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Correlation between aortic elasticity and the severity of coronary artery stenosis in patients with coronary heart disease

Mohamed Salah[1], Waleed Yousif[2], Mahmoud Elhawy[3], Ahmed Mohamed Abd Elatef[4]
[1-4] Department of Cardiology, Faculty of medicine, Al-Azhar University (Assuit), Egypt

Abstract
Objectives: The aim of this study is to assess the aortic elasticity in relation to the severity of coronary stenosis in patients with coronary heart disease (CHD).
Methods: The study included 50 persons divided into three groups: based on the severity of coronary stenos measured by coronary angiography (CAG). All subjects underwent full history taking, complete clinical examination, echocardiographic examination, full laboratory data, ECG and coronary angiography.
Results: Among study population 22 female (44.0%) and 28 male (56.0%) with mean age (55.530 ± 6.802) There was considered extremely statistically significant between the three groups as regard aorta stiffness index was greater in moderate and severe stenos groups than the slight stenos group (P\<0.0004), whereas dispensability index showed the opposite trend (P\<0.0001). the two indexes changed in a stepwise pattern with the narrowness of coronary artery,
Conclusion: The elasticity indexes of ascending aorta correlate closely with the severity of coronary stenosis, positive correlation between Gensini scoring of coronary artery narrowing and stiffness index of ascending aorta. In contrast, dispensability index was negatively correlated with Gensini score.

Keywords: atherosclerosis, coronary artery disease, M-mode echocardiography

Introduction
Coronary heart disease (CHD) is a major cause of death and disability in developed countries. Although CHD mortality rates have declined over the past four decades in the United States (and elsewhere), CHD remains responsible for about one-third of all deaths in individuals over age 35. It has been estimated that nearly one-half of all middle-aged men and one-third of middle-aged women in the United States will develop some manifestation of CHD [1].
Coronary artery disease (CAD), also known as ischemic heart disease (IHD), is the most common of the cardiovascular diseases. Types include stable angina, unstable angina, myocardial infarction, and sudden cardiac death. A common symptom is chest pain or discomfort which may travel into the shoulder, arm, back, neck, or jaw. Occasionally it may feel like heartburn. Usually symptoms occur with exercise or emotional stress, last less than a few minutes, and improve with rest. Shortness of breath may also occur and sometimes no symptoms are present [2].
Coronary artery disease has a number of well determined risk factors. These include high blood pressure, smoking, diabetes, lack of exercise, obesity, high blood cholesterol, poor diet, depression, family history, and excessive alcohol. About half of cases are linked to genetics. Smoking and obesity are associated with about 36% and 20% of cases, respectively. Smoking just one cigarette per day about doubles the risk of CAD. Lack of exercise has been linked to 7–12% of cases.] Exposure to the herbicide Agent Orange may increase risk. Rheumatologic diseases such as rheumatoid arthritis, systemic lupus erythematosus, psoriasis, and psoriatic arthritis are independent risk factors as well [3].

Aim of the study
The aim of this study is to assess the aortic elasticity in relation to the severity of coronary stenos i in patients with coronary heart disease (CHD).

Patients and Methods
Study design
This is a prospective, randomized study that involved 50patients referred to Cardiology Department Azhar Assiut University Hospital which were known to be CAD patients and divided into three groups group based on the severity of coronary stenosis measured by coronary arteriography (CAG):.

Exclusion criteria
- Hemodynamically unstable patients, Rheumatic heart disease, Valvular heart disease. Patient with aortopathy, Patient with Cardiomyopathy and Patient with end stage renal and liver diseases.

Methods
All patients in this study were subjected to:
- **Full history taking**: with stress on symptoms of coronary artery disease, heart failure, renal insufficiency, and medication taking for treatment of hypertension.
- **Careful Clinical examination**: All patients will be assessed clinically, including the evaluation of cardiovascular risk factors (HTN, PVD, signs of CHF).
- **Twelve-leads surface ECG**: To assess QRS duration and criteria suggestive of ischemia.

Conventional echocardiography examination
- Complete Transthoracic Echocardiographic examination including conventional echocardiography and tissue doppler echocardiography, all echocardiographic examinations performed after 20–30 min of rest with the

patient in quiet respiration in the partial left lateral decubitus position, using a 2–4 MHz transducer, and accompanied by recording resting electrocardiography, using the following modalities of echo: 2D echo, M mode echo, Colour Doppler echo, CW and PW Doppler, Pulsed tissue Doppler imaging All measurements obtained online and Echocardiographic parameters measured according to the American Society of Echocardiography Values for each parameter obtained by averaging measurements from three successive cardiac cycles [4].

- Parasternal left ventricle long axis view adjacent to sternum will be taken and probe will be adjusted to display ascending aorta long axis. M-mode sampling line will be placed 3 cm above aortic valve. M-mode diameter measurements were made in systole (point of maximal anterior motion of aorta) and at end-diastole (q wave on electrocardiogram) to determine systolic and diastolic diameters of ascending aorta, respectively. LVEDD was measured when aortic valve was closed, whereas LVSD was measured when aortic valve was completely opened. Measuring point was positioned at bottom border of anterior wall of the ascending aorta and upper border of posterior wall.
- Stiffness index and distensibility index of ascending aorta were calculated according to the following formula [5].
- Stiffness index of ascending aorta = In (systolic pressure/diastolic pressure) / [(vascular systolic diameter - vascular diastolic diameter) / vascular diastolic diameter].
- Distensibility index = 2 (vascular systolic diameter - vascular diastolic diameter) / [vascular diastolic diameter x (systolic pressure – diastolic pressure) cm2 / dyne.• All patients underwent coronary angiography using standard Jerkins method.

Coronary Angiography

- Diagnosis was made independently by two interventional physicians, and a third physician's opinion was needed when the two interventional physicians did not reached agreement in diagnosis. Interventional physicians were blind to other information of patients.
- Modified Gensini scoring was used to evaluate the coronary artery disease. The coronary artery tree was divided into eight segments, and the modified Gensini score (GS) system was used for the quantitative scoring of the degrees of vascular lesions, recorded as GS [6].

Statistical Analysis

The data were collected & have been analyzed using SPSS (Statistical Package for Social Science). Data have been presented using the Mean and Standard deviation then both groups & compared using the t-test for independent sample means and the chi-square tests.

The following tests were done

- X= Mean.
- SD= Standard deviation.
- T test for independent samples.
- ANOVA= Analysis of variance.
- X2 = Chi square test.
- Post Hoc test.
- P value> 0.05= Non-significant (NS) P value< 0.05= Significant (S)
- P value< 0.01= Highly significant (HS)

Results

Baseline demographic data

The study was conducted on 50 individuals who presented to the echocardiography unite at Azhar Asyut University Hospital & 100 of them known to have CAD28 male(56%) and 22 female(44%) with mean age 55.530 ± 6.802. All patients were treated by anti-ischemic drugs. The study was started in November 2017 and was terminated in Augusts 2018.

***** In our study we enrolled 50 patients with CAD and divided them in to three groups according to modified gensini score.
Group I: Slight stenosis
Group II: Moderate stenosis
Group III: Serious stenosis

There was no statistically significant difference between the three groups as regard to demographic data.

Table 1: Comparison of baseline demographics in different groups

	Group I	Group II	Group III	
Cases	20	18	12	
Age	54.9 +/- 11	58 +/- 11.43	61.91 +/- 9	0.21
Male	8 (40%)	11 (61.1%)	9 (75%)	0.1335
Female	12 (60%)	7 (38.9%)	3 (25%)	
DM	5 (25%)	9 (50%)	5 (41.7)	0.272
HTN	6 (30%)	8 (44.4%)	5 (41.7)	0.281

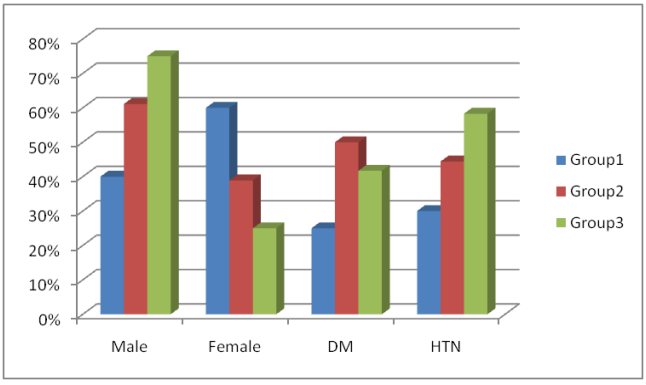

Fig 1: Comparison of baseline demographics in different groups

Comparison between three groups according to stiffness index and distensibility index There was considered extremely statistically significant between the three groups as regard, aorta stiffness index was greater in moderate and severe stenosis groups than the slight stenosis group (P\<0.0004), whereas distensibility index showed the opposite trend (P\<0.0001). the two indexes changed in a stepwise pattern with the narrowness of coronary artery.

Table 2: Comparison between three groups according to stiffness index

Group	Stiffness index			P-value
	Mean	±	SD	
Group I	2.29	±	0.26	< 0.0004
Group II	2.66	±	*0.34*	
Group III	2.85	±	0.28	

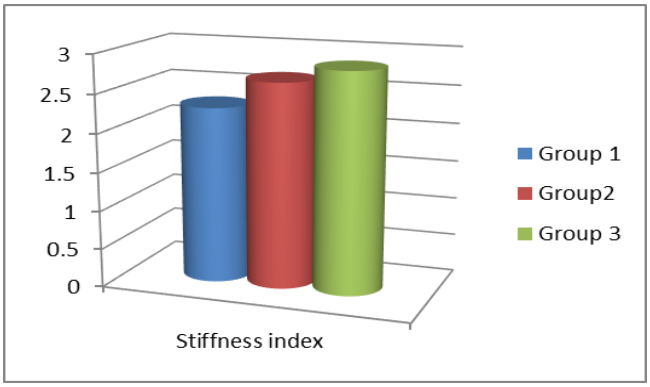

Fig 2: Comparison between three groups according to stiffness index

Table 3: Comparison between three groups according to stiffness distensibility index

Group	Distensibility index			P-value
	Mean	±	SD	
Group I	0.79	±	0.22	< 0.0001
Group II	47	±	0.17	
Group III	0.38	±	0.11	

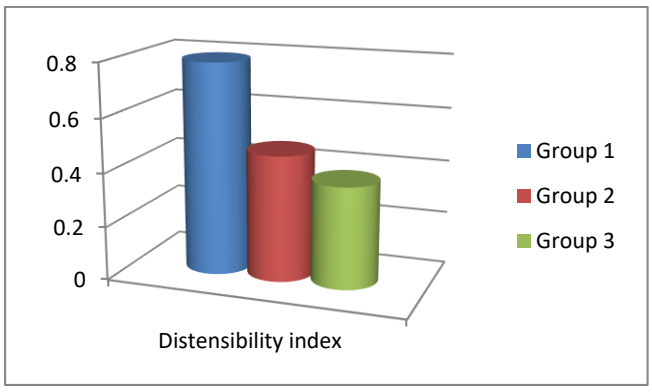

Fig 3: Comparison between three groups according to stiffness index distensibility index

Discussion

Our results came in agreement with (Qixiu Lu & Houlin Liu (2015) [7]. Who investigated 184 patients with CHD, Patients were divided into three groups based on the severity of coronary stenosis measured by coronary arteriography (CAG): slight stenosis (group 1), moderate stenosis (group 2) and serious stenosis (group 3). M-mode was performed, and elasticity indexes of ascending aorta including stiffness index, distensibility index, were calculated and correlated with the severity of coronary stenosis. Ascending aorta stiffness index was increased, whereas distensibility index was decreased in moderate and severe stenosis groups compared with slight stenosis group ($P < 0.01$).The elasticity indexes of ascending aorta correlate closely with the severity of coronary stenosis Nonetheless, there are some differences to be mentioned: we used 50 subjects (male 28, female 22), patients only with CSA and we used M-mode only to assess aortic stiffness.

Our results also came in agreement with(Garis Gungor MD, *et al*. 2013) [8] in which fifty consecutive subjects (male 41, female 9) younger than 40 years old who were hospitalized with diagnosis of acute coronary syndrome and had undergone coronary angiography . The control group included 70 age–sex (58 male, 12 female) matched individuals without a diagnosis of CAD. Aortic stiffness index (SI), aortic distensibility (D), and pressure-strain elastic modulus (Ep) were calculated from the aortic diameters measured by two-dimensional M-mode echocardiography and blood pressure obtained by sphygmomanometer. Aortic systolic velocity (SAo), and early (EAo) and late (AAo) diastolic velocities were determined by pulse-wave TDI from the anterior wall of ascending aorta 3 cm above the aortic cusps in parasternal long-axis view. Stiffness index was higher (median 5.40, IQR 5.98 vs. median 4.14 IQR 2.43; p = 0.03) and distensibility was lower (median 2.86 × 10−6 cm2/dyne, IQR 2.51 × 10−6 cm2/dyn vs. median 3.46 × 10−6 cm2/dyne, IQR 2.38 × 10−6 cm2/dyne; p = 0.04) in patients with CAD compared to the control group. Nonetheless, there are some differences to be mentioned: we used 50 subjects (male 28, female 22), no age selection, patients only with CSA and we used M-mode only to assess aortic stiffness and no group control used but Patients were divided into three groups based on the severity of coronary stenosis measured by coronary arteriography (CAG): slight stenosis (group 1), moderate stenosis (group 2) and serious stenosis (group 3) according to MGS.

Our results also came in agreement with (Ties A Mulders, *et al*., 2011 [9] Who Investigated 50 patients with premature CAD and a positive family history of premature CVD. Who select a population of individuals with a genetic predisposition to CVD. In the families of these participants, who also investigated 50 first-degree relatives without overt CVD. In addition, Who investigated 50 unrelated controls without overt CVD. Who matched for gender and age.

In all groups they assessed traditional risk factors for CVD according to the standard procedures in their hospital. For the first-degree relatives and controls, they assessed the Framingham risk score. The first-degree relatives and controls were not allowed to have a history of CVD and were excluded if they had any symptoms of CVD, both of which were assessed by a standardized questionnaire. Furthermore, controls were not allowed to use any medication or to have a positive family history of CVD. Furthermore, they assessed coronary artery calcification (CAC) scores in the first-degree relatives, to evaluate subclinical atherosclerosis they found that first-degree relatives were more often smokers (38% vs 20%; $p<0.05$), had higher total cholesterol levels (5.460.9 mmol/l vs 5.060.8 mmol/l; $p<0.05$) and higher low-density lipoprotein cholesterol levels (3.560.9 mmol/l vs 3.160.7 mmol/l; $p<0.05$) compared with controls. The Framingham risk score was somewhat higher in first-degree relatives compared with controls, but did not reached statistical significance. Patients with premature CAD had higher glucose levels (5.560.8 mmol/l vs 5.260.7 mmol/l and 5.160.4 mmol/l; $p<0.05$), lower total cholesterol levels (4.261.0 mmol/l vs 5.460.9 mmol/l and 5.060.8 mmol/l; $p<0.05$), lower low-density lipoprotein cholesterol levels (2.260.7 mmol/l vs 3.560.9 mmol/l and 3.160.7 mmol/l; $p<0.05$) and higher triglycerides (2.163.8 mmol/l vs 1.160.6 mmol/l and 1.060.5 mmol/l; $p<0.05$) compared with first-degree relatives and controls. The patients also more often used anti-hypertensive and cholesterol- lowering medication, mostly for secondary prevention reasons. With regard to blood pressure, systolic blood pressure was comparable between the groups (patients 130.7618.5 mm Hg; first-degree relatives 129.7611.3 mm Hg; controls 125.2615.6 mm Hg). Diastolic blood pressure was higher in patients compared with controls (84.8610.4 mm Hg vs 79.469.9 mm Hg; $p<0.05$). Unadjusted PWV of first-degree relatives did not

significantly differ from controls (8.261.9 m/s vs 7.561.2 m/s), whereas patients had higher PWV compared with first-degree relatives and controls (9.662.9 m/s vs 8.261.9 m/s and 7.561.2 m/s; $p<0.05$). There are some differences to be mentioned: we investigated 50 patients and divided them into 3 groups according to modified Gensini score to assess the severity of CAD and not used control group and we use M-mode on aorta to assess aortic elasticity

Conclusion

The elasticity indexes of ascending aorta correlate closely with the severity of coronary stenosis, positive correlation between Gensini scoring of coronary artery narrowing and stiffness index of ascending aorta . In contrast, distensibility index was negatively correlated with Gensini score.

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