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Abdominal aortic diameter as a predictor of early cardiovascular dysfunction in asymptomatic diabetic elderly

KEYWORDS: abdominal aorta diameter, diabetes, elderly, cardiovascular dysfunction

Moatassem S Amer
Department of Geriatrics and Gerontology, Faculty of Medicine Ain Shams University Cairo - Egypt

Hoda MF Wahba
Department of Geriatrics and Gerontology, Faculty of Medicine Ain Shams University Cairo - Egypt

ABSTRACT *Background and objective: In the presence of type II diabetes, the prevalence of all cardiovascular disease (including carotid stenosis, abdominal aortic aneurysm, and peripheral artery disease) is doubled. The aim of this study was to correlate abdominal aortic diameter with early cardiovascular dysfunction in asymptomatic diabetic elderly. Methods: Case-control study, 60 diabetic patients and 60 nondiabetic patients, age and sex matched no symptoms of any heart disease. Consent, medical history, blood sample (fasting blood sugar, lipid profile, C-reactive protein), abdominal ultrasound (abdominal aortic diameter at iliac bifurcation) and trans-thoracic echocardiography were done. Results: Negative significant correlation between ejection fraction and abdominal aortic diameter in both genders (r = -0.259, p = 0.045). Conclusion: enlarged abdominal aortic diameter can indicate early cardiovascular dysfunction in the form of decreased ejection fraction in asymptomatic diabetic elderly and these results can be applied to both genders.*

Introduction

Aging has a remarkable effect on the heart and arterial system, leading to an increase in cardiovascular disease (CVD) including atherosclerosis, hypertension, myocardial infarction, and stroke [1].

The aging heart demonstrates alterations including hypertrophy, altered left ventricular (LV) diastolic function, and diminished LV systolic reverse capacity [1, 2]. Aging of the vasculature results in increased arterial thickening and stiffness as well as dysfunctional endothelium [3]. However, the health of the arterial and cardiac systems is not mutually exclusive, as each system greatly affects the other. For instance, an increase in arterial stiffness leads to compensatory mechanisms by the myocardium including LV hypertrophy and fibroblast proliferation, resulting in decreased cardiac output and increase in fibrotic tissue [1, 2].

The abdominal aorta is known to be more susceptible to arterial dilation than to occlusion primarily due to the effects of vascular aging. Few studies have considered the effects of cardiovascular risk factors on arterial diameter [4].

The normal aortic diameter in adults usually ranges from 16 to 18 mm in women and 19 to 21 mm in men. Individuals with diameters outside this range seem to be at increased risk of other cardiovascular disease. There is a graded association between increasing aortic diameter and both cardiovascular mortality and peripheral arterial disease. The magnitude of increased risk of cardiovascular death seems to be about 4% to 6% per mm increase over a diameter of about 23 mm. While the threshold of 3 cm is useful in the diagnosis of abdominal aortic aneurysm (AAA), it is arbitrary in terms of the vascular biology and pathophysiology of the abdominal aorta [5].

The prevalence of type 2 diabetes, which represents roughly 90% of all diabetes, increases with age. The morbidity and mortality associated with macrovascular events far outweigh the risks of microvascular complications in older people with diabetes [6]. In the presence of type II diabetes, the prevalence of all cardiovascular disease (including carotid stenosis, AAA, and peripheral artery disease) is doubled [7]. Diabetes is characterized by accelerated atherosclerosis with widely distributed vascular lesions [8]. Reports document that almost 70% of adults with type 2 diabetes mellitus will die from cardiovascular disease (CVD) [9].

Early detection of CVD risk factors in patients with established diabetes and early intervention should delay onset of CVD in this population. Determinants of progression of coronary atherosclerosis and development of clinical events in patients with diabetes need to be better defined. Methods used to measure atherosclerosis and vascular disease, such as carotid ultrasound, echocardiography, magnetic resonance imaging, and ankle-brachial index, require additional evaluation. [10].

Despite the fact that AAA is an expression of atherosclerotic disease, the prevalence of AAA in diabetic patients is less than expected. In other words, AAA in diabetes is a non-frequent macrovascular complication related to atherosclerotic disease. Such a conclusion appears quite remarkable; premature macrovascular disease in other vascular beds (e.g. presence of microalbuminuria and increased intima-media thickness of the carotid artery) is already present in an early (pre-) diabetic stage [11].

Hence, the current study aimed to assess the correlation of early cardiovascular dysfunction and abdominal aortic diameter in asymptomatic diabetic elderly.

Materials and methods

Acceptance by the ethical committee of ------ University was taken. A case-control study recruited 120 subjects all 60 years or above from ----- University outpatient clinics. Subjects with comorbidities other than diabetes were excluded (e.g. ischemic heart disease, hypertension, renal disease). The subjects were grouped into cases group; sixty subjects with diabetes type II, previously diagnosed and on therapy and a second group the control group; sixty apparently healthy subjects with no history of any disease.

The serum from the 12 hour fasting blood samples was used to measure fasting blood sugar, cholesterol, LDL,

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HDL, triglycerides and C-reactive protein. 2hour postprandial serum sugar was also measured.

The abdominal ultrasound was used to assess the aortic diameter at the level of the iliac bifurcation; the maximum diameter of the aorta was measured from the leading edge to leading edge. A maximum anteroposterior or transverse diameter more than 30mm was considered an aneurysm.

The transthoracic echocardiography was done via 2.5-3.5 MHz transducer, measurements were from transapical or parasternal views (except in poorly echogenic subjects a subcostal view was used). The measures that were taken were; left ventricular dimensions [end diastolic diameter (EDD), end systolic diameter (ESD)], wall thickness (posterior wall), left ventricular systolic function [% fraction shortening (FS), ejection fraction (EF)] by M-mode, left atrial size, and annular aortic root.

Data collected was revised, and using version 17 of the statistical package for social sciences the results were calculated. Qualitative data was presented as frequency (numbers and percentages). Quantitative data was presented in the form of mean ±standard deviation and range. Independent t test was used to compare groups with quantitative continuous variables. The probability of error at 0.05 was considered significant, while at 0.01 and 0.001 are highly significant.

Results

The mean age of the diabetic group was 68 ±5years and the nondiabetic group was 67±5 years. The mean duration of diabetes in the diabetic patients was 11.12±4.79 years. The fasting blood sugar in the diabetics was 159.52±45.95 mg/dl and 2hr postprandial blood sugar 240.35±57.64 mg/dl while in the non diabetics was 92.70±14.41 mg/dl and 136.03±35.95 mg/dl respectively.

The differences in the lipid profile of both groups was insignificant except for the cholesterol levels which was significantly higher in the diabetics p=0.005 with a mean level of 213.08±34.19 mg/dl. Similarly, the C-reactive protein level was significantly higher in the diabetics p=0.000 with mean level of 6.90±2.88.

A significant negative correlation between EF and abdominal aorta diameter was found in the diabetic group table (1).

Comparing the data of the males and females in both groups revealed a significant difference between the aortic root diameter in the diabetics being higher in the males (32.43±5.02) (p=0) and a significantly larger abdominal aortic diameter in the nondiabetic females (15.6±1.64) than nondiabetic males (13.65±1.63) (p=0).

Discussion

While diabetes confers greater cardiovascular disease risk, recent evidence suggests that individuals with diabetes have a wide range of risk [12].

Therefore many studies aimed to use noninvasive imaging techniques such as carotid intima-media thickness (IMT) to provide a mechanism for studying the evolution of atherosclerosis. In adults, investigators have used carotid IMT to document the extent and progression of atherosclerosis [13]. Studies have shown that increased carotid IMT is associated with known cardiovascular risk factors and is efficacious in predicting future coronary artery disease and stroke [14]. Carotid IMT has also been used to study atherosclerosis in adults with type 2 diabetes mellitus. These studies have shown that type 2 diabetes mellitus is associated with an increase in carotid IMT and a 40% higher risk of myocardial infarction and stroke [15]. Similarly, relatively large maximal infrarenal diameter in non-aneurismal aortas increased total mortality and CVD mortality [16]. In accordance with the findings of Norman *et al.*, there were indications of a somewhat increased CVD mortality in subjects with a low aortic diameter (<18 mm) (MRR = 1.21, 95% CI 0.84–1.74). Hence was the aim of the current study; to find a relation between early cardiovascular dysfunction and abdominal aortic diameter in asymptomatic diabetic elderly, allowing primary preventive measures to be taken. The mean duration of diabetes in the diabetic patients was 11.12±4.79 years which provides a sample in which the pathophysiology of diabetes has been ongoing for a relatively short period given the subjects are above sixty. The subjects had no symptoms of any cardiovascular dysfunction.

When correlating certain measures of the echocardiography with the diameter of the abdominal aorta, a negative significant relation was found between the ejection fraction of the diabetic subjects and the diameter of their abdominal aorta. Many studies have found a relation between the AAD and ejection fraction in AAA but none have studied the relation in aorta dimensions that were within the normal range. Such findings are displayed in the research by Bekkers et al. in 2005 which showed that patients with AAA were older and had an increased ascending aorta diameter, larger left ventricular dimensions, higher left ventricular mass index, and lower ejection fraction [17].

The only measurements that displayed gender differences were the aortic annular root diameter and abdominal aortic diameter. The AARD was significantly larger in the diabetic males than the females of the same group (p=0.00), which is supported by the findings previously found by Heer et al., in a study in 2011 which stated "The diameters, both Dmax and Dmin, of the male aortic root were significantly larger than the diameters of the female aortic root. There is no significant correlation between length of the subjects and the dimensions and weight of the subjects and the dimensions" [18]. Contradicting, the AAD was significantly larger in the females of the nondiabetic group than the males of the same group but still both were within the normal range as set by Norman et al., 2011 "the normal aortic diameter in adults usually ranges from 16 to 18 mm in women and 19 to 21 mm in men" [19].

The authors believe that despite the agreement of several studies further specific studies in the elderly are required to ensure that this correlation is not due to a cluster of age related physiological changes.

Conclusion

Deducing from the negative correlation between the EF and AAD in the cases; enlarged AAD can indicate early cardiovascular dysfunction in the form of decreased EF and these results can be applied to both genders.

Conflict of interest: none

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Table (1): Echocardiographic findings in diabetic patients (mean±SD, correlation with aortic diameter).

	Mean ± SD	R	P
LV EDD	52.16±6.22	0.056	0.671
RWT	0.20±0.05	0.005	0.969
LV ESD	34.92±8.12	0.166	0.205
EF	58.57±14.22	-0.259	0.045
LAD	43.37±7.06	0.056	0.672
AARD	30.78±4.60	0.122	0.355

LV EDD: left ventricular end diastolic diameter, RWT: relative wall thickness, LV ESD: left ventricular end systolic diameter, EF: ejection fraction, LAD: left atrial diameter, AARD: aortic annular root diameter

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