



THE ASCENDING AORTIC DISTENSIBILITY INDEX IN 2D TRANSTHORACIC ECHOCARDIOGRAPHY – A CROSS SECTIONAL SINGLE CENTRE STUDY AMONG SOUTH INDIAN POPULATION

Cardiology

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ABSTRACT

Aortic distensibility is related to the elastic property of the aorta. Quantification of aortic distensibility using 2D trans-thoracic echocardiography is a simple non-invasive method to identify persons at risk for cardiovascular events. Our study was done to identify the variations of ascending aortic distensibility index with age, sex and patients with Atherosclerotic cardiovascular disease (ASCVD) in Indian population. Totally 264 patients were included in our study. Aortic distensibility index was calculated by Stefanadis formula using 2D echocardiography. Normal population, Persons with ASCVD risk factors (DM, HT or both) and persons with clinical ASCVD (CAD & CVA) were classified as group 1, group 2 and group 3 respectively. Mean age group of the population was 41.97 (SD±16.01) years. There was a decreasing trend of aortic distensibility index as the age advanced (Spearman correlation (p)<0.001). Males had significantly lower aortic distensibility index than females (P<0.0001). Aortic distensibility index was significantly lower in group 2 and group 3 comparing normal population (P=0.0001).

KEYWORDS

Introduction:

As age advances the aorta and other vessels stiffen and this process is accelerated by systemic hypertension. Reduced vessel compliance is one of the earliest detectable manifestations of adverse structural and functional changes within the arterial wall [1]. Aortic distensibility index and aortic pulse wave velocity (PWV) are the two important parameters related to the elastic property of the aorta and they are important pathogenic markers of cardiovascular diseases [2]. Quantification of aortic distensibility and PWV by cardiovascular magnetic resonance (CMR) or ultrasound technology are accurate and reproducible and they help in identifying early cardiovascular disease in asymptomatic patients [3, 4]. However, reference ranges for aortic distensibility index in adults are lacking in Indian population. Our study aims to identify the variations of ascending aortic distensibility index with age, sex and patients with Atherosclerotic cardiovascular disease (ASCVD) in Indian population.

Materials and methods

This study was a cross sectional study conducted in our tertiary care hospital during March 2018. All patients referred to our OPD for cardiac assessment were studied. Clinical history, cardiac examination, electrocardiography and echocardiography were done in all patients. Normal population, Persons with ASCVD risk factors (DM, HT or both) and persons with clinical ASCVD (CAD & CVA) were classified as group 1, group 2 and group 3 respectively. Ascending aortic diameter (2-3 cm away from aortic root) was measured in both systole and diastole using 2D trans-thoracic echocardiography in all persons. Brachial arterial blood pressure was also measured for all persons. Aortic distensibility index was calculated using Stefanadis formula [4].

• Aortic Distensibility (in $\text{cm}^2 \text{dyne}^{-1} 10^{-6}$)

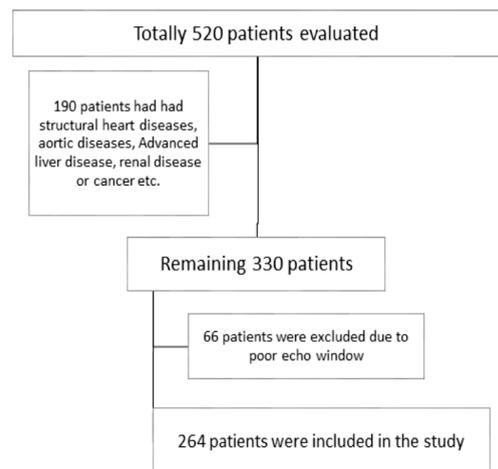
$$= \{2 \times (\text{Systolic diameter} - \text{Diastolic diameter})\} / (\text{Diastolic diameter} \times \text{Brachial pulse pressure})$$

Inclusion criteria:

Age > 18 years

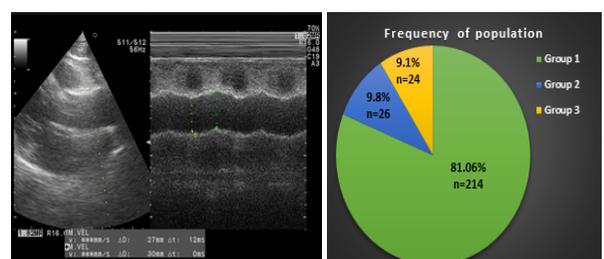
Exclusion criteria:

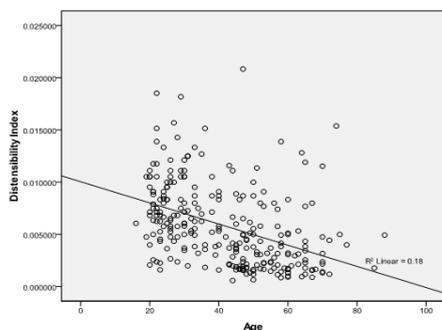
- Patients with structural heart diseases like congenital or valvular heart disease
- Patients with aortic diseases
- Advanced liver disease, renal disease or cancer
- Patients with poor echo window



Results:

Totally 264 patients were studied. Mean age group of the population was 41.97 (SD±16.01) years. 148 (56.06%) were males and 116 (43.94%) were females. Mean aortic distensibility index values were $0.006474 \text{ cm}^2 \text{dyne}^{-1} 10^{-6}$ (SD± 0.0038022), 0.0030842 (SD± 0.0023815) and 0.0026847 (SD± 0.002107) for group 1, group 2 and group 3 respectively. There was a decreasing trend of aortic distensibility index as the age advanced (Spearman correlation (p)<0.001). Males had significantly lower aortic distensibility index than females (P<0.0001). Aortic distensibility index was significantly lower in group 2 and group 3 comparing normal population (P=0.0001).





		Frequency	%	Mean DI	Median DI	SD DI	95% CI	P value
Sex	Male	116	43.94	0.0047 856	0.00363 75	0.003 8832	0.0040 757- 0.0054 956	<0.0001 Mann whitney u test
	Female	148	56.06	0.0065 873	0.00625	0.003 595	0.0060 054- 0.0071 691	
Diagnosis	Group 1 Normal	214	81.06	0.0064 74	0.00579 7	0.003 8022	0.0059 622- 0.0069 857	0.0001 Kruska l wallis test
	Group 2 DM/HT N/Both	26	9.8	0.0030 842	0.00238 1	0.002 3815	0.0021 645- 0.0040 038	
	Group 3 CAD/C VA	24	9.1	0.0026 847	0.00187 35	0.002 107	0.0018 379- 0.0035 316	

Discussion:

Aortic distensibility index and aortic pulse wave velocity (PWV) are the two important parameters related to the elastic property of the aorta. Aortic stiffness increases in arteriosclerosis (Degenerative stiffness of the arterial beds) [5]. The proximal aorta is rich in elastin so that it could accommodate the stroke volume. The thoracic aorta and its immediate branches are more elastic, but the distal vessels are progressively stiffer due to the predominance of collagen fibers (5,000 times more tensile than elastin) [6]. Quantification of this aortic stiffness helps us in identifying patients at high risk of future cardiovascular events. Non-invasive methods used to quantify aortic stiffness are applanation tonometry, echocardiography and cardiac MRI.

Pulse wave velocity (PWV) is the most validated method for non-invasive quantification of arterial stiffness. It is considered the gold standard index of aortic stiffness due to its simplicity, accuracy, reproducibility, and strong prediction of adverse outcomes [1, 7]. Similar to PWV, distensibility index is also an important tool to measure aortic stiffness. Aortic distensibility can be measured both by echocardiography and cardiac MRI. To assess aortic distensibility by MRI, steady-state free precession cine imaging with electrocardiographic gating is needed to measure the changes in cross-sectional aortic area. It has a temporal resolution of <40ms [8]. Non-invasive estimation of aortic stiffness is a predictor of future development of hypertension in healthy volunteers [9]. A meta-analysis has shown that PWV is an important predictor of adverse cardiac events and mortality. An increase of aortic PWV of 1 m/s increases cardiovascular risk by > 10% [10]. Our study showed that distensibility index decreases with advancing age. The reason could be due to the cellular changes in the aorta due to aging.

Both thoracic aortic and coronary artery calcification are associated with impaired aortic distensibility [11,12]. Patients with renal failure have marked reduction in aortic distensibility and disturbances in diastolic blood flow in the aorta. This leads to reduced coronary perfusion. Increased aortic stiffness is an independent predictor of 10-year mortality in diabetic patients [13]. This is similar to our study. In our study, the aortic distensibility was significantly lower in patients with ASCVD and ASCVD risk factors like DM and HT. Patients with

chronic aortic regurgitation (AR) have increased arterial distensibility. This is due to the greater compliance of aorta that is needed to lessen the impact of the large stroke volume. In marfan syndrome, increased aortic wall stiffness starts early in childhood and progresses with age. In hypertrophic cardiomyopathy aortic stiffness is increased comparing normal subjects. The presence of macroscopic myocardial fibrosis (seen as areas of Late gadolinium-enhancement in MRI) is associated with increased in aortic stiffness and thus affects the LV performance [14].

Several studies have shown that antihypertensive medications (ACE inhibitors, ARBs, Beta blockers, Calcium channel blockers etc) and statins could improve aortic distensibility. Similarly, studies have shown that increased physical activity is correlated with improved aortic distensibility when compared with sedentary subjects. Elderly patients with isolated diastolic heart failure have impaired aortic distensibility and it correlates with the severity of exercise intolerance. Exercise training improves aortic distensibility. Different exercise training methods (endurance vs. resistance) have different effects on vascular tone [15].

Limitations:

Our study was done in a limited population. Echocardiographic estimation could not be done in significant number of patients due to poor echo window. This suggests that this method can not be applied universally to all patients. Long term prognostic significance was not assessed in our study.

Conclusion:

Ascending aortic distensibility index is an easily measured parameter by echocardiography. Distensibility index decreases as age advances. It is significantly lower in male population and patients with ASCVD and ASCVD risk factors like DM and HT as shown in our study.

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