Diabetes mellitus (DM) is a group of metabolic disorders characterised by hyperglycemia and caused by abnormalities in insulin production and/or insulin activity. Cases with diabetes either do not make enough insulin (type 1 diabetes) or cannot utilise insulin effectively (type 2 diabetes), or both, which happens in a variety of diabetes types [1].

Type 2 diabetes is a complex metabolic and endocrine condition. Interactions between genes and the environment produce a varied and progressive illness characterised by varying degrees of insulin resistance and pancreatic ß-cell malfunction. Overweight and obesity are key factors to the development of insulin resistance and poor glucose tolerance [1].

Diabetes mellitus is a frequent cardiovascular disease risk factor (CVD). Cases with type 2 diabetes mellitus (T2DM) have raised cardiovascular morbidity and mortality and are more prone to cardiovascular disease [2].

The risk of cardiovascular disease is proportional to the combination of many risk factors, such as hypertension, dyslipidemia, and obesity. It is widely established that the treatment of conventional risk factors is crucial for reducing the CVD risk of T2DM cases. In the DM population, CVD risk factors are poorly managed [2].

Despite the fact that diabetes has long been acknowledged as a major cardiovascular risk factor, a surprising negative link exists between diabetes and the occurrence of abdominal aortic aneurysm. In addition, the expansion rate of abdominal aortic aneurysms reduced in these individuals [3].

Extremely prevalent among cases with T1DM (30%) and T2DM (60%). Traditionally, hypertension causes degeneration of the medial layer of the aortic wall, which results in dilatation of the thoracic aorta, declined aortic wall compliance, and elevated pulse pressures [4, 5].

Involving aortic root (AOR) diameter, proximal aortic diameter has been found to be inversely linked to pulse pressure. Consequently, a smaller AOR diameter may rise the likelihood of developing hypertension, whereas a bigger AOR is indicative of a greater vascular risk [6].

A dilated AOR was connected with a raised risk of stroke, heart failure, and death [7]

The purpose of this study was to examine the correlation between AOR diameter and T2DM in cases with hypertension.

Patients and Methods:

This prospective case control study was carried out on 80 HTN cases aged above 18 years. This study was performed at Cardiology Department -Tanta University Hospital, during the period from March 2020 to February 2021.

The study was done after approval from the Ethical Committee Tanta University. An informed written consent was obtained from all cases.

Exclusion criteria were Type 1 diabetes mellitus cases, smoker, age less than 18 years, valvular heart disease, congenital heart disease and atrial fibrillation and other types of arrhythmias.

Cases were divided in to three groups: Group A (30 HTN cases) with type 2 DM with good metabolic control (Hb AIC $\leq$ 7.0), group B: (30 HTN cases) with type 2 DM with poor metabolic control (Hb AIC > 7.0) and C (Control group) 20 HTN, non-DM subjects of the same age and sex group with no other comorbid conditions.

All cases were subjected to: Full history taking, full clinical examination (General examination and local cardiac examination), resting 12 leads ECG, routine laboratory investigation [complete blood count (CBC), fasting and 2 hours post prandial blood sugar level, total cholesterol, LDL, HDL and triglycerides], echocardiography, and tissue Doppler imaging (TDI).

Echocardiography: All studies were performed using (a GE vivid seven Cardiac ultrasound phased array system with tissue Doppler imaging using M4S transducer 4 M.HZ.). Two-dimensional and M-mode echocardiographic assessment was done.

Echocardiographic data are reported as the mean of five cardiac cycles in succession. We chose the normal upper limits for aortic root diameter (ARD) from the healthy cases of the Pressioni Arteriose Monitorate E Loro Associazioni (PAMELA) research [8, 9] since their geographic and demographic features are comparable to those of our study cases. These partition values were for absolute ARD, ARD indexed to BSA, and height in men and women, respectively: 3.8 cm, 2.1 cm/m2, and 2.3 cm/m in males and 3.4 cm, 2.2 cm/m2, and 2.2 cm/m, respectively [10].

TDI: TDI is possible in both pulsed-wave and colour forms. Pulsed-wave TDI is utilised to quantify peak myocardial velocities and is well suited for the detection of long-axis ventricular motion, since the longitudinally oriented endocardial fibres are most parallel to the US waves in the apical views. Mitral annular motion is an excellent proxy measure of longitudinal left ventricular (LV) contraction and relaxation since the apex remains largely fixed during the cardiac cycle [11].

Echocardiography was done in partial left lateral decubitus position to: M-mode assessment of LV systolic function through getting the long parasternal axis view and directing the M-mode cursor across the LV & it is measured also in the parasternal short view with directing the M-mode cursor across the mid LV. [12] The Left ventricle mass (LVM) was calculated using the ASE-corrected cube formula. As recommended by de Simone et al. [13], it was indexed by both BSA (LVMI) and height multiplied by 2.7 (LVMH2.7) to give a more restrictive tolerance for obesity. Aortic root size was estimated at the widest point of Valsalva's sinuses using M-mode echocardiography under two-dimensional control [12] as

the maximum distance between the two leading edges of AOR anterior and posterior walls at end diastole.

A single cardiologist, uninformed of the case's clinical features, performed M-mode echocardiogram guided by two-dimensional echocardiography with the patient in a partial left decubitus posture. M-mode measurements were obtained at end diastole and end systole in accordance with the guidelines of the American Society of Echocardiography (ASE) [12]. For measurements, only frames with good imaging of interfaces and simultaneous vision of septum, LV internal diameter, and posterior wall were utilised. The relative wall thickness of the myocardium was estimated by dividing the posterior wall thickness in diastole by the internal diameter [12].

Statistical analysis

SPSS v27 (IBM, Chicago, IL, USA) was used for statistical analysis. Using the Shapiro-Wilks test and histograms, the normality of the data distribution was determined. The quantitative parametric data were given as mean and standard deviation (SD) and analysed using the ANOVA (F) test with post hoc comparisons (Tukey). The Chi-square test was utilised to analyse qualitative data reported as frequency and percentage (%). A two-tailed P value less than or equal to 0.05 was considered statistically significant and if more than ≥0.05 it would be considered statistically insignificant.

Results:

Patient characteristics (age, weight, height, BMI, BSA and sex) were insignificantly different among all groups. Table 1

Table 1: Patient characteristics among all groups

	Group A (n = 30)	Group B (n = 30)	Group C (n = 20)	P value
Age (years)	58.70 ± 12.67	53.67 ± 11.51	59.35 ± 11.08	0.159
Weight (Kg)	87.27 ± 9.75	86.03 ± 11.12	81.00 ± 12.60	0.134
Height (m)	1.67 ± 0.08	1.71 ± 0.07	1.68 ± 0.07	0.194
BMI (kg/m^2)	31.38 ± 4.41	29.55 ± 3.89	28.97 ± 5.67	0.142
BSA (kg/(m2)	1.96 ± 0.12	1.98 ± 0.14	1.90 ± 0.12	0.110

Sex	**Male**	18 (60%)	17 (56.7%)	10 (50%)	0.782
	Female	12 (40%)	13 (43.3%)	10 (50%)	

Data are presented as mean ± SD or frequency (%). BMI: Body mass index, BSA: Body surface area

SBP, HR and cholesterol were insignificantly different among all groups. DBP had a significant difference among all groups (P = 0.002). DBP had a significant decline in group B than A (P1 = 0.012) and C (P3 = 0.001) but was insignificantly different between group A and C (P2 = 0.253). MAP had a significant difference among all groups (P = 0.003). Mean arterial BP had a significant decline in group A and C than B. (P1 = 0.016. P3 = 0.007) but was insignificantly different between group A and C. Pulse Press had a significant difference among all groups (P = 0.003). Pulse Press was significantly raised in group B than A (P1 = 0.005) and C (P3 = 0.002) but was insignificantly different between group A and C. HBA1C had a significant difference among all groups (P <0.001). HBA1C had a significant decline in group C than A and B and in group A than B (P3 = 0.018). Table 2

Table 2: Clinical data and Laboratory investigations

	Group A (n=30)	**Group B (n=30)**	**Group C (n=20)**	**P value**		
SBP (mmHg)	137 ± 15.68	142 ± 15.90	1378.75 ± 15.26	0.428		
DBP (mmHg)	84.67 ± 9.19	78 ± 9.43	88 ± 11.96	0.002*	P1	0.012*
					P2	0.253
					P3	0.001*
MAP (mmHg)	92.44 ± 5.23	96.33 ± 4.58	91.58 ± 5.94	0.003*	P1	0.016*
					P2	0.812
					P3	0.007*
Pulse Press	52.33 ± 15.69	64 ± 13.73	49.75 ± 17.81	0.003*	P1	0.005*
					P2	0.567
					P3	0.002*
HR (beats/min)	73.59 ± 10	73.17 ± 8.48	71.93 ± 6.77	0.799		
HBA1C	6.77 ± 0.18	8.31 ± 2.72	5.74 ± 0.43	<0.001*	P1	0.001*
					P2	<0.001*
					P3	0.018*
Cholesterol	180.03 ± 46.57	182.30 ± 37.01	179.85 ± 42.30	0.971		

Data are presented as mean ± SD, SBP: systolic blood pressure; DBP: diastolic blood pressure; MAP: Mean arterial blood pressure, HR: heart rate; SD: standard deviation; P1: p value between group A and group B; P2: p value between group A and group C; P3: p value between group B and group C; *: significant as p value <0.05.

FS had a significant difference among all groups (P = 0.001). FS was insignificantly different between group B and A (P1 = 0.583), had a significant decline in group A (P2 = 0.001) and in group B (P3 <0.001) than C. EF had a significant difference among all groups (P <0.001).

EF was insignificantly different between group B and A (P1 = 0.429), had a significant decline in group A (P2 = 0.010) and in group B (P3 <0.001) than C. AOR had a significant difference among all groups (P = 0.016). AOR was insignificantly different between group B and A (P1 = 0.694), had a significant decline in group A than C (P2 = 0.017) and had a significant decline in group B than C (P3 = 0.007). AOR had a significant difference among all groups (P = 0.016). AOR was significantly raised in group B than A (P1 = 0.694), had a significant decline in group A than C (P2 = 0.017) and had a significant decline in group B than C (P3 = 0.007). Aortic root/BSA had a significant difference among all groups (P = 0.005). Aortic root/BSA had a significant decline in group A and B than C. (P2 = 0.016. P3 = 0.006). but was insignificantly different between group A and B (P = 9.28). Left Atrium was insignificantly different among all groups. Table 3

Table 3: FS, EF, AOR and Left Atrium among all groups

	Group A (n = 30)	Group B (n = 30)	Group C (n = 20)	P value		
FS (%)	27.47 ± 3.93	26.97 ± 3.19	30.90 ± 3.32	0.001*	P1	0.583
					P2	0.001*
					P3	<0.001*
EF (%)	60.57 ± 5.70	58.90 ± 5.03	65.05 ± 4.50	<0.001*	P1	0.429
					P2	0.010*
					P3	<0.001*
AOR (mm)	32.37 ± 3.21	32.43 ± 2.71	34.98 ± 3.86	0.016*	P1	0.694
					P2	0.017*
					P3	0.007*
Aortic root/BSA	16.72 ± 1.71	16.51 ± 2.241	18.52 ± 2.75	0.005*	P1	0.928
					P2	0.016*
					P3	0.006*
Left atrium (mm)	36.87 ± 4.17	36.80 ± 6.12	34.60 ± 4.10	0.227		

Data are presented as mean ± SD, FS; Fraction shortening; EF: ejection fraction; BSA: body surface area; SD: standard deviation; P1: p value between group A and group B; P2: p value between group A and group C; P3: p value between group B and group C; *: significant as p value <0.05.

Early wave DT had a significant difference among all groups (P = 0.025). Early wave DT was insignificantly different between group B and A (P1 = 0.583), had a significant decline in group A (P2 = 0.049) and in group B (P3= 0.023) than C. Tissue doppler early velocity wave had a significant difference among all groups (P = 0.004). Tissue doppler early velocity wave had a significant decline in group A and B than C. (P2 = 0.038. P3 = 0.003) but was

insignificantly different between group A and B. Early velocity/Tissue Doppler early velocity wave had a significant difference among all groups (P = 0.033). Early velocity/Tissue Doppler early velocity wave was insignificantly different between group A and B (P1 = 0.879), was significantly raised in group A than C (P2 = 0.023) and was significantly raised in group B than C (P3 = 0.016). Isovolumic relaxation time (ms) had a significant difference among all groups (P = 0.006). Isovolumic relaxation time (ms) was was insignificantly different between group A and B (P2 = 0.651), had a significant decline in group B than A (P1 = 0.008), and had a significant decline in group B than C (P3 = 0.005). Early Wave DT was insignificantly different among all groups. Table 4

Table 4: Early Wave DT, Tissue Doppler early velocity wave, Early velocity/Tissue Doppler early velocity wave and Isovolumic relaxation time among all groups

	Group A (n = 30)	Group B (n = 30)	Group C (n = 20)	P value		
Early Wave DT	283.76 ± 62.66	289.80 ± 66.13	237.38 ± 74.96	0.025*	P1	0.935
					P2	0.049*
					P3	0.023*
Tissue Doppler early velocity wave (m/s)	0.086 ± 0.03	0.079 ± 0.03	0.107 ± 0.02	0.004*	P1	0.582
					P2	0.038*
					P3	0.003*
Early velocity/Tissue Doppler early velocity wave	8.82 ± 3.72	8.91 ± 3.57	6.51 ±2.29	0.033*	P1	0.879
					P2	0.023*
					P3	0.016*
Isovolumic relaxation time (ms)	92.67 ± 17.05	89 ± 15.90	102.85 ± 17.21	0.006*	P1	0.672
					P2	0.093
					P3	0.014*

Data are presented as mean ± SD, P1: p value between group A and group B; P2: p value between group A and group C; P3: p value between group B and group C; *: significant as p value <0.05.

Discussion

DM is a syndrome of chronic hyperglycemia due to insulin deficiency or resistance or both [14]. DM leads to multiple complications that include macrovascular and microvascular complications. The macrovascular complications include coronary artery disease, peripheral vascular disease and cerebral vascular disease. However microvascular damage causes diabetic retinopathy, nephropathy and neuropathy [14].

In our study, SBP, HR and cholesterol were insignificantly different among all groups. DBP had a significant difference among all groups (P = 0.002). DBP had a significant decline in group B than A (P1 = 0.012) and C (P3 = 0.001) but was insignificantly different between group A and C (P2 = 0.253). Pulse Press had a significant difference among all groups (P = 0.003). Pulse Press was significantly raised in group B than A (P1 = 0.005) and C (P3 = 0.002) but was insignificantly different between group A and C.

In agreement with our results, Nardi et al. [15] 1693 hypertension cases (aged 63.7 9.6 years) were recruited. The population was separated between those with diabetes and those without diabetes. ARD was assessed utilising echocardiography M-mode tracings at the level of Valsalva's sinuses. They found SBP was not different in the two groups whereas DBP was lower and PP was higher in DM cases. However, in a disagreement with our results, cholesterol levels were significantly higher in DM group.

In our study, HBA1C had a significant difference among all groups (P <0.001). HBA1C had a significant decline in group C than A and B and in group A than B (P3 = 0.018).

The present results agree with results obtained from Sameh et al., Tamer et al., and Ahmed et al., [16-18] research investigating the association between HBA1c level, DM duration, and longitudinal strain measures. Poor glycemic management (as evidenced by an elevated HBA1c level) and a longer duration of DM were significantly associated with longitudinal strain parameters. The DM group exhibited lower GLS values, which was the primary sign for detecting subclinical systolic dysfunction, according to the current study. GLS (%) -18.95 ± 2.02

In our study, fractional shortening (FS) had a significant difference among all groups (P = 0.001). FS was insignificantly different between group B and A (P1 = 0.583), had a significant decline in group A (P2 = 0.001) and in group B (P3 <0.001) than C. EF had a significant difference among all groups (P <0.001). Ejection fraction (EF) was insignificantly

different between group B and A (P1 = 0.429), had a significant decline in group A (P2 = 0.010) and in group B (P3 <0.001) than C.

Boyer et al. [19] suggested that although the prevalence of subclinical LV longitudinal systolic dysfunction in DM cases with reserved LVEF varied among studies, this may depend on the patient characteristics, such as the severity of DM or DM-related complications. Many previous studies have claimed that diastolic dysfunction is the early detectable parameter for DCM. These also is concordant with current study as Group C Doppler, diastolic function and strain parameters differed significantly from other groups included in the study.

In agreement with our results, Ehl et al. [20] evaluated 2400 cases undergoing stress myocardial perfusion SPECT (MPS). LVEF was measured by gated SPECT and then compared with respect to DM status. They concluded a significantly lower LVEF in DM compared with non-DM cases (P=0.001) in a large patient population.

In our study, AOR was insignificantly different between group B and A (P1 = 0.694), had a significant decline in group A than C (P2 = 0.017) and had a significant decline in group B than C (P3 = 0.007). Aortic root/BSA had a significant decline in group A and B than C. (P2 = 0.016. P3 = 0.006). but was insignificantly different between group A and B (P = 9.28). Left Atrium was insignificantly different among all groups.

In agreement with our results, Nardi et al. [15] revealed that AOR diameter/BSA had a significant decline in DM cases only when indexed for BSA and this difference held after adjustment by ANCOVA for age and sex. Dilated AOR diameter/BSA was detected in 8.6% of the DM cases and in 11.6% of HTN cases without diabetes (p = 0.04)

In our study, Early wave declaration time (DT) had a significant difference among all groups (P = 0.025). Early wave DT was insignificantly different between group B and A (P1 = 0.583), had a significant decline in group A (P2 = 0.049) and in group B (P3= 0.023) than C.

In the study of Abdelfattah et al., [21], they made a case control study to detect subclinical Left Ventricular Dysfunction by Two-Dimensional Speckle Tracking and Tissue Doppler Echocardiography in young cases with type 1 DM. Their study was a case control study that was done on 100 cases who were divided equally into 2 groups, DM group and healthy control group. There was a highly statistically significant difference between the 2 groups regarding A wave velocity, E/A ratio and DT with P value 0.023.

Tissue doppler early velocity wave had a significant decline in group A and B than C. (P2 = 0.038. P3 = 0.003) but was insignificantly different between group A and B.

Raafat [22] enrolled 90 age and sex matched subjects 30 uncontrolled diabetes cases with HbAlc > 8% and 30 managed DM cases with HbAlc 8% were separated into two groups based on HbAlc, while a third group of 30 normal cases acted as controls. They compared left ventricular diastolic function between the studied groups and found that the mean peak early mitral inflow velocity E wave and the colour M-mode flow propagation velocity of early diastolic flow (Vp) were significantly lower, whereas the mean peak late mitral inflow velocity A wave had a significant rise, in uncontrolled diabetics as compared with controlled DMcases and the control group.

In our study, Early velocity/Tissue Doppler early velocity wave had a significant difference among all groups (P = 0.033). Early velocity/Tissue Doppler early velocity wave was insignificantly different between group A and B (P1 = 0.879), was significantly raised in group A than C (P2 = 0.023) and was significantly raised in group B than C (P3 = 0.016). Nardi et al. [15] revealed an inverse relationship of AOR diameter/BSA was found with early/atrial flow velocity and tissue Doppler early velocity

In our study, Isovolumic relaxation time (IVRT) (ms) had a significant difference among all groups (P = 0.006). Isovolumic relaxation time (ms) was insignificantly different between group A and B (P2 = 0.651), had a significant decline in group B than A (P1 = 0.008), and

had a significant decline in group B than C (P3 = 0.005). Early Wave DT was insignificantly different among all groups.

Ozkan, [23] prospectively evaluated 70 cases allocated into 3 groups. All cases were required to exercise on a treadmill. Before and shortly after peak exertion, echocardiographic evaluations were conducted. They observed that DM individuals with DD had a declined exercise capacity as measured by DT and IVRT, which may be the result of a worsening of preexisting LVD.

Conclusions:

AOR in HTN cases had a significant decline in DM cases compared with non-DM. In our results, glycemic control didn't play a significant role in aortic root.

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