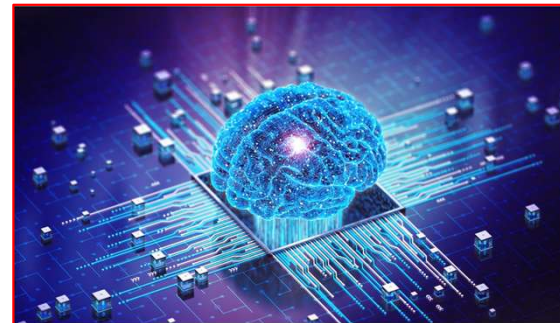
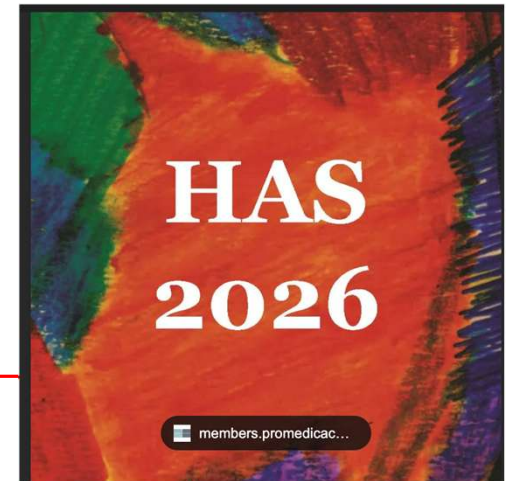


“AI-Based Aortic Risk Calculator” for Clinical Decision Making in TAA

John A. Elefteriades, MD
Founding Director, Aortic Institute at Yale-New Haven

The Houston Aortic Symposium
Frontiers in Cardiovascular Diseases
The Eighteenth in the Series

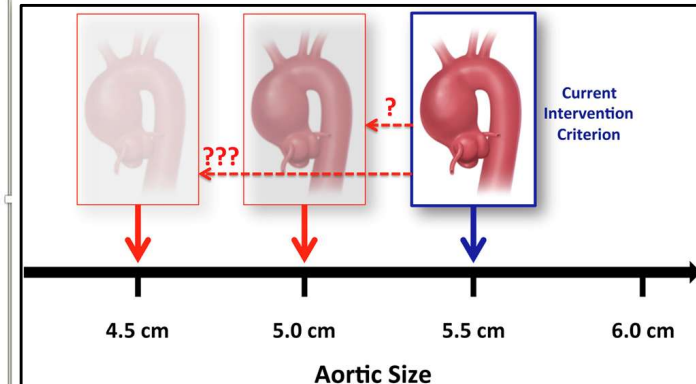
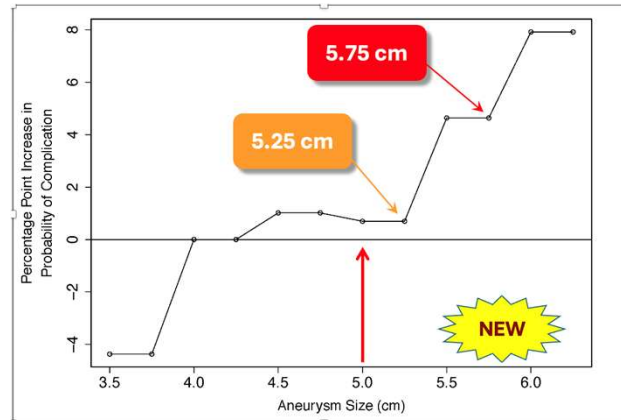
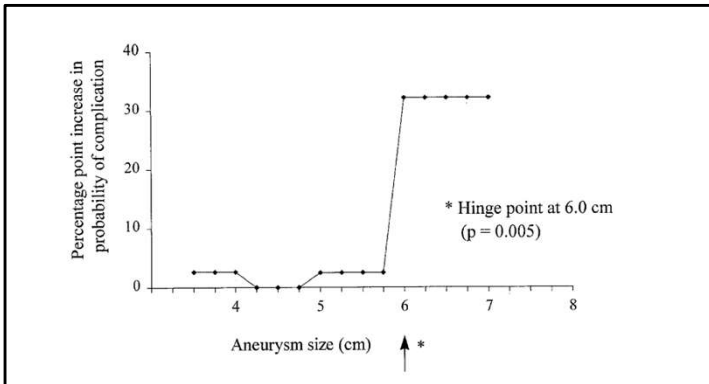
March 5-7, 2026



We have supported size criteria for intervention

We have supported size criteria based on our extensive Yale Aortic Institute Database:

- 4500+ patients
- 33+ years of f/u



AATS/ACC/AHA Guidelines **2022 Isselbacher**
EACTS/STS Guidelines **2024 Czerney**

YES!! 5 cm



NON-SIZE CRITERIA WE HAVE FOUND TO BEAR ON AORTIC RISK

	PARAMETER	TAKE HOME MESSAGE
1	Pain	Pain mandates surgery.
2	Length/Tortuosity	A bit better than diameter.
3	Genes	Powerful criterion.
4	Family History	Powerful criterion.
5	Bicuspid Aortic Valve	No longer a separate risk factor.
6	Diabetes	Protective!
7	Aortic stress (exercise, BP)	Enter into decision-making “gestaltdt”.
8	Biomarkers (“RNA Signature” test)	Nearing validation.
9	<i>KIF6</i>	Nearing validation.
10	Root vs. Asc	Root more malignant than ascending.
11	PET Imaging	PET “light-up” implies activity and rupture risk

Elefteriades JA et al. AORTA. 2023

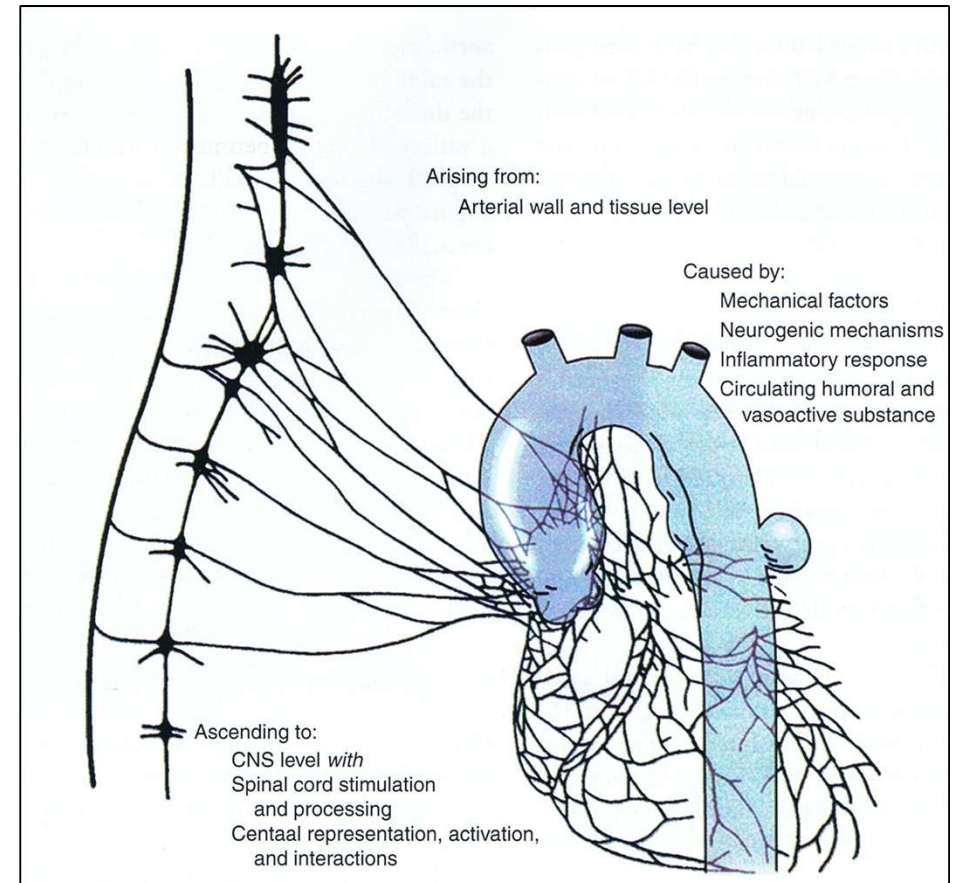
Pain

A Symptomatic Ascending Aortic Aneurysm Merits Replacement: Regardless of Size

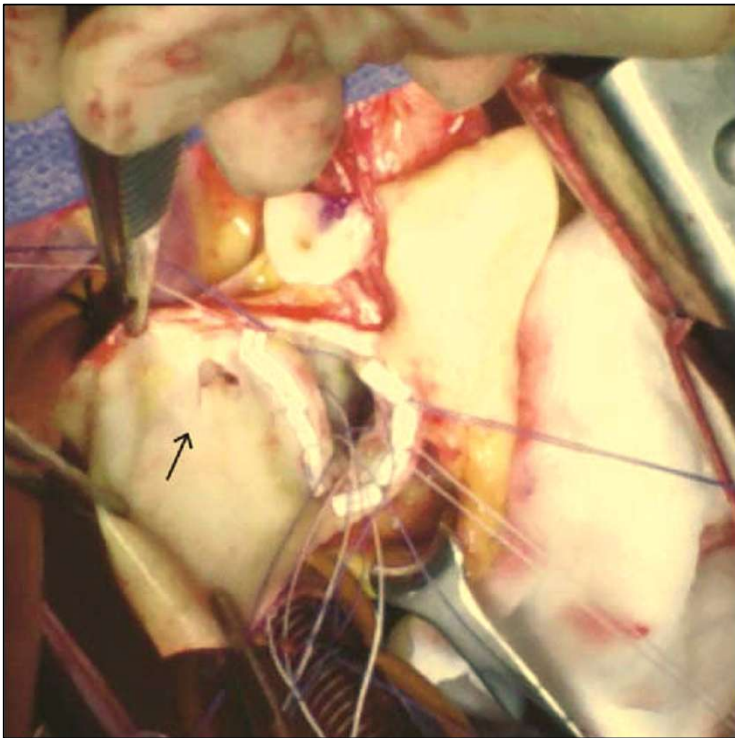
Pain is the only avenue by which the aorta can "speak" to us.

Elefteriades JA et al. Ann Thorac Surg. 2005.

Figure courtesy of Boudoulas H, Stefanadis, C. The Aorta: Structure, Function, Dysfunction, and Diseases. Informa 2009.

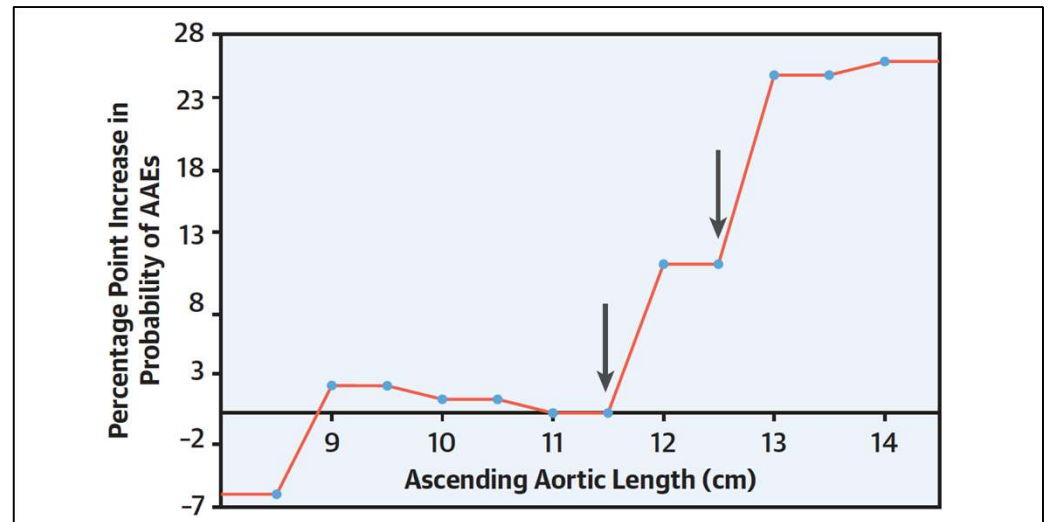


In patients with pain, we often find pathology corresponding to painful symptoms.



Spontaneously aborted dissections in two ascending aortic aneurysm patients with **pain**

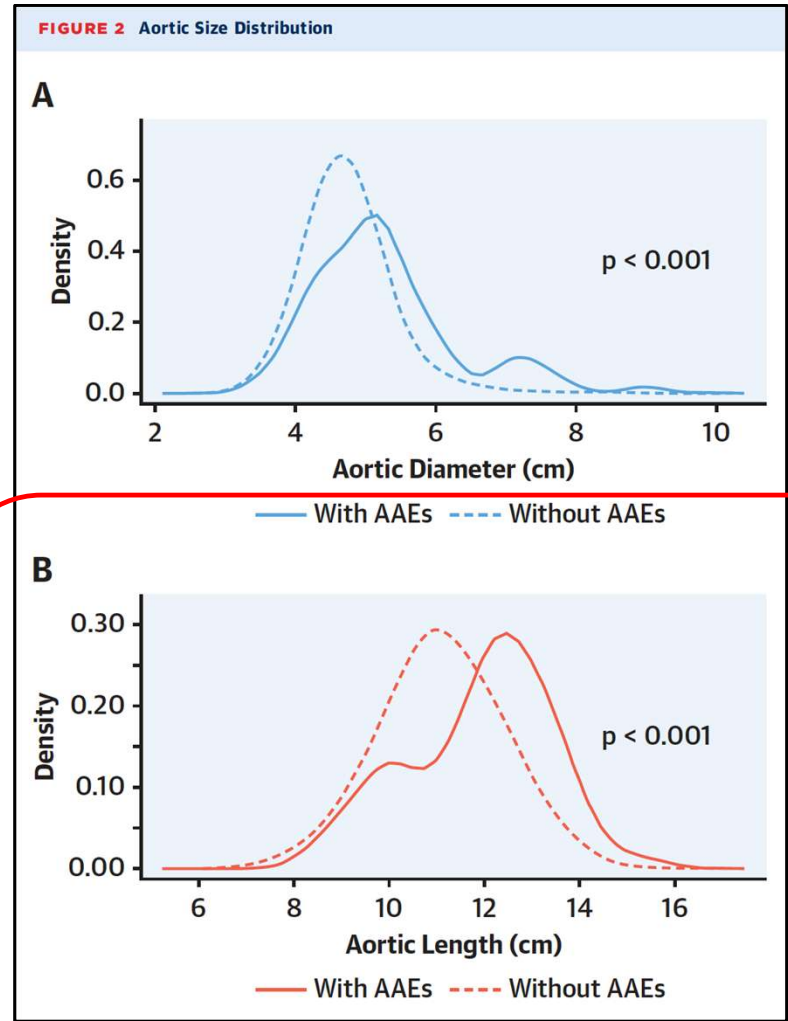
Length/Tortuosity



- Ascending Aortic Length > 13 cm is critical.
- 5X increase in adverse events.

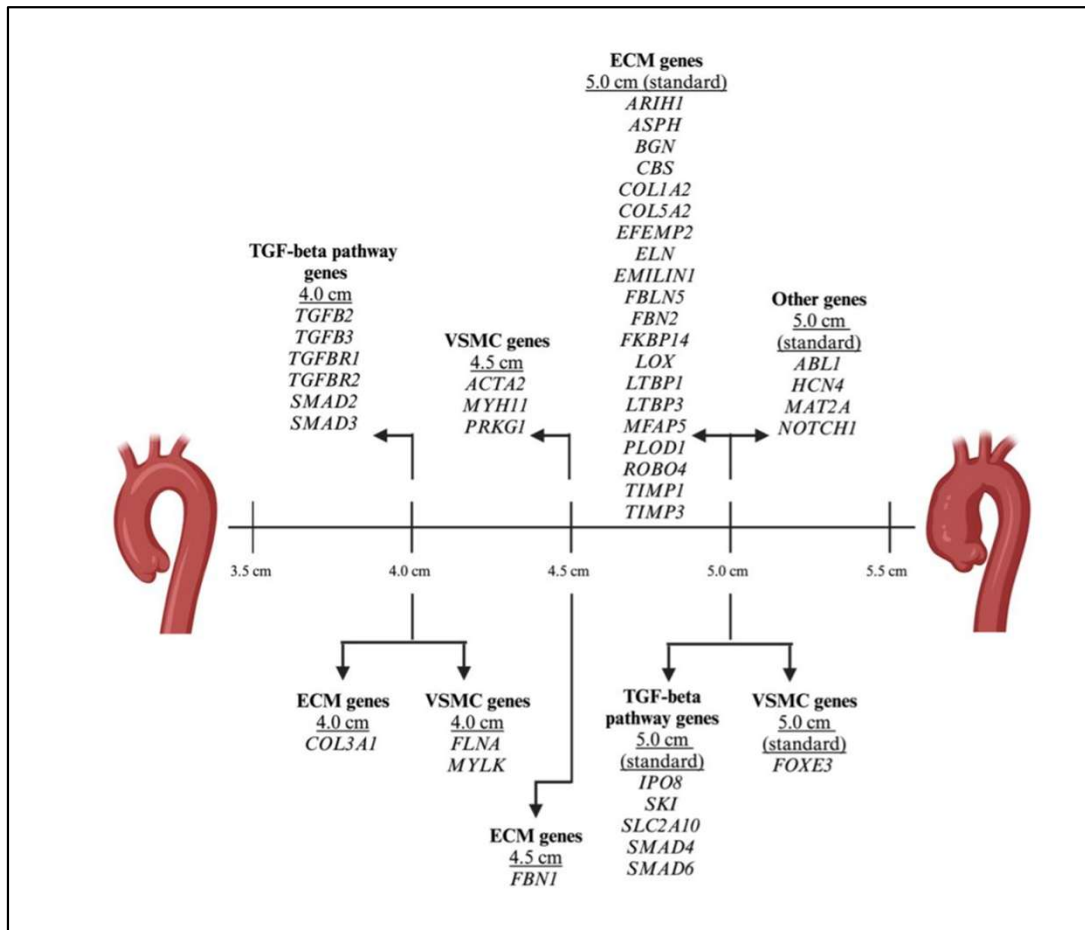
Wu J, Zafar MA, Elefteriades JA, et al. Ascending Aortic Length and Risk of Aortic Adverse Events: The Neglected Dimension. *J Am Coll Cardiol* 2019;74:1883-1894.

Length/Tortuosity



Genes

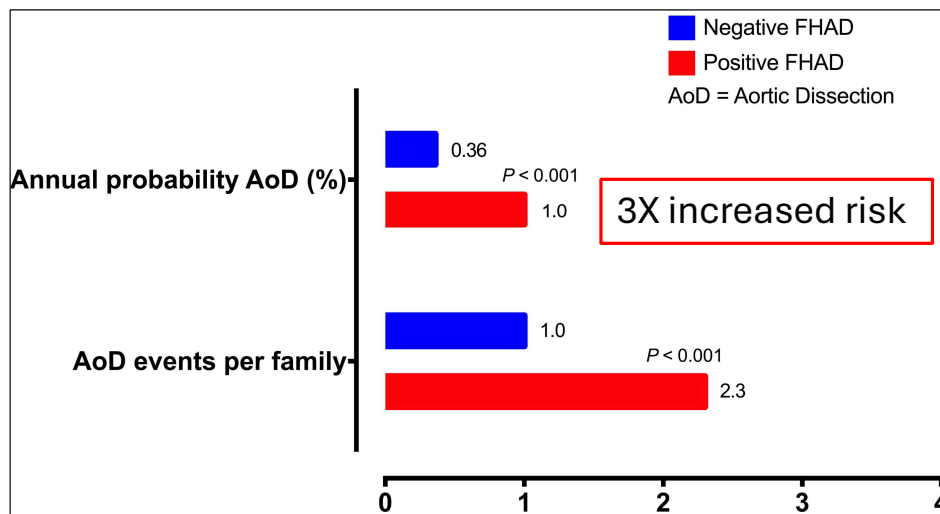
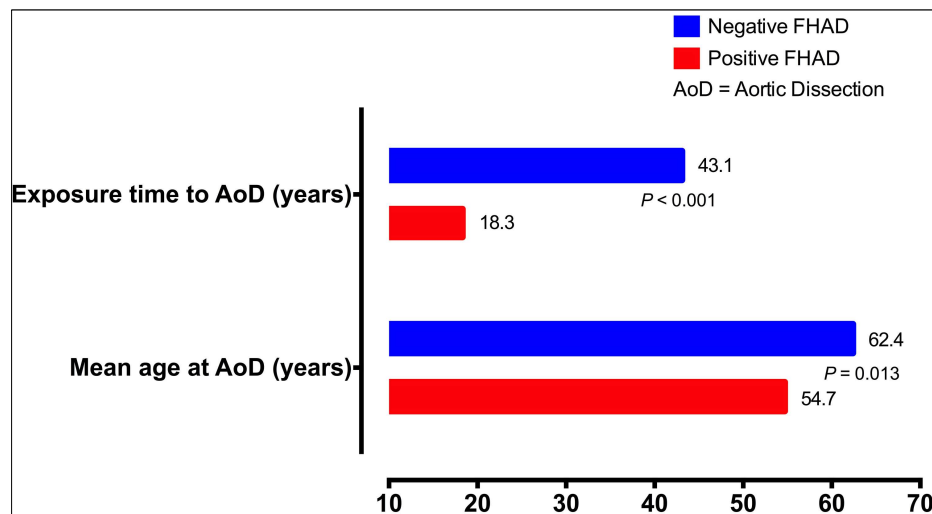
Use the "Sizeline" to gauge appropriate time for surgical intervention.



"Timeline" for Surgical Intervention for Ascending Thoracic Aortic Aneurysms (TAA)

- Chart limited to genes "Definitive", "Strong", "Moderate", or "Limited" level of evidence for association with TAA. Genes without substantial evidence are deliberately omitted.
- When there is a range of diameters recommended, for simplicity, we have indicated the lower limit.
- This chart is intended for general guidance. Full clinical decision-making should be made for any specific patient.

Family History



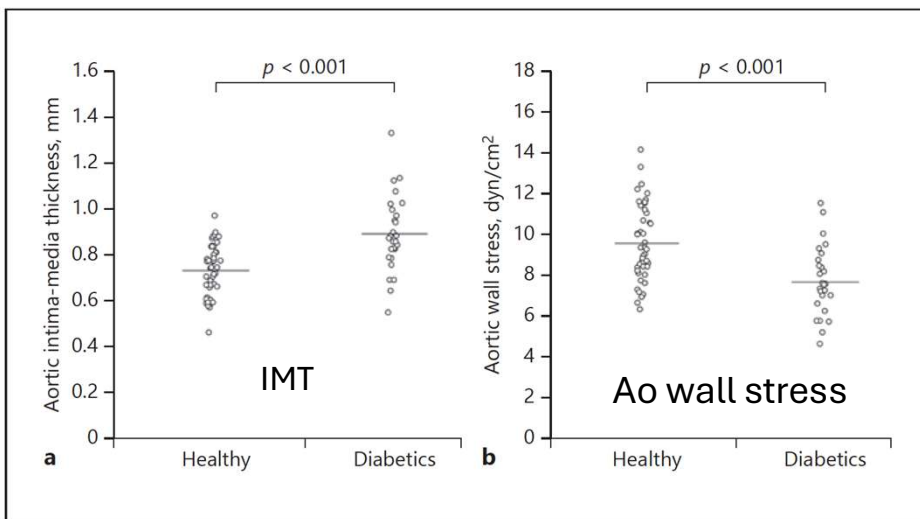
Ma WG, Chou AS, Elefteriades JA, et al. Positive family history of aortic dissection dramatically increases dissection risk in family members. *Int J Cardiol* 2017;240:132-137.

Diabetes

Law of Laplace

$$T = \frac{p \times d}{t}$$

Diabetes plays **protective** role—**against** enlargement and dissection.



CARDIOLOGY

Review

Cardiology 2018;141:107–122
DOI: 10.1159/000490373

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Published online: November 19, 2018

Diabetes Mellitus: Is It Protective against Aneurysm? A Narrative Review

Kanchi Patel^a Mohammad A. Zafar^a Bulat A. Ziganshin^{a, b}
John A. Elefteriades^a

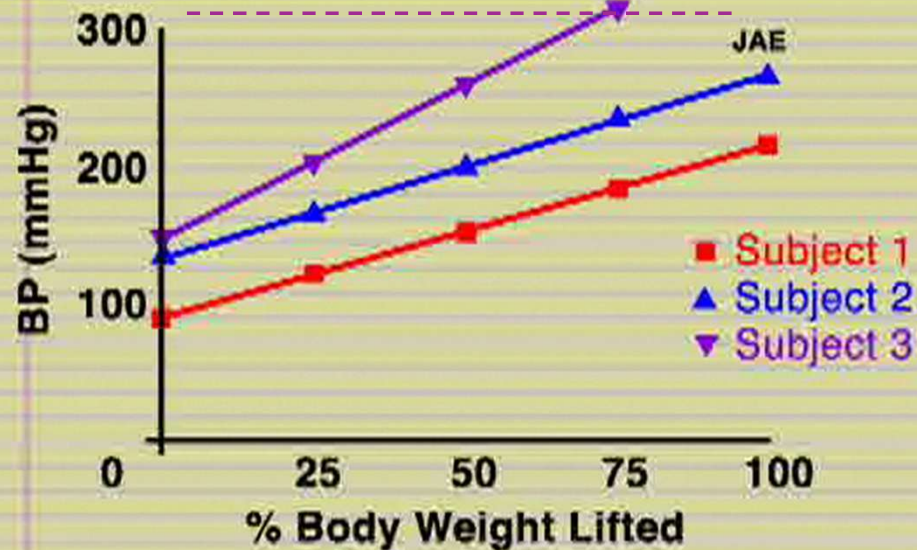
Astrand H. Reduced aortic wall stress in diabetes mellitus. Eur J Vasc Endovasc.Surg. 2007..

Aortic stress (exercise, BP)



Weightlifting and Blood Pressure

Relationship of Systolic BP to Weight Lifted



LETTERS

Weight Lifting and Rupture of Silent Aortic Aneurysms

To the Editor: It is unclear whether aortic dissection is associated with high-intensity strength training.

Methods. From our Yale University aortic database,¹ and from outside cases brought to our attention after lay press reports of our aortic research,^{2,3} we identified and reviewed case materials of 5 patients who experienced acute dissection of the ascending aorta in the setting of high-intensity weight training or other strenuous exercise.

Results. The 5 patients ranged in age between 19 and 53 years. None had previously diagnosed aneurysm or personal history of hypertension or collagen vascular disease. Only 1 patient had a family history of aortic disease. None had signs of Marfan syndrome.

All patients were involved in strenuous strength training at the instant that their dissection pain occurred. Two patients were weight training, a third was attempting to move a heavy granite structure, and the other 2 were doing push-ups.

All patients manifested acute ascending aortic dissection. Diagnosis was made by computed tomography scan in 3 patients, by echocardiography in 1, and by autopsy in the fifth. The diameter of the aorta on the imaging studies performed immediately after dissection ranged from 4.0 to 5.2 cm, indicating underlying enlargement, but not to a level expected to present a high risk of dissection.⁴

of the patients in this series, however, had these known risk factors. Furthermore, because limiting maximal effort prevents extreme (>200 mm Hg) elevations in blood pressure,⁵ it also seems reasonable to limit weight lifting in individuals at risk.

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David Silverman, MD
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1. Eleftheriades JA. Natural history of thoracic aortic aneurysms: indications for surgery, and surgical vs non-surgical risks. *Ann Thorac Surg.* 2002;74:51877-51880.
2. Heilker K. Fears mount over dangers of hoisting heavy weights. *Wall Street Journal.* March 13, 2003:D1.

3. Carey A. Body language reason enough to start lifting less. *The Philadelphia Inquirer.* June 16, 2003:E1.

4. de Virgilio C, Nelson RJ, Milliken J, Snyder, R, MacDonald W, Robertson JM. Ascending aortic dissection in weight lifters with cystic medial necrosis. *Ann Thorac Surg.* 1990;49:638-642.

5. O'Rourke MF. Effects of aging on aortic distensibility and on aortic function in man. In: Boudoulas H, Toutouzas PK, Wooley CF, eds. *Functional Abnormalities of the Aorta.* Armonk, NY: Futura Publishing Co Inc; 1996.

6. MacDougall JD. Blood pressure response to resistive, static, and dynamic exercise. In: Fletcher GF, ed. *Cardiovascular Response to Exercise.* Mount Kisco, NY: Futura Publishing Co; 1994.

JAMA The Journal of the
American Medical Association

JAMA. 2003 Dec 3;290(21):2803.



KIF6

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genes

Article

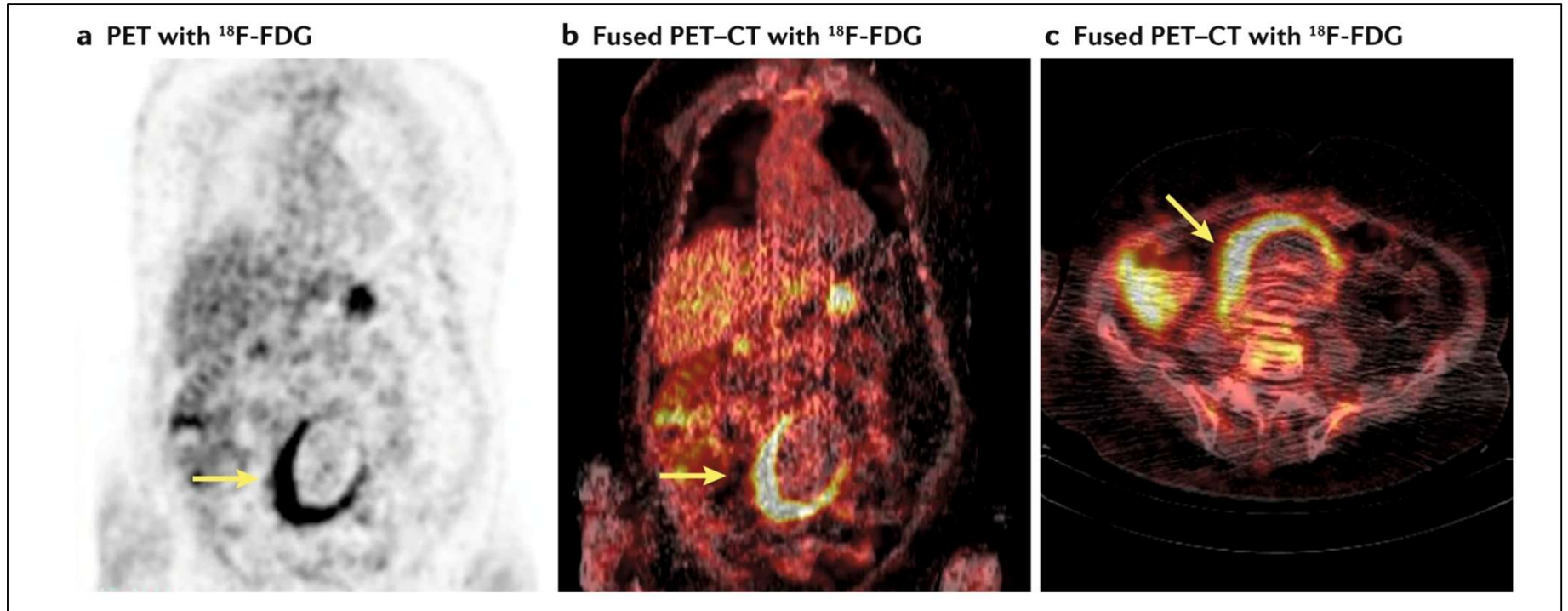
KIF6 Trp719Arg Genetic Variant Increases Risk for Thoracic Aortic Dissection

Juan J. Velasco ¹, Yupeng Li ² , Bulat A. Ziganshin ¹, Mohammad A. Zafar ¹ , John A. Rizzo ³, Deqiong Ma ⁴, Hui Zang ⁴, Asanish Kalyanasundaram ¹ and John A. Elefteriades ^{1,*}

Table 3. Association of *KIF6* Trp719Arg with thoracic aortic dissection.

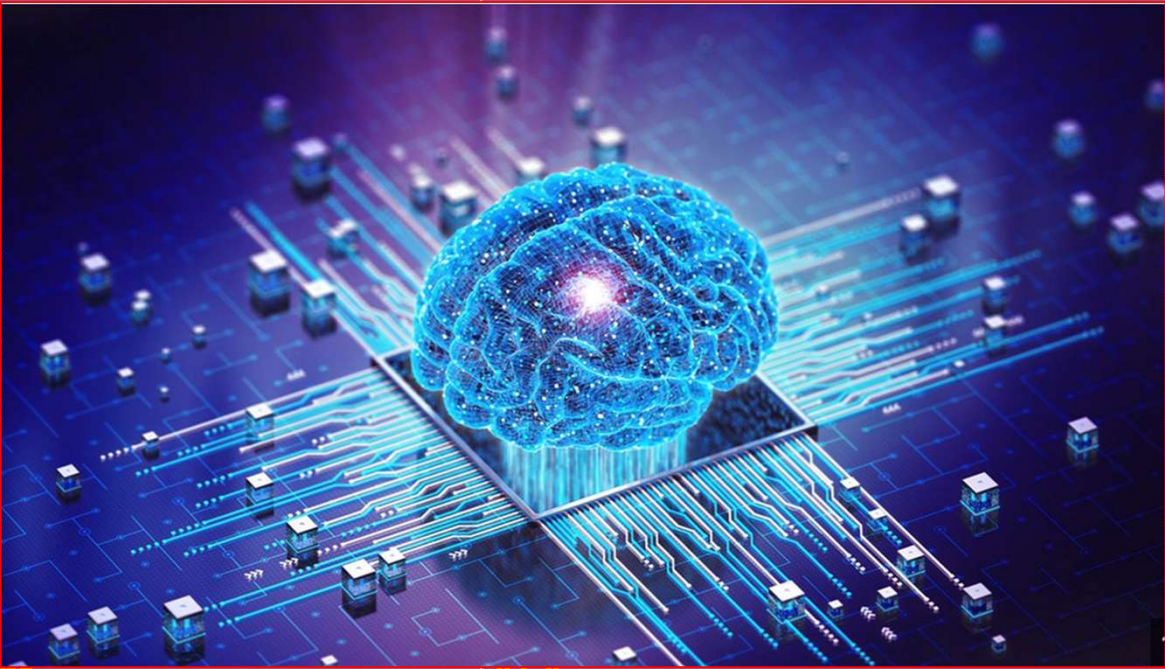
Genotype	Case	Control	Unadjusted			Adjusted*		
			OR	95% CI	<i>p</i> Value	OR	95% CI	<i>p</i> Value
Including CHD								
Arg/Arg+Arg/Trp Arg/Trp Arg/Trp	97	155	1.75	1.14–2.69	0.0112	2.14	1.18–3.90	0.013
Arg/Trp	77	115	1.87	1.19–2.94	0.0068	2.39	1.27–4.48	0.0066
Arg/Arg	20	40	1.40	0.74–2.65	0.3077	1.40	0.56–3.50	0.4692
Trp/Trp	43	120	ref			ref		

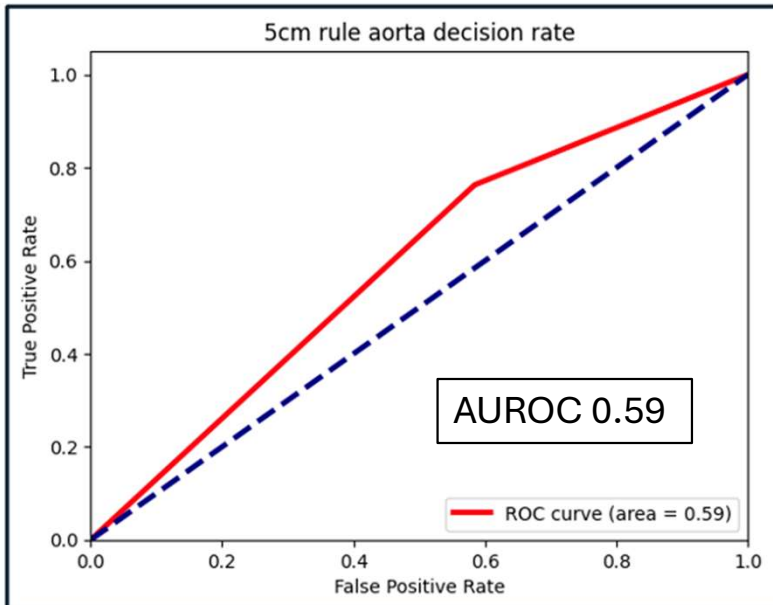
PET Imaging



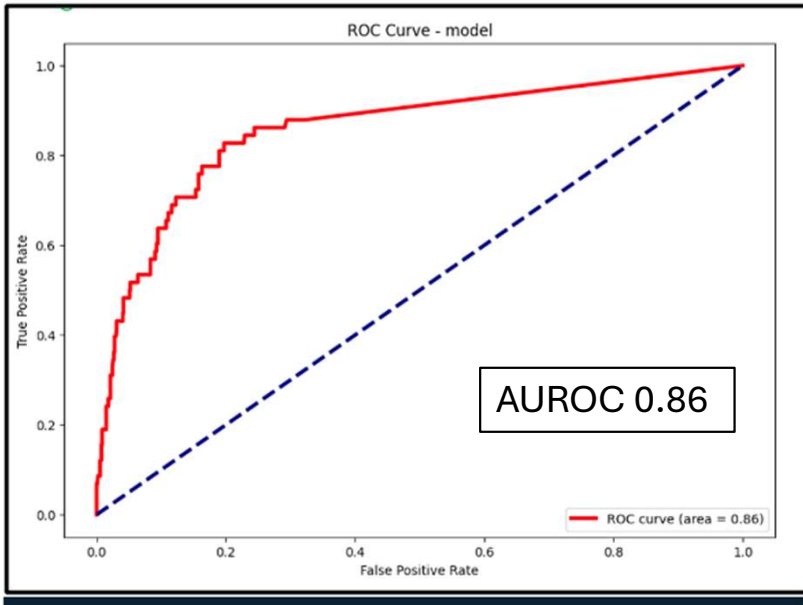
PET imaging may reflect inflammation and degradation of aortic wall. Sign of advanced pathologic state, predictive of rupture.

Sakalihasan N, Michel J-B, Powell JT, Kuivaniemi H, Defraigne J-O, et al. Nature Reviews Disease Primers. Oct 2018.

	TOPIC	TAKE HOME MESSAGE
	The “Aortic Size Paradox” (IRAD)	Must consider denominator of patients at risk.
	Diameter (Brief)	Good start—Served us well.
1	Pain	
2	Length	
3	Genes	
4	Family	
5	Bicuspid	
6	Diabetes	
7	Aortic size	
8	Biomarker (test)	
9	<i>KIF6</i>	
10	Root vs	
	Judgment	KEY



Traditional Method



Our “Aortic Risk Calculator”

Diameter Alone

Artificial Intelligence ROC Curve

POSITIVE PREDICTIVE ACCURACY 98%

Elefteriades JA et al. Presented at SVS 2024.

Aortic Aneurysm Risk Calculator

Patient Management

Run Patient Through Model

View Results

Logout

Welcome, Dr. Elefteriades Run Model

Running Model for: Jim Beam

Step 1: Enter Patient Data or connect to Epic

Enter Patient Data

- Aortic and Cardiovascular Features ▼
- Patient Demographics and General Medical History ▼
- Other Medical Conditions ▼
- Manual Measurements ▼

Save Data

Step 2: Run Model

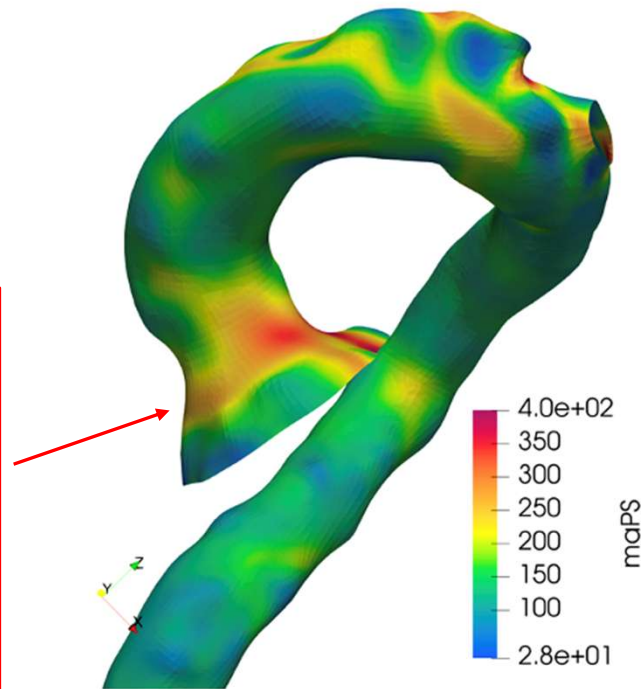
Connect to Epic

- Manual Measurements ▼

Connect to Epic



preD



Note severely increased wall stress at the junction of the aortic root with the ascending aorta: just where we see clinical tears in Acute Type A Dissection.

We look forward very soon to adding direct calculation of “wall stress” to the variables available to our AI calculations.

We anticipate this addition will increase prediction accuracy even further.



JUDGMENT