



Comparison of magnetic resonance imaging assessment of aortic valve area and severity of stenosis to echocardiogram in patients.



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Introduction

1. To compare the aortic valve area (AVA) measured from cardiac magnetic resonance (CMR) with those derived from transthoracic echocardiogram (TTE).
2. To assess if the morphology of the aortic valve affects the difference between the 2 modes of imaging.

Methods

- Prospective study, consisting of 45 patients (24 bicuspid aortic valve, 21 trileaflet aortic valve)
- Patients were matched for age, gender, systolic blood pressure, AS severity, end diastolic and systolic volume as well as presence of other comorbidities such as diabetes mellitus, hypertension and coronary artery events.
- AVA was planimetered directly from the short axis FLASH sequence at 3 T CMR and compared with TTE derived AVA from equation of continuity (Figure 1), making use of the maximum blood flow velocity across the aortic valve.

$$\text{AV area} \times \text{AV VTI} = \text{LVOT area} \times \text{LVOT VTI}$$

Equation of continuity

$$\text{AV area} = \pi (\text{LVOT diameter}/2)^2 (\text{LVOT vmax}/\text{AV vmax})$$

Derived equation from above to calculate AVA in this study

Figure 1 : Equation to derive AVA from TTE

Results

- CMR planimetry AVA is found to correlate well with TTE derived AVA in both bicuspid (correlation=0.658) and trileaflet aortic valves (correlation=0.707).
- However, there is significant overestimation in the AVA, when TTE derived AVA is compared to CMR planimetry in both valvular morphology. (Bicuspid:1.02cm² versus 1.84cm², p<0.05; Trileaflet:1.07cm² versus 1.84cm², p<0.05).
- This resulted in a significant difference noted in the reclassification of AS severity in bicuspid aortic valve patients (p=0.001) but interestingly, not in trileaflet patients (0.122), as shown in Figure 2 and 3.
- Overestimation of AS severity by TTE seems to be more affected in bicuspid aortic valve patients than trileaflets, possibly due to the abnormal eccentric jet across the bicuspid aortic valves.

Trileaflet aortic valve			TTE AS severity			Total
			Mild	Moderate	Severe	
MRI AS severity	Mild	Count	6	9	1	16
	Moderate	Count	2	0	2	4
	Severe	Count	0	1	0	1
Total		Count	8	10	3	21

Figure 2 : Reclassification of AS severity in trileaflet valves.

Bicuspid aortic valve			TTE AS severity			Total
			Mild	Moderate	Severe	
MRI AS severity	Mild	Count	5	11	5	21
	Moderate	Count	0	1	1	2
	Severe	Count	0	0	1	1
Total		Count	5	12	7	24

Figure 3 : Reclassification of AS severity in bicuspid valves.

- TTE overestimates severity
- TTE matches CMR severity
- TTE underestimates severity

Discussion

- In theory, AS severity is based on the AVA, blood flow velocity, and mean pressure gradient across aortic valve. Clinically, AS severity is based solely on the blood flow velocity measured from TTE¹.
- Errors arise when AVA is derived from TTE. By using the derived equation (πr^2) in Figure 1, it is assumed that the LVOT is circular, when in fact it is cylindrical². Measurement errors made in measuring the LVOTd in unclear TTE images will be amplified due to the power of 2³.
- Future study to compare AVA with gold standard, which is derived from Gorlin equation, making use of mean pressure gradient or the actual AVA post-aortic valve replacement, in order to assess which method is nearest to the actual AVA value.

Conclusion

Echocardiogram-derived aortic valve area overestimates aortic stenosis severity, resulting in a statistically significant change in reclassification in patients with bicuspid aortic valve disease.

References

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