Mass General Brigham

Role of CTA-derived Imaging Parameters in Bicuspid-Aortic Valve Associated Aortopathy

Mangun K. Randhawa, M.D., Jena Depetris, M.D., Reece J. Goiffon, M.D., Doreen DeFaria, M.D., Ayaz Aghayev, M.D., Mark Lindsay, M.D., Ph.D., Eric Isselbacher, M.D., MSC, Thoralf Sundt, M.D., Brian Ghoshhajra, M.D., M.B.A., Arminder Jassar, M.D., Sandeep Hedgire, M.D.

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

HARVARD UNIVERSITY

@mrandhawaMD

CARDIOVASCULAR IMAGING RESEARCH CENTER

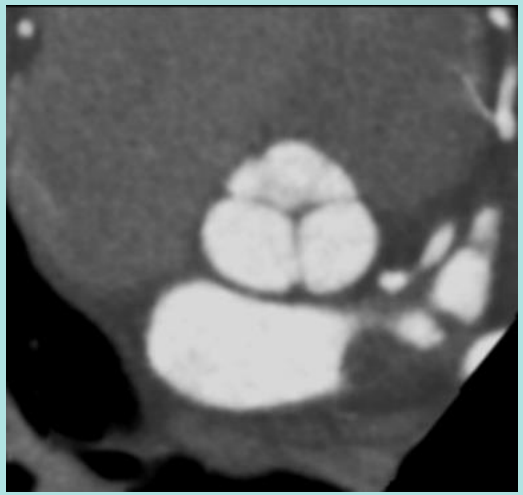
AATS Aortic Symposium

Introduction

- BAV is the **most common** congenital heart abnormality found in **2%** of the population [1]

- **BAV-associated aortopathy:** aortic dilatation or aneurysms affecting the aortic root and/or ascending aorta (26% 25-year risk) [2]

- **Clinical decision-making** currently relies on ascending aortic diameter & rate of expansion [3]



Tricuspid aortic valve (normal)

Bicuspid aortic valve (BAV)

Ascending aortic aneurysm

Previous Research & Guidelines

1

ACC/AHA 2022 and AATS 2018 guidelines [4, 5]

- Surgical threshold of 5.5cm
- Catastrophic aortic events below established thresholds [6]

2

Previous studies using CTA

- Aneurysmal phenotype [3], cusp fusion pattern [7], aortic volume [8], tortuosity [9], stiffness [10], wall stress [11], flow dynamics [12]

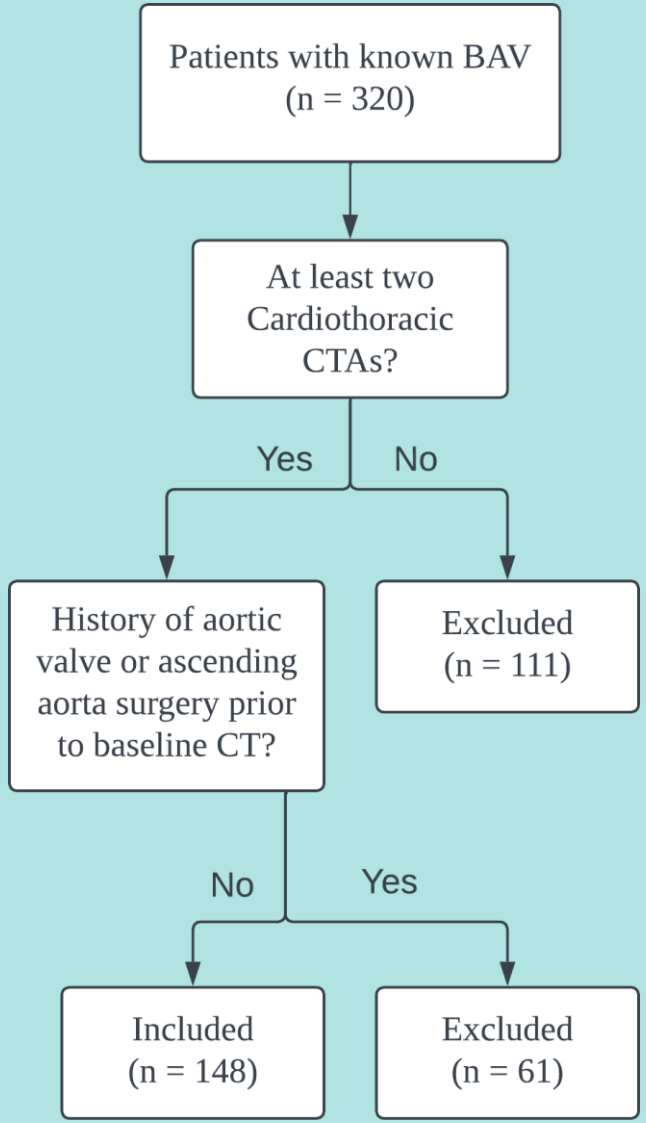
3

Thoracic aortic aneurysms and “elongated aortas”

- Kruger et al – aortic dissection more common in patients with “elongated aortas” [13]
- Wu et al – adding aortic length improves risk discrimination [14]

Study Design

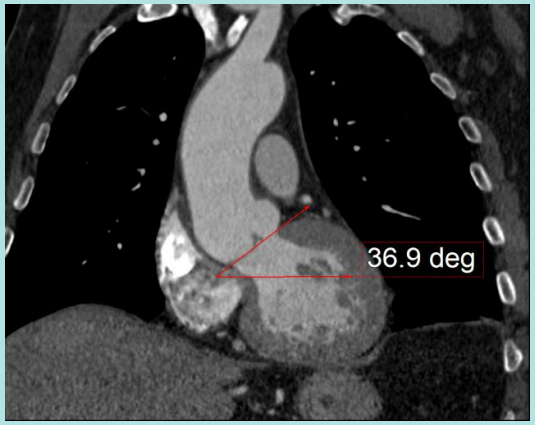
- Retrospective, IRB-approved study
- Inclusion criteria: At least 2 ECG-gated cardiothoracic CTAs from Jan 2004 – April 2020
- Exclusion criteria: Aortic valve or ascending aortic surgery prior to baseline scan
- 148 patients (119 males, 29 females; Mean age 52.7 ± 11.7 years)
- Median imaging follow-up – 5.4 years (IQR 4.7-6 years)
- Image analysis: 2 trained experts independently validated by an experienced Radiologist



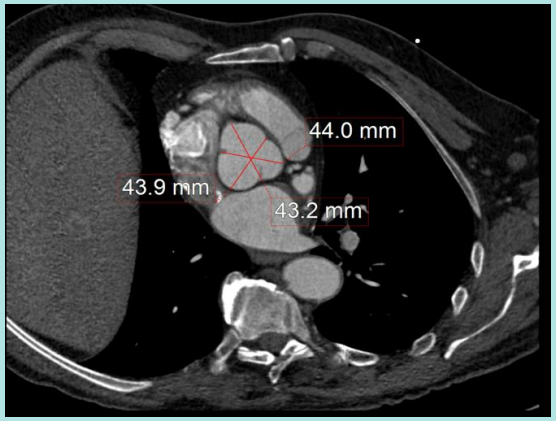
Primary Outcome Measurement: Ascending aortic diameter growth rate

Methods – Measured Parameters

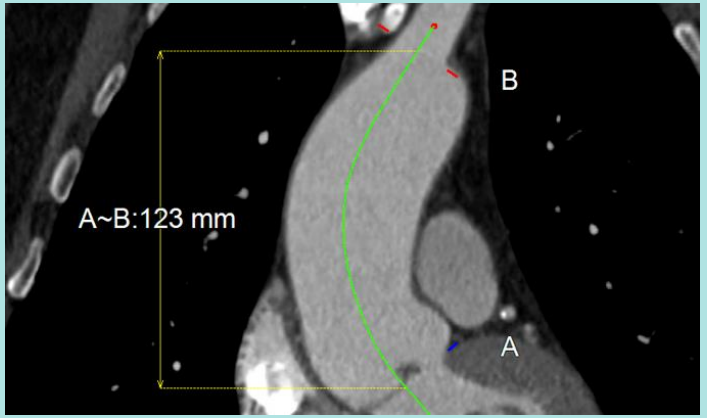
Ao Annulus Angle



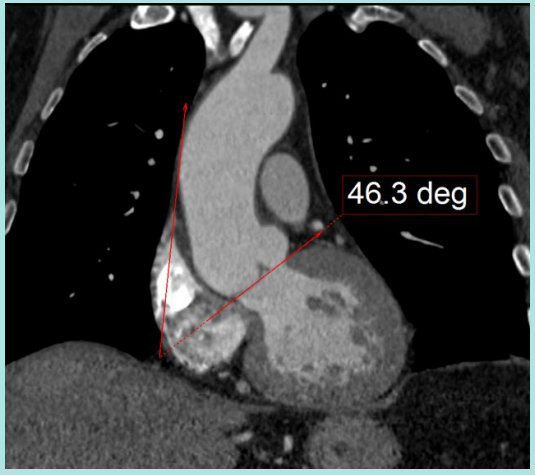
Ao Root Diameter



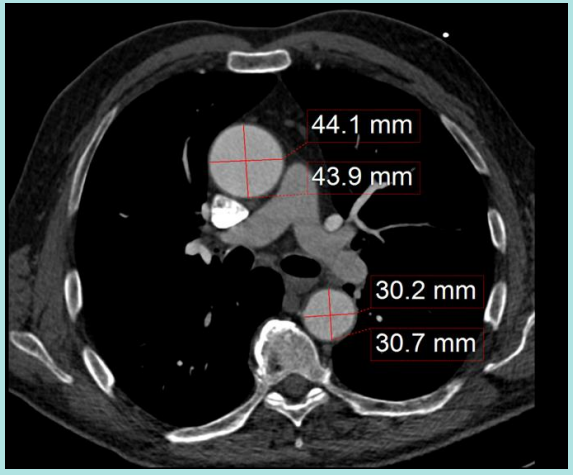
Aortic Length



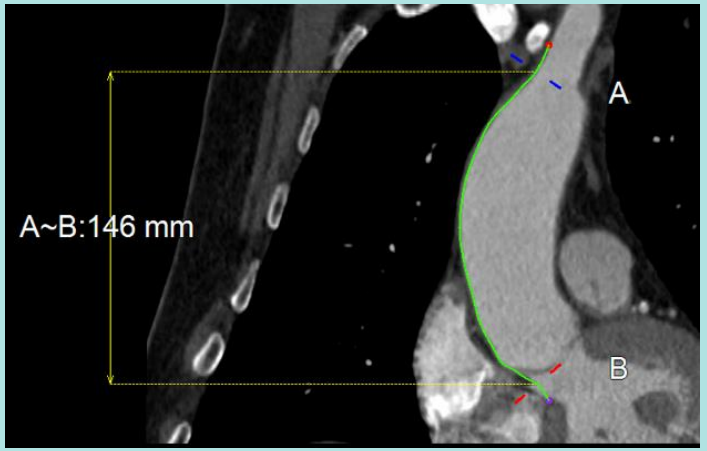
Asc Ao Angle



Asc and Desc Ao Diameters



Greater Curvature Length



Baseline Characteristics

Parameters	n	Mean ± SD	Median	IQR
Aortic Valve Calcium Score (AVCS) (if > 0)	52	1563		
Aortic Annulus Angle / degrees	148	48 ± 12	47	[21–94]
Ascending Aorta Angle / degrees	148	52 ± 15	54	[20–102]
Aortic Length / mm	128	114 ± 16	115	[82–154]
Greater Curvature Length / mm	128	144 ± 20	145	[113–190]
Aortic Diameters / mm				
Aortic Root	148	42 ± 6	42	[28–60]
Ascending Aorta	148	43 ± 7	44	[26–58]
Descending Aorta	148	27 ± 4	27	[19–51]
Ascending:Descending (A:D) Ratio	148	1.59 ± 0.27	1.59	[1.03–2.25]

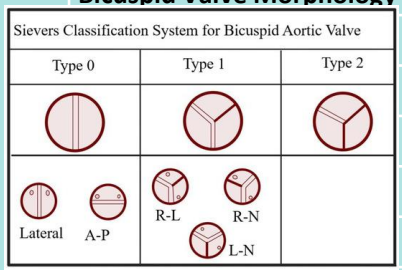
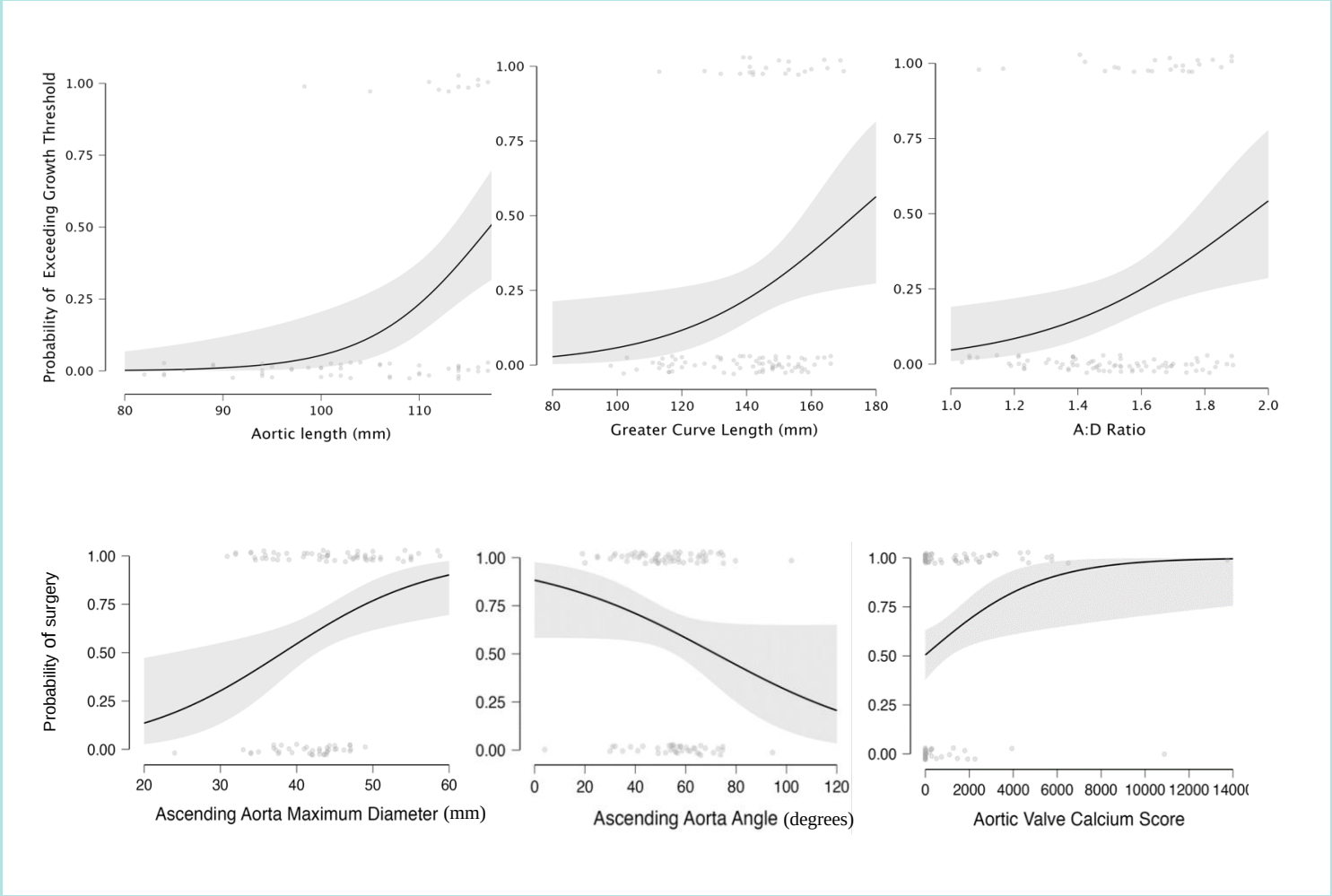
	Characteristics		n = 148
Demographics	**Age / years**		52.7 ± 11.7
	Height / cm		176 ± 9.4
	Weight / kg		90.6 ± 28.6
	BSA / m²		2 ± 0.3
	Male		119 (80.4%)
	Bicuspid Valve Morphology		
		Type 0	11 (7.4%)
		Type 1	131 (88.5%)
		R-L fusion	105
		R-N fusion	25
		L-N fusion	0
		Unknown	1
		Type 2	6 (4%)
Clinical history	**Low-density lipoprotein (LDL) / mg/dL**		95 ± 35
	High-density lipoprotein (HDL) / mg/dL		45 ± 17
	Cholesterol / mg/dL		166 ± 44
	Triglycerides / mg/dL		142 ± 108
	Statin Therapy		57 (38.5%)
	Hypertension		70 (47.2%)
	Beta Blocker Therapy		53 (75.7%)
Medical history	**ARB Therapy**		22 (31.4%)
	Smoking History		43 (29%)
	Cocaine Use		6 (4%)
	Known Collagen Vascular Disease		3 (2%)
	Aortic Coarctation		6 (4%)

Fig: Bulut et al, J. Cardiovasc. Dev. Dis. (2023)

Correlation between Imaging Parameters and Ascending Aortic Growth

	Ascending Aortic Growth ≥ 0.7 mm/y threshold		
Imaging Variables	**p value**	**OR**	**95% CI**
AVCS	0.471	1.00	1169-1678
Aortic Annulus Angle	0.812	0.98	0.90–1.08
Ascending Aorta Angle	0.084	0.77	0.62–1.01
Aortic Length	**0.002**	**1.18**	**1.06–1.31**
Greater Curve Length	**0.025**	**1.03**	**1.00-1.07**
Aortic Root Max	0.492	1.08	0.87–1.39
Ascending Max	0.139	1.12	0.97–1.36
Descending Max	0.341	1.13	0.89–1.50
A:D Ratio	**0.011**	**24.11**	**2.04-284.57**

Logistic Regression



Results

Positive correlation: Positive correlation of aortic length, greater curvature length, root and ascending aortic diameters, and A:D ratio with aortic diameter growth rate

Inverse Relationship: Ascending aortic angle negatively correlates with growth rate

Logistic Regression Insights: Increased odds of exceeding threshold for growth rate with each mm increment in aortic length **>120 mm**, greater curvature length **>170** mm, and A:D ratio of **>1.9**

Surgical Intervention Data: 60.8% of patients had surgery, associated with lower ascending aortic angle, and a higher baseline AVCS and max aortic diameter

Key Points from Discussion

- **Need for Better Risk Tools:** High rates of aortic complications in BAV-aortopathy
- **Beyond Aortic Diameter:** Ascending aortic diameter alone is insufficient for comprehensive risk assessment
- **Shift in Research Focus:** Advancements in imaging techniques are moving beyond traditional echocardiographic methods
- **Aortic Length as a Key Predictor:** Aortic length is shown to be more predictive of complications than aortic diameter
- **New Risk Stratification Tools**: Could potentially serve as early screening and risk assessment in BAV patients
- **Future Research Directions:** Prospective trials to validate these findings and the development of a BAV-specific risk model

Conclusions

1

CTA-Driven Prognostics

Aortic length, greater curvature length, and A:D ratio can predict ascending aortic diameter growth in BAV patients, offering a new dimension to risk stratification

2

Predictive Parameters for Surgical Intervention

Baseline ascending aortic diameter, AVCS, and aortic angle can influence the necessity for surgical intervention

3

Beyond Diameter Measurement

Integrating diverse CTA-derived parameters may enhance the assessment and management of BAV-associated aortopathy

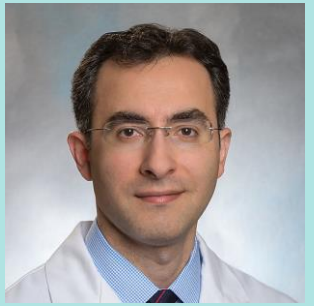
Teamwork Makes The Dream Work


Mangun Randhawa


Jena Depatris


Reece Goiffon


Doreen DeFaria


Ayaz Aghayev


Mark Lindsay


Eric Isselbacher


Thoralf Sundt


Brian Ghoshhajra


Arminder Jassar


Sandeep Hedgire


Angelo Takigami


Vikas Thondapu


Daniel Montes


Jaclyn Pagliaro

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