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RESEARCH ARTICLE
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CORRELATION BETWEEN AORTIC ROOT DIAMETER & HEART FAILURE AMONG HEART FAILURE PATIENTS IN CARDIOLOGY DEPARTMENT SUEZ CANAL UNIVERSITY HOSPITAL

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Abstract

Background: Aortic diameter & heart failure have been the subject of few research, & the findings of existing enquiries have been conflicting. Heart failure is more common in men than in women with a top 5th enlarged aortic root, based on the Cardiovascular Health Study. Reverse causality may apply to this cross-sectional data.

Aim: This study was designed to examine the association among aortic root diameter (AoD) and incident heart failure (HF). AoD rises with age, which might lead to arterial stiffness, afterload alterations, cardiac remodeling, in addition to HF development.

Results: Among all the study patients, aortic annulus diameter (AAD) & ascending aorta diameter had significant direct correlations with Sinus of Valsalva diameter (SVD), Sinotubular junction diameter, LVEDV(A4C), LVESV(A4C), LVEDV(A2C), LVESV(A2C), E/A, LA volume, TR Vmax, Age, while had significant indirect correlations with PHT MV, IVRT & EF

Conclusion: This study proved that there's correlation between Aortic root diameter & Heart Failure.

Keywords: longitudinal changes, stiffening, afterload changes, remodeling, Ejection fraction, Simpson's method

Introduction

With ageing, the proximal aorta undergoes an outward redesign. Post-mortem investigations reveal age-associated structural changes within the aortic wall, specifically a decline in elastin content and a consequent rise in collagen deposition. Epidemiological studies have characterized the age-associated widening in aortic root diameter (AoD) (1). An increase in aortic root diameter has functional ramifications, such as greater proximal aortic stiffness, since the less extensible collagen fibres absorb mechanical stresses instead of the arterial wall's elastin (2). Ventricular stiffness is a contributing factor to ventricular dysfunction, unfavourable cardiac remodelling, & increased ventricular afterload, all of which are closely associated with the development of heart failure (3). An greater risk of developing heart failure may be linked to a larger aortic root at baseline, which is a sign of both increased ventricular afterload & increased proximal aortic stiffness (4). Additionally, was discovered that a higher degree of aortic root diameter growth over time (i.e., a bigger shift in AoD) may be associated with a higher risk of incident heart failure (5). Last but not least, the relationship between AoD & HF may differ depending on the type of incident HF. This is because arterial remodelling & its relationship to ventricular remodelling may have different effects on the development of heart failure with preserved ejection fraction (HFpEF) as opposed to heart failure with reduced ejection fraction (HFrEF).

Aim of the study

This study was designed to examine the association among aortic root diameter (AoD) and incident heart failure (HF). AoD rises with age, which might lead to arterial stiffness, afterload alterations, cardiac remodeling, in addition to HF development.

Research Design & Methodology:

Patients over forty who presented to the cardiology department at Suez Canal University Hospital with heart failure symptoms & signs were included in this cross-sectional diagnostic research, which employed a simple random sample. The research excluded individuals with atrial fibrillation, functional aortic regurgitation, atrial fibrillation patients, infiltrative cardiomyopathy, congenital heart abnormalities, & valvular heart disease, which includes aortic valve disease excluding aortic valve sclerosis.

C- Data collection tools:

Personal interviews of heart failure patients who develop symptoms & signs of heart failure by history taking & full examination. Vital signs evaluation such as pulse, blood pressure, temperature & respiratory rate.

Echocardiographic assessment using Philips iU22 echo machine to assess:

- Left ventricular systolic function using Simpson's method & eye balling techniques, including:

*End diastolic volumes in apical four & two chamber views.

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*Preserved LV systolic function: 50% or more.

*HFmrEF systolic function about 40-49%

*HFrEF systolic function about 39% or less.

- Left ventricular diastolic function using Tissue Doppler technique, including:

*E/A: mild (delayed relaxation) DD: 0.8 or less, moderate (pseudonormalization) DD 0.8 to 1.5, restrictive filling pattern of DD 2 or more.

*E/e': elevated filling pressure about 14 or more

*Medial e': impaired when it is less than 8, & lateral e' impaired when it is less than 10.

*LA volume: Dilated when indexed volume is 34 ml/m2 or more.

*IVRT: normal range 50-80 ms, elongated if more than this, or shortened in restrictive filling pressures.

*Pulmonary S/D ratio: normal value is more than 1, blunted or reversed ratio (systolic flow reversal) with increasing severity of diastolic dysfunction.

*MV Deceleration Time (Mitral valve Pressure half time): DD1 more than 200 ms, DDII 160-199 ms, DD III less than 160 ms.

*TRV max: mild PHTN 2.8 m/s, while moderate to severe PHTN 2.8 to 3.4 m/s or more.

-Its relation to aortic root diameter by 2D method measurements in systole & diastole, including:

*Aortic annulus diameter in end systole.

*Sinus of Valsalva diameter in end diastole.

* Sinutubular junction diameter in end diastole.

*Proximal ascending aortic diameter in end diastole.

- Statistical analysis:

Data were collected & analyzed it using excel & SPSS programs to get our results about the correlation between aortic root remodeling & heart failure either HFrEF or HFpEF among cardiac patients in Suez Canal University Hospital.

Categorical data was expressed as counts & /or percentage & tested for significant difference between cross-sectional studies using Excel & SPSS programs.
Continuous data was expressed as means+/- SD & was compared between groups using SPSS program.
Following the adjustment for clinical risk factors associated with heart failure, such as gender, age, body mass index, systolic and diastolic blood pressure, high blood pressure treatment, diabetes mellitus, smoking, previous myocardial infarction, along with valvular heart disease we correlated the changes in aortic root diameter & HF development among cardiac patients in Suez Canal University Hospital.

Results
This study included 194 patients with heart failure. Their baseline data shown in (table 1).

Table 1: shows baseline demographic characteristics of the study patients

		N= 194	
Age (years)	**Mean ±SD**	63.3±10.5	
	Range	43 -83	
Gender	**Male**	119	61.3%
	Female	75	38.7%
BMI (Kg/m^2)	**Mean±SD**	27.3±5.4	
	Range	24-34	

Qualitaitative variables were expressed as mean±SD, while quantitative variables were expressed as numbers & percentages

Abbreviations: EF; ejection fraction.
The current study patients had mean age of (63.3±10.5 years old) ranged from 43 to 83 years old. More than half of them (61.3%) were males & (38.7%) were females. Body mass index (BMI) had mean of (27.3+5.4) ranged from 24 to 34 Kg/m2.

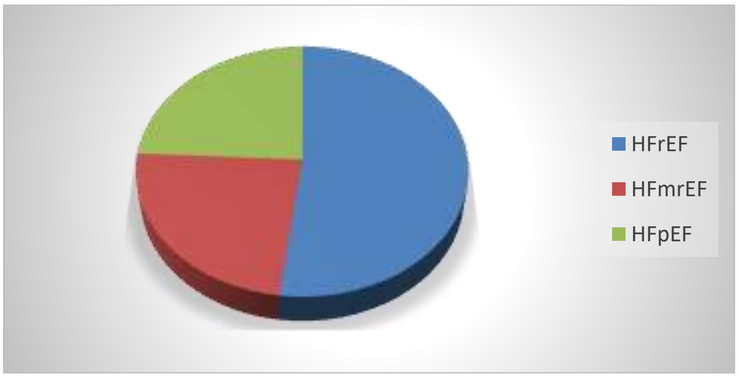

Figure 1: Distribution of patients according to EF (n=194).

According to EF, 101 patients (52.1%) had reduced EF, 47 patients (24.2%) had preserved EF & 46 patients (23.7%) had mid-range EF.

Table 2: Comparison of aortic measurements among the study groups.

	HFrEF group n= 101	HFmrEF group n=46	HFpEF group n=47	P-value
Aortic Annulus diameter (mm)	23.3±0.78	22.3±0.60	21.66±0.85	**<0.001*1**
Sinus of Valsalva diameter (mm)	38±1.4	35.8±1.0	35.49±1.9	**<0.001*1**
Sinotubular junction diameter (mm)	37±1.4	34.9±1.0	34.49±1.9	**<0.001*1**

ANOVA test. *Statistically significant as p<0.05.

Table 2 shows that compared to patients with HFpEF, those with HFrEF had significantly greater mean values for the following parameters: AAD, SVD, sinotubular junction diameter, as well as ascending aorta diameter (p<0.001).

Table 3: Comparison of aortic measurement with cardiac parameters among the study patients (n=194).

		Aortic Annulus D	Ascending Aorta D
Sinus of Valsalva diameter (mm)	r	.908**	.905**
	P-value	**<.001**	**<.001**
Sinotubular junction diameter (mm)	r	.910**	.897**
	P-value	**<.001**	**<.001**
LVEDV(A4C) (ml)	r	.455**	.322**
	P-value	**<.001**	**<.001**
LVESV(A4C) (ml)	r	.639**	.494**
	P-value	**<.001**	**<.001**
LVEDV(A2C) (ml)	r	.505**	.408**
	P-value	**<.001**	**<.001**
LVESV(A2C) (ml)	r	.661**	.562**
	P-value	**<.001**	**<.001**
E/A	r	.353**	.273**
	P-value	**<.001**	**<.001**
E/e'	r	.129	.081
	P-value	.073	.264
PHT MV (ms)	r	-.331**	-.257**
	P-value	**<.001**	**<.001**
IVRT (ms)	r	-.186**	-.184*
	P-value	**.010**	**.010**
LA volume (ml)	r	.278**	.248**
	P-value	**<.001**	**<.001**
S/D ratio PV	r	.096	.014
	P-value	.181	.846
TR Vmax (ml\s)	r	.309**	.342**
	P-value	**<.001**	**<.001**
Age (years)	r	.646**	.516**
	P-value	**<.001**	**<.001**
EF (%)	r	-.825**	-.649**
	P-value	**<.001**	**<.001**

Abbreviations: LVEDV; left ventricular end diastolic volume, LVESV; left ventricular end systolic volume, PHT MV; Pressure half-time of mitral valve, IVRT; Isovolumic relaxation time, LA; left atrium, S\D ratio; systolic/diastolic ratio, TR Vmax; maximal. tricuspid regurgitation velocity. Pearson correlation test. *Statistically significant as p<0.05.

In this table, among all the study patients, aortic annulus diameter & ascending aorta diameter had significant direct correlations with Sinus of Valsalva diameter, Sinotubular junction diameter, LVEDV(A4C), LVESV(A4C), LVEDV(A2C), LVESV(A2C), E/A, LA volume, TR Vmax, Age, while had significant indirect correlations with PHT MV, IVRT & EF.

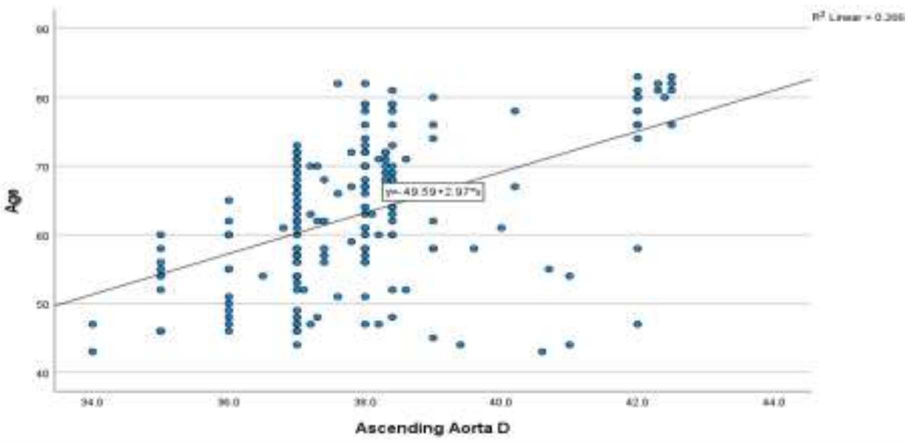

Figure 2: Correlation between age & ascending aortic diameter among the study patients (n=194).

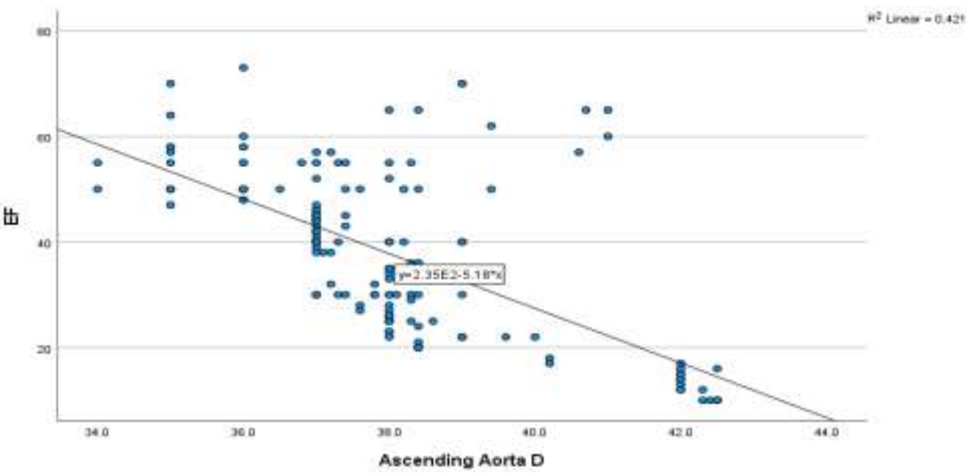

Figure 3: Correlation between EF & ascending aortic diameter among the study patients (n=194).

Discussion

We demonstrated in this cross-sectional diagnostic study that among HF patients in the cardiology department at Suez Canal University Hospital, there is a positive direct correlation between aortic root diameter and HF, specifically HFrEF, HFmrEF, and HFpEF.

The mean age of HFrEF patients was substantially greater than that of HFpEF patients ($p<0.001$). Additionally, a statistically significant difference was observed in the percentage of male patients having HFrEF in comparison with those having HFpEF (65.3% vs 48.9%, $p=0.045$).

Patients suffering from HFrEF had significantly larger mean diameters of the aortic annulus, sinus of Valsalva, sinotubular junction, as well as ascending aorta compared to those with HFpEF ($p<0.001$).

The mean LVEDV, LVESV, E/A, E/e', LA volume, and S/D ratio PV were considerably greater in patients with HFrEF than in those with HFpEF ($p<0.05$). However, there was a statistically significant difference ($p<0.05$) in the mean PHT MV & IVRT between patients with HFrEF and those with HFpEF.

Aortic annulus and ascending aorta diameters were significantly correlated with Sinus of Valsalva diameter, Sinotubular junction diameter, LVEDV(A4C), LVESV(A4C), LVEDV(A2C), LVESV(A2C), E/A, LA volume, TR Vmax, and age in all study participants. They were also significantly correlated with PHT MV, IVRT, and EF in an indirect manner.

Our findings are supported by the Framingham Heart Study on Aortic Root Remodelling and HF chance (6), that discovered in individuals in their middle and older years, a bigger aortic root before starting the study was linked to a higher chance of developing heart failure in the future.

Additionally, there was a higher chance of incident heart failure during follow-up for individuals with larger aortic root dilatation throughout an 8-year period. Risks of HfrEF were found to be 20% to 22% higher and HfpEF to be 11% to 13% higher for every 1-standard deviation rise in baseline or longitudinal change in AoD, according to the point estimates. Accordingly, it was hypothesized that the severity of aortic root remodelling may influence the onset of subsequent HF. A greater probability of both forms of HF was observed to be related with a higher AoD in that cohort research. A study published in the Egyptian Heart Journal (7) that investigated the correlation between aging and aortic root width provides some support to our results. According to the research, ascending aortic diameter increases with age, larger thorax diameter, and higher heart volume values. Aortic as well as cardiac volume measurements were higher in males than in females, and there was a positive correlation between ascending aortic diameter along with thorax and heart volume measurements. Greater LVDd & LVDs values were seen as aortic diameter increased, however these differences were statistically insignificant.

Conclusion

This study revealed positive significant correlation between increasing Aortic root diameter & worsening Heart failure among Heart Failure patients either HFrEF, HFmrEF & HFpEF.

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