Spectrum of ascending aortic aneurysms at a peri-urban tertiary hospital: an echocardiography-based study

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Background and Aim

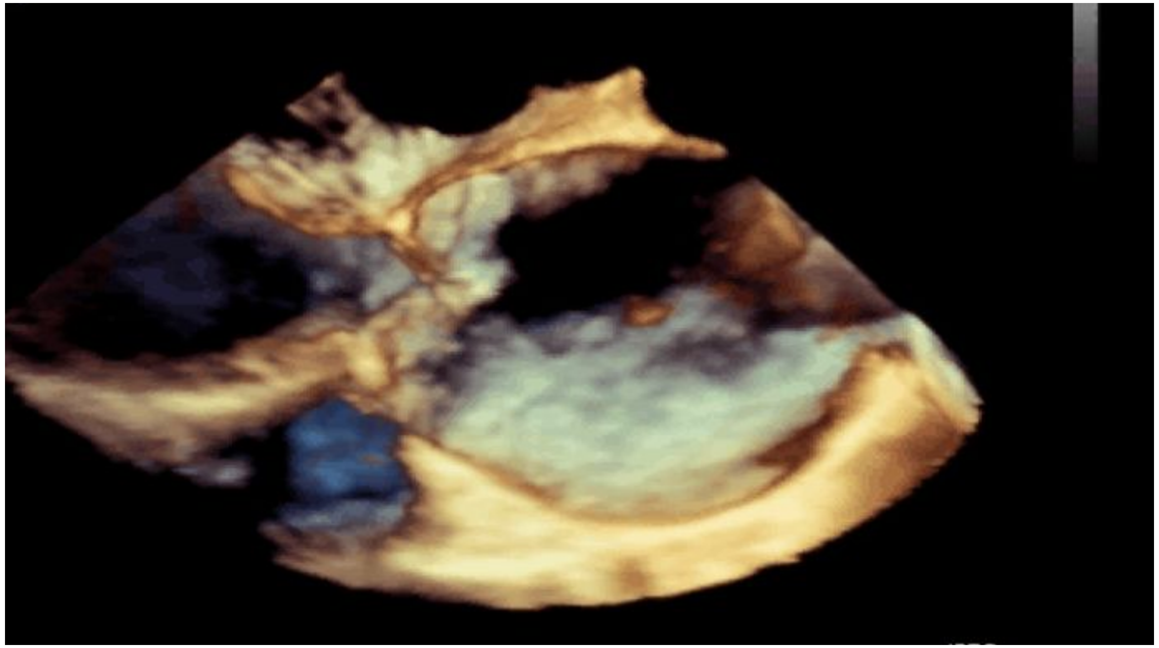
- Thoracic ascending aortic aneurysms are an important cause of disability and death and require early detection for effective management.
- Prevalence of aortic aneurysms ranges from 1.6% to 7.2% in a general population aged 60 years or older .
- Mortality due to aortic aneurysms is estimated to be between 157,357 and 18,899 globally according to the global burden of disease 2019, thus making death due to aortic aneurysms a significant public health concern.
- Currently, there is a paucity of data from Africa pertaining to TAA aneurysms. This study aimed to describe the spectrum of TAA aneurysms at a peri-urban tertiary hospital.

Yuyun MF, Sliwa K, Kengne AP, et al. Cardiovascular diseases in sub-Saharan Africa compared to high-income countries: an epidemiological perspective. Glob Heart. (2020) 15(1):15.

Wang Z, You Y, Yin Z, Bao Q, et al. Burden of aortic aneurysm and its attributable risk factors from 1990 to 2019: an analysis of the global burden of disease study 2019. Front Cardiovasc Med. (2022) 9:1–14.

Objectives

1) Describe demographics, clinical characteristics, two-dimensional echocardiography, and strain imaging of TAA aneurysms at Chris Hani Baragwanath Academic Hospital (CHBAH).
2) Morbidity and mortality associated with ascending aortic aneurysm at CHBAH.



Methods

A descriptive retrospective study was conducted based on clinical and echocardiographic imaging data of 139 patients with a clinical diagnosis of TAA aneurysms from October 2017-October 2022 at CHBAH (M170389). Data of 45 age and gender matched controls was extracted from a prior study (M200977).

Inclusion criteria
The inclusion criteria were (i) age greater than 18 years, (ii) confirmed TAA aneurysm (aorta >40mm in size or dilation greater than 1.5 times the normal diameter of the adjacent healthy arterial segment).

Exclusion criteria
The exclusion criteria were (i) suboptimal image quality of aorta (ii) isolated abdominal aortic or arch aneurysms (iii) extensive missing data.

- An S5-1 transducer on a Philips EPIQ 9 system, was used to obtain the aortic measurements from parasternal long axis views where the aortic root and proximal aorta and the left ventricle could be visualised.
- Measurements at four different levels in the proximal aorta were made (i) the aortic annulus (AA); (ii) sinuses of Valsalva (SOV); (iii) Sino-tubular junction (STJ); and (iv) the proximal ascending aorta (AAO).
- All measurements were performed according to the American Society of echocardiography 2015 chamber quantification guidelines.
- Strain imaging was performed to measure left ventricular (basal, apical, and global longitudinal strain as well as to determine the circumferential strain (CS) of the AAO.
- Peak global CS was measured from short axis images of the AAO and timed to aortic valve closure. CS of the AAO was measured using Philips QLAB version 11.0 software. Beta two (β2) index was measured using the formula β2 = ln (systolic blood pressure/Diastolic blood pressure)/Aorta CS.

Statistical analysis
Statistica version 14.00.15 was used for computation of data. Continuous variables were expressed as mean and standard deviation (SD) or median (IQR). Student's t-test or Mann-Whitney U test were used to compare continuous variables. Chi-square test was used to compare categorical variables. ANOVA was used to compare continuous variables. For non-parametric data Kruskal–Wallis test was performed. A P value of ≤0.05 was considered statistically significant.

Results

Table 1: Clinical characteristics of the study population and controls

Variable	Study patients	controls	p-value
	N= 139	N=45	
Age (years)	50±14.8	46.3±6.7	0.106
Gender (F/M)	73/66 (53%/47.4%)	24/21 (53.3%/47.7%)	0.9
BSA (m^2)	1.73±0,2	1.81±0.2	0.02
SBP (mmHg)	137.2±22.1	128.4±10.5	0.01
DBP (mmHg)	72.7±16.6	81.6±10.2	<0.001
Heart Rate (bpm)	80.6±14.7	73.7±10.7	0.004
NYHA class (I/II/III/IV)	(30.2%/59.7%/8.6%/1.4%)		
Co-morbidities			
Hypertension	68 (50%)		
HIV	63 (45.3%)		
Diabetes	4 (2.8%)		
Medication			
Carvedilol	62 (44.6%)		
Enalapril	87 (62.5%)		
Coversyl	6 (4.3%)		
Furosemide	84 (60.4%)		
Hydrochlorothiazide	15 (10.7%)		
Amlodipine	21 (15.1%)		
Nifedipine XL	10 (7.2%)		

Abbreviations: BSA: Body surface area, DBP: Diastolic Blood Pressure, SBP: Systolic Blood Pressure, NYHA: New York heart association

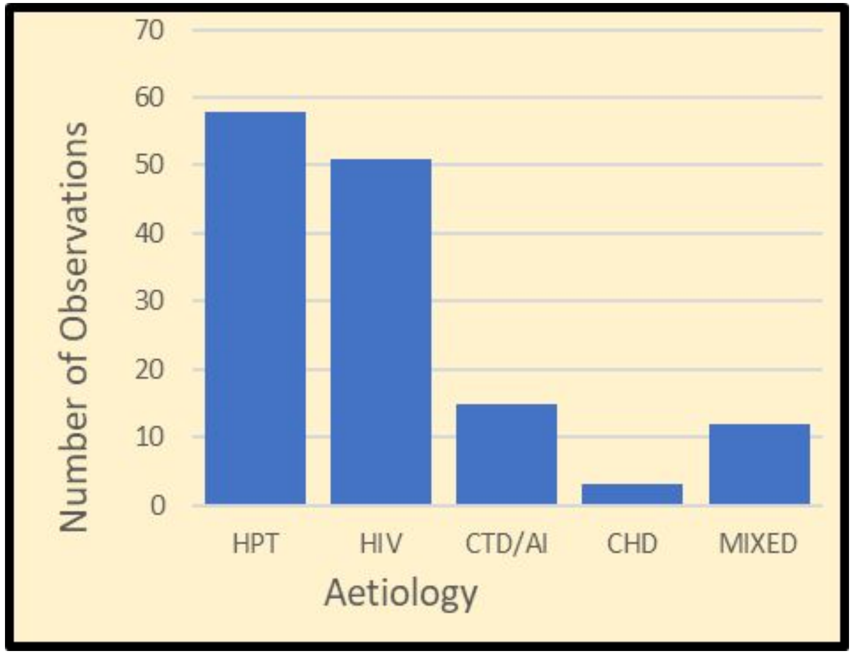


Figure 1:Bar graph showing the distribution of TAA aneurysm cases by aetiology. CHD: Congenital Heart Disease, CTD/AI: Connective tissue disease/Autoimmune, HIV: Human Immunodeficiency Virus, HPT: Hypertension, Mixed: Mixed aetiologies

Results

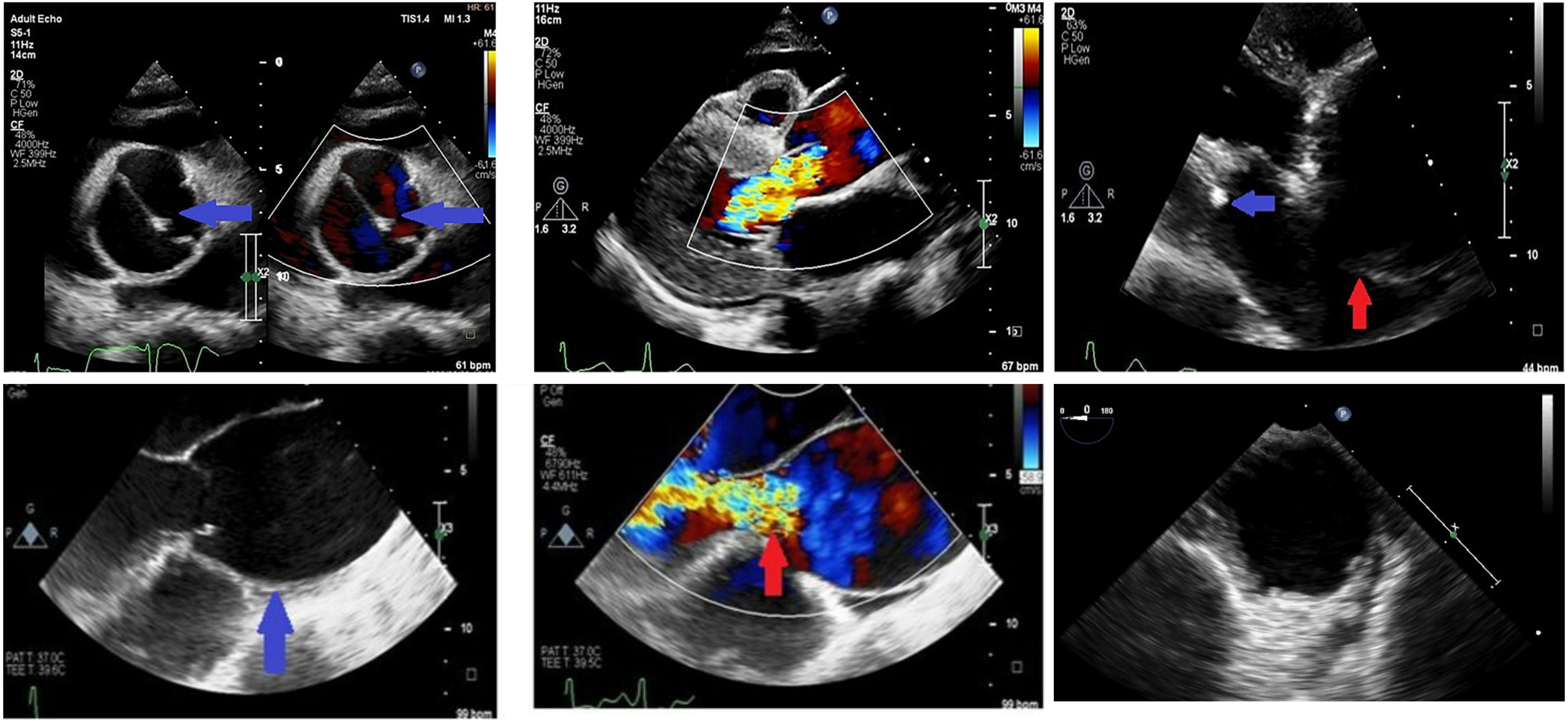
Table 2 : Echocardiographic characteristics of the study population compared to normal controls

Variable	Study patients (n=139)	Controls (n=45)	P-value
Left ventricular function			
LV EDD (mm/m^2)	32.6±7.4	23.6±3.4	<0.001
LV ESD (mm/m^2)	29.4±7.4	16.1±2.7	<0.001
EDV (ml/m^2)	96.3±44.2	46.3±10.6	<0.001
ESV (ml/m^2)	53.2±32.8	17.9±7.1	<0.001
LVEF (%)	46.7±12.7	63.3±7.0	<0.001
Left atrial volume (ml/m^2)	34.4±15.2	23.3±7.4	<0.001
Aortic measurements			
Annulus (mm)	23.5±4.3	19.6±2.5	<0.001
Annulus (mm/m^2)	13.8±2.9	10.8±1.4	<0.001
Sinuses (mm)	44.1±9.2	28.8±7.9	<0.001
Sinuses (mm/m^2)	26±6.5	15.7±3.5	<0.001
Sino-tubular junction (mm)	46.2±10.1	26.0±3.2	<0.001
Sino-tubular junction(mm/m^2)	27.3±7.4	14.3±1.6	<0.001
Ascending aorta (mm)	48.9±10.1	26.5±3.0	<0.001
Ascending aorta (mm/m^2)	28.9±7.8	14.5±1.6	<0.001
Valvular pathology			
Aortic regurgitation (none/mild/moderate/severe) (%)	9.3/14.3/25.8/50.3	-	
*PASP (mmHg)	30.7±20.8	17.6±5.7	<0.001
Strain parameters			
Left ventricle GLS (%)	-13.9±3.9	-18.1±6.7	<0.001
Left ventricle basal CS strain (%)	-13.9±5.6	-17.9±5.8	<0.001
Left ventricle apical CS strain (%)	-19 (-23 to -12.7)	-24.6 (-32.7 to -20.6)	0.002
**Aortic CS (%)	4.4 (3.2–6.2)	9.0 (7.1–13.4)	<0.001
Aortic stiffness index($ß_2$)	15.39 ± 20.65	5.04 ± 2.09	0.001

Data are presented as mean± SD, median (IQR) or %. Abbreviations: CS: Circumferential strain; EDV: End-diastolic volume indexed; ESV: End-systolic volume indexed; GLS: global longitudinal strain; LV: Left ventricle; LV EDD: Left ventricular end-diastolic diameter; LVEF: Left ventricular ejection fraction; LVESD: Left ventricular end-systolic diameter; PASP: Pulmonary artery systolic pressure.

- Compared to controls, patients with aortopathy had a significantly dysfunctional and hypertrophied LV (LV mass (g/m2)136.42 ± 53.90 vs60.16 ± 24.22<0.001).
- The aorta was significantly enlarged from the root to the ascending aorta compared to controls. Patients that presented with aortic dissection had larger diameters compared to the group without dissection (54.5 ± 8.0 mm vs. 48.2 ± 10.3 mm, P = 0.02).
- Most of the patients had functional aortic regurgitation. Half of the patients had severe AR.
- The aortic circumferential strain was markedly reduced in the aortopathy group compared to controls. Further to this, the aortic stiffness index was higher in the aortic aneurysm group compared to controls, suggesting reduced compliance.
- Right ventricular enlargement(34.7±8.2mm vs29.5±5.5mm, P<0.01) was noted in the patients with aortopathy when compared to controls, and raised filling pressures and pulmonary artery systolic pressures implying long-standing disease and late presentation.

Results



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2D
71%
C 50
P Low
HGen
CF
48%
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11Hz
16cm
2D
72%
C 50
P Low
HGen
CF
48%
4000Hz
WF 399Hz
2.5MHz
1.6
3.2
67 bpm
2D
63%
C 50
P Low
HGen
1.6
3.2
44 bpm
PAT T: 37.0C
TEE T: 39.6C
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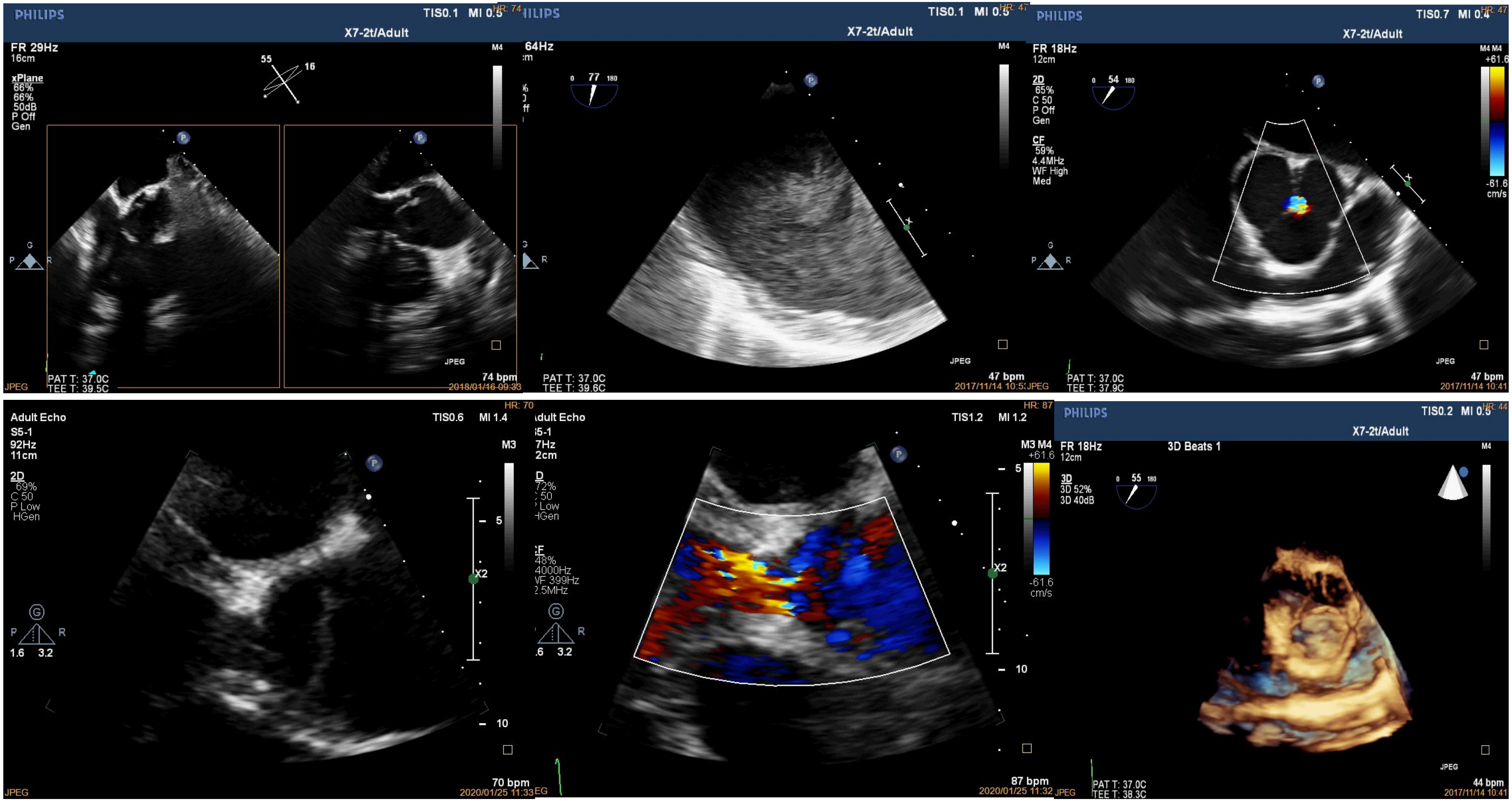
Results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FR 18Hz
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Adult Echo
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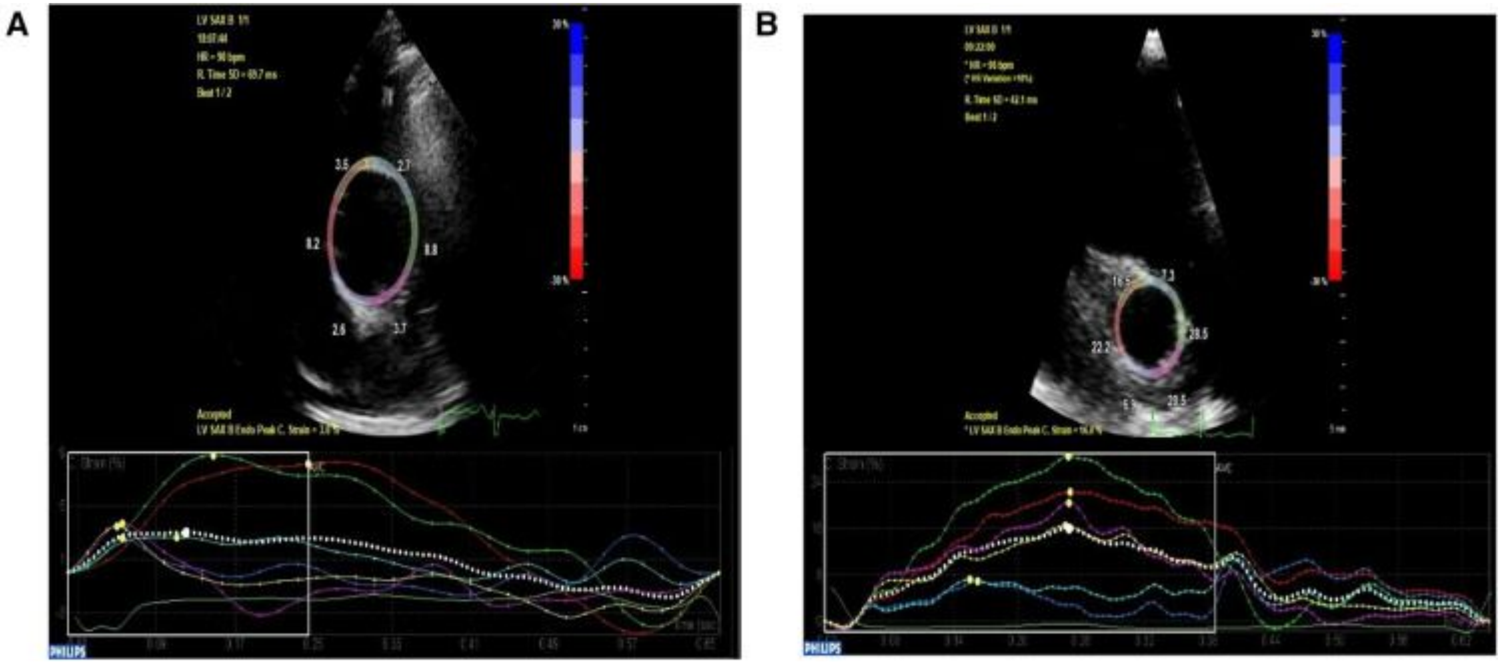
Results



High parasternal short axis view of the ascending aorta depicting decreased circumferential strain at 3% in a patient with ascending aortic aneurysm (A) compared to age and gender-matched normal control with preserved circumferential strain at 16% (B).

Results

Table 3: Comparison of Aortic parameters between severe and non-severe aortic regurgitation groups

Parameter	Severe AR (n=70)	Moderate AR (n=36)	Mild and No AR n=33)	P value (ANOVA)
Age (years)	51.611±14.89	52.47±15.35	54.81±16.42	0.610
Gender (M/F)	34/36	17/19	15/18	0.594
Body Surface area (m^2)	1.68±0.21	1.76±0.22	1.79±0.26	0.057
Systolic blood pressure (mmHg)	135.34±19.85	134.89±20.27	143.59±27.63	0.170
Diastolic blood pressure (mmHg)	66.39±14.56	72.46±13.46	86.81±15.88[a,c]	<0.001
Aortic annulus (mm)	24.45±5.22	23.29±4.58	22.55±4.12	0.152
Aortic annulus (mm/m^2)	14.67±3.14[c]	13.43±2.89	12.87±3.21	0.016
Aortic sinus (mm)	46.33±9.35[c]	42.52±8.33	41.00±9.21	0.012
Aortic sinus (mm/m^2)	27.89±6.37[c]	24.37±4.47[b]	23.39±7.67	0.001
Sino-tubular junction (mm)	49.94±10.38[c]	44.30±7.39[b]	40.30±9.74	<0.001
Sino-tubular junction (mm/m^2)	30.08±7.20[c]	25.32±4.31[b]	23.18±8.53	<0.001
Ascending aorta (mm)	24.45±5.22[c]	23.29±4.58	22.55±4.12	<0.001
Ascending aorta (mm/m^2)	14.67±3.14[c]	13.43±2.89[b]	12.87±3.21	<0.001
LV Ejection Fraction (%)	48.50±13.36	48.00±10.89	53.94±12.19	0.087
LV Basal Strain (%)	-14.42±5.33	-14.31±6.14	-12.34±5.98	0.24
LV Apex Strain (%)	-18.36±8.47	-18.35±7.00	-18.68±11.17	0.985
LV Global Longitudinal Strain (%)	-13.78±6.01	-13.70±3.56	-13.77±3.66	0.997
Circumferential strain of AAO (%)	4.82±4.67	4.34±2.46	3.78±3.73	0.503
Aortic stiffness index ($ß_2$)	19.30±25.40[c]	12.95±12.82	8.75±10.31[a]	<0.001

Data are presented as mean± SD, median (IQR) or % **Abbreviations:** AAO: Ascending aorta, AR: Aortic Regurgitation, LV: Left Ventricle, [a]Mild or No AR vs Moderate AR, [b]Moderate vs Severe AR, [c]Severe vs Mild or No AR

- Patients with severe aortic regurgitation had larger aortic diameters, most significant at the ascending aorta and sino-tubular junction level.
- There was no difference in CS between the three groups, however, the aortic stiffness index was higher in the severe aortic regurgitation group compared to mild or no AR group.
- Poor distensibility of the aorta has been correlated with faster hemodynamic deterioration and rapid progression of disease in patients with aortic regurgitation
- There was no difference in the LV strain parameters between the three groups. Most of the patients with severe AR had HIV (57.9%) or hypertension (24.6%).

Morbidity and mortality

- The morbidity due to heart failure (70%) and chronic aortic dissection (10%) was high in this study. All 14 patients in the chronic dissection group had uncontrolled hypertension with SBP ≥ 145 mmHg.

- All patients were presented for surgery, except for 12 patients who either refused surgery or were considered too high of an intraoperative risk.

- Four patients demised while awaiting surgery, two patients refused surgery and then subsequently demised. A total of 41 patients (29.4%) ultimately underwent surgery. Five patients demised post operatively and one patient developed severe post-operative aortic regurgitation.

- The overall mortality was 7.9% (11/139). This is likely a significant underestimate as there was follow up of only 54% of the patients due to difficulties with contacting the patients.

- Of note, five patients with acute aortic dissection were excluded due to lack of data, three of these patients demised and two underwent successful surgery. The mortality for this subgroup was 40%.

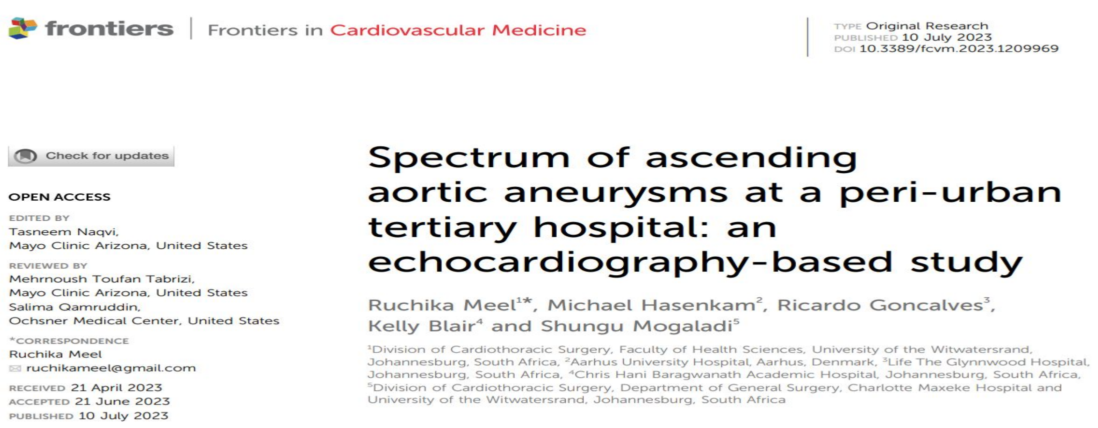
Conclusions

- This is the first study from Africa detailing the differences in clinical and echocardiographic characteristics in those with thoracic ascending aortic aneurysms compared to controls.
- Thoracic ascending aortic aneurysms were mostly present in young black African females and the main aetiologies were hypertension and HIV.
- This study reveals a high burden of ascending aortic aneurysms in the study population, which largely develop undetected and ultimately present late with advanced heart failure or aortic dissection.
- Delayed presentation of TAA aneurysms results in considerable morbidity and mortality and highlights the need for (i) prevention and control of modifiable risk factors for aortic aneurysms such as hypertension and HIV and (ii) screening programs and establishment of centers of excellence for effective management of aortic aneurysms in Africa.
- Echocardiography has been presented as a useful low-cost tool for the detection of aneurysms and potential risk stratification using advanced strain imaging, however further studies are needed to define its role in screening in this population.

Limitations

- The study comprised a predominantly African population and therefore limiting the applicability to other populations.
- Morbidity and mortality data could not be fully accessed due to poor patient follow-up.
- Furthermore, interobserver variability may have affected the measurement of echocardiographic parameters, however, standard deviations of measurements were small and like those reported in other studies and so interobserver variability influence was negligible.
- The absolute values of aorta CS are subject to inter-vendor differences.

Thank you!



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