4D CT Analysis of the Bicuspid Aortic Valve

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Objectives

- To evaluate the role of 4D analysis using multiphase computed tomography (MCCT) in the description of the aortic annulus (AA) of the bicuspid aortic valves (BAV) with regards to the latest expert consensus classification

- To describe the dynamical morphometrics of the different types of BAV

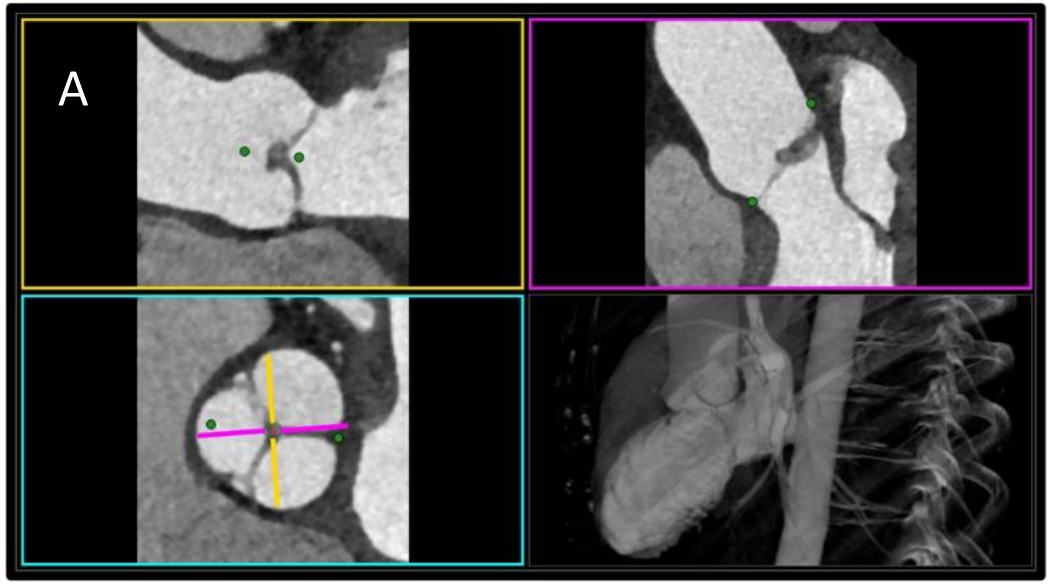
Methods

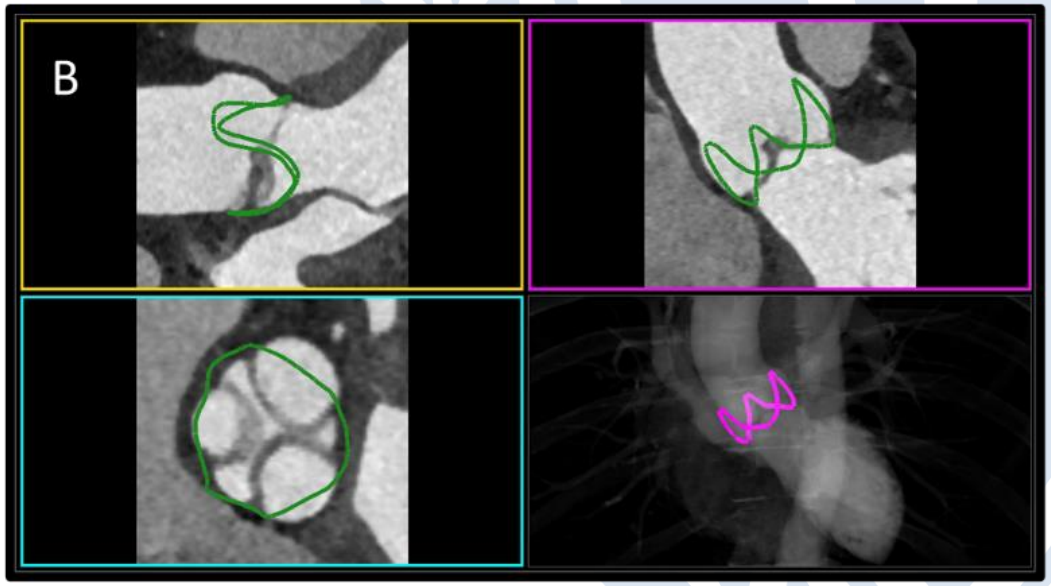
- 15 patients with BAV who had undergone MCCT and echocardiogram within 6 weeks.
  - >18 years-old
  - In sinus rhythm with no significant coronary artery stenosis (>50%).
  - Exclusion criteria: more than moderate aortic stenosis or regurgitation, ascending aortic diameters > 45mm, infective endocarditis or previous cardiac surgery.
- 15 patients with a normal functioning tricuspid aortic valve and similar exclusion / inclusion criteria

Methods

- In-house software for image analysis: Lattido®

- Observers pinpointed the annulus border on 9 reconstructed orthogonal planes (long axis reformation) rotating around the normal axis of the annulus in steps of 20° (A).
- The 3D coordinates of the 18 consecutive points defined along the edges of the annulus were interpolated into a 3D curve using a cubic spline (B).

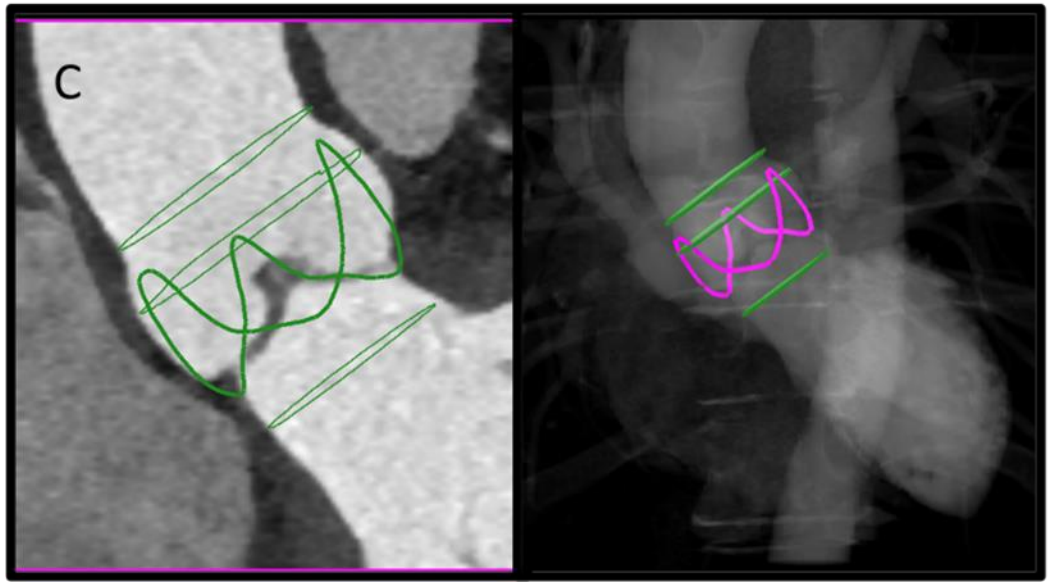


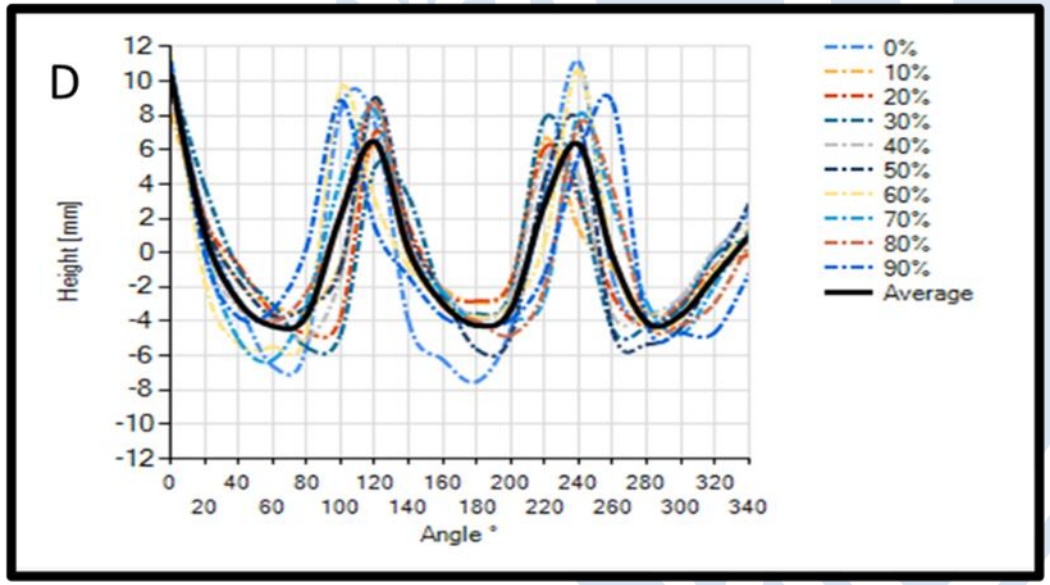


Methods

- After adjusting the best-fit plane of these 3D points, three additional planes were automatically created for manual inner contouring of the other aortic root components: two planes were generated 10 mm distant to the best fit AA plane at the level of the left ventricular outflow tract (LVOT) and at the level of sinus of Valsalva (SoV). The third plane, defined as the sino-tubular junction (STJ), intercepted the three higher points of the AA (C).

- This procedure was repeated for all the 10 temporal phases of the RR interval (D).

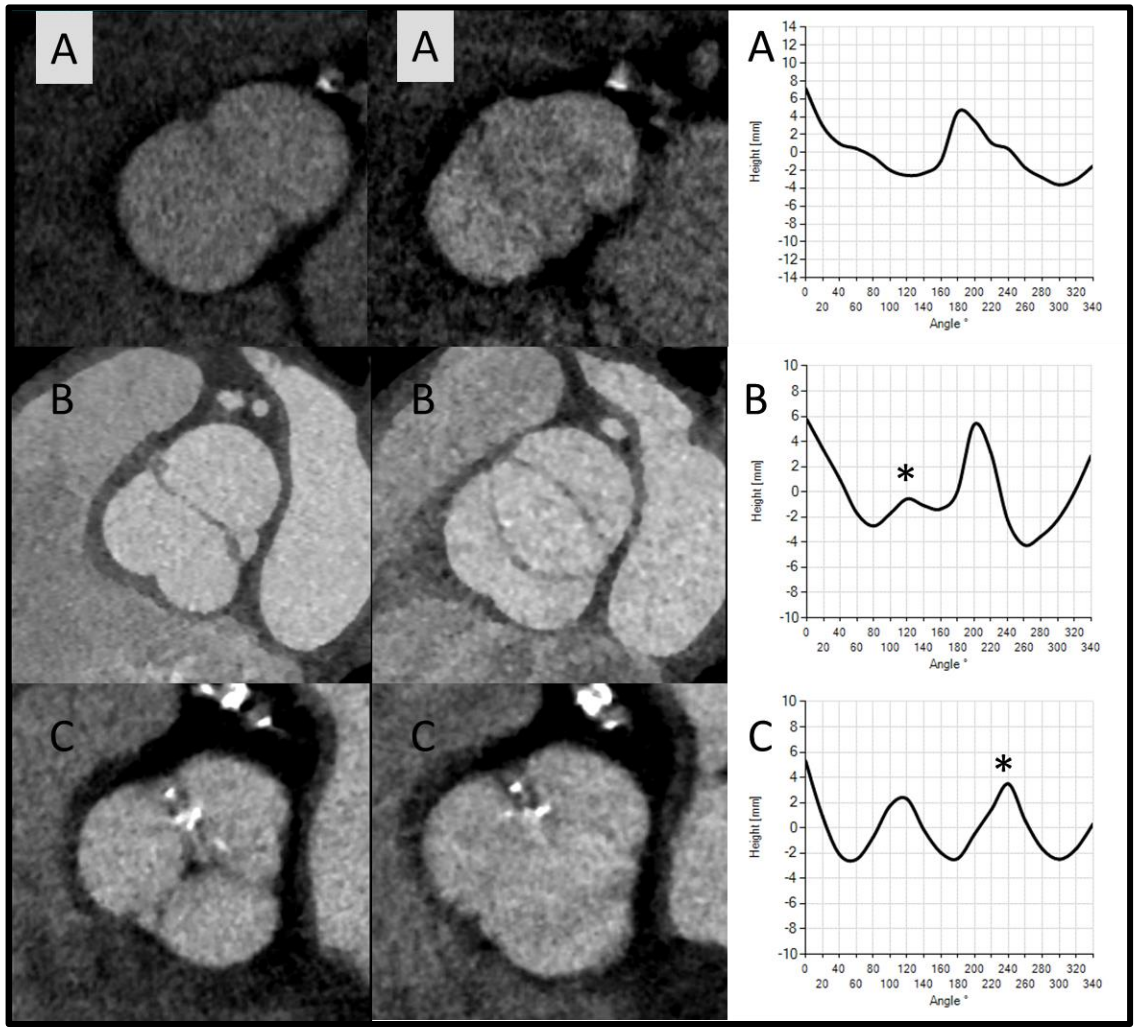




Results: Baseline Characteristics

	BAV	TAV
Age	54.53 +/- 13.26	57.73 +/- 10.56
Sex (male)	15 (100%)	5 (33.3%)
BSA	1.95 +/- 0.16	1.75 +/- 0.3
Ejection fraction	60.6 +/- 1.81	59.2 +/- 7.81
CT indication		
BAV evaluation	11 (73.3%)	0 (0%)
Chest pain	3 (20 %)	8 (53.3%)
Arrythmias	0 (0%)	5 (33.3%)
Other	1 (6.7%)	2 (13.4%)
Sievers classification		
Type 0	3 (20%)	
Type 1	12 (80%)	
L/R	8	
N/R	3	
N/L	1	

Results: Aortic Annulus representation in the 3 types of bicuspid aortic valve



A: the 2-sinus type (symmetrical),

B: the fused type (asymmetrical),

C: the partial-fusion type (asymmetrical).

(*Asterisk: nonfunctional commissure*)

Results: Measurements of the aortic root

Aortic Annulus

	BAV	TAV	p
Mean 3D area cm^2	10.97 +/- 1.52	7.58 +/- 1.59	< 0.001
Mean indexed 3D area cm^2/m^2	5.64 +/- 0.84	4.3 +/- 0.38	< 0.001
Mean 2D area cm^2	7.58 +/- 0.99	5.14 +/- 1.24	< 0.001
Mean 2D indexed area cm^2/m^2	3.89 +/- 0.54	2.91 +/- 0.34	< 0.001
Mean 3D perimeter cm	13.88 +/- 1.22	11.75 +/- 1.29	< 0.001
Mean 2D Diameter cm	3.07 +/- 0.26	2.5 +/- 0.31	< 0.001
Height mm	21.81 +/- 3.83	16.7 +/- 2.2	< 0.001

Aortic Root

		BAV cm^2/m^2	TAV cm^2/m^2	p
LVOT	ED	3.72 +/- 0.41	3.45 +/- 0.99	0.41
	ES	3.04 +/- 0.55	2.81 +/- 0.87	0.45
Valsalva	ED	6.06 +/- 1.00	4.69 +/- 1.00	<0.001
	ES	5.83 +/- 0.94	4.67 +/- 1.08	0.004
STJ	ED	5.13 +/- 1.62	3.62 +/- 0.99	0.001
	ES	5.25 +/- 1.63	3.64 +/- 1.17	0.001

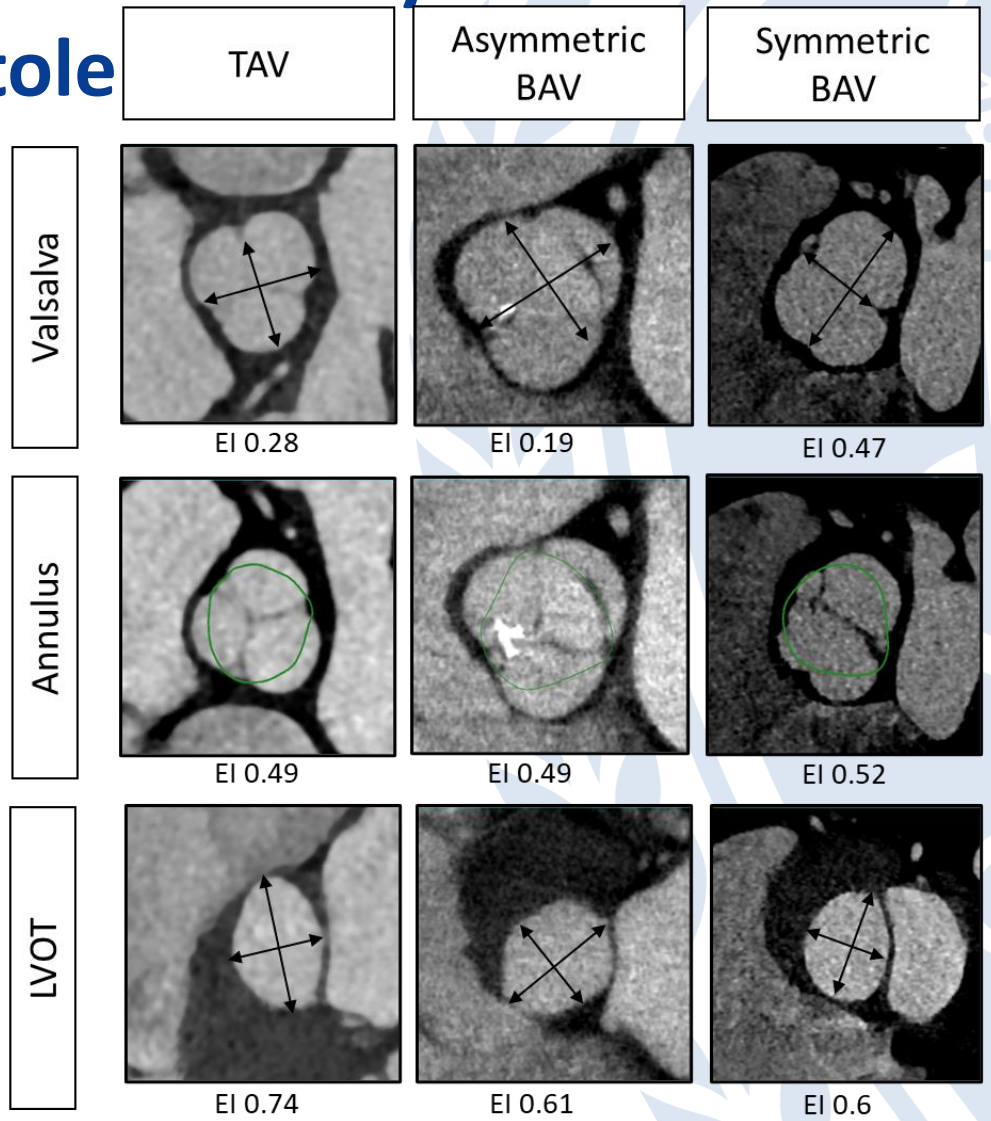
ED: end-diastole; ES: end-systole

Results: Height of the non-functional commissure

	Commissure 1	Commissure 2	Nonfunctional commissure	p
Symmetric	18.24 +/- 3.2	17.15 +/- 3.6	6.01 +/- 4.27	< 0.001
Asymmetric	16.38 +/- 0.86	15.88 +/- 1.69	15.37 +/- 0.88	0.316

In mm

Results: Summary of the eccentricity index of the aortic root in TAV and BAV at end-diastole



Conclusion

- 3D morphometric analysis of the BAV using MCCT allows to identify the type of BAV, and to describe the position and height of the nonfunctional commissure.
- There are significant differences in the morphology of the aortic root between TAV and the different types of BAV.
- Further studies should be done to evaluate the impact of 3D analysis on the procedural planning in pathological BAV.