

MEET THE EXPERT UNPLUGGED

Aneurismi aortici: dalle linee guida alla real life



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ESC

European Society
of Cardiology

European Heart Journal (2024) **45**, 3538–3700

<https://doi.org/10.1093/eurheartj/ehae179>

ESC GUIDELINES

2024 ESC Guidelines for the management of peripheral arterial and aortic diseases

European Journal of Cardio-Thoracic Surgery 2024, 65(2), ezad426

<https://doi.org/10.1093/ejcts/ezad426>

GUIDELINES

Cite this article as: Czemy M, Grabenwöger M, Berger T, Aboyans V, Della Corte A, Chen EP et al. EACTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ. Eur J Cardiothorac Surg 2024; doi:10.1093/ejcts/ezad426.

EACTS/STS Guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ

The aorta as an organ

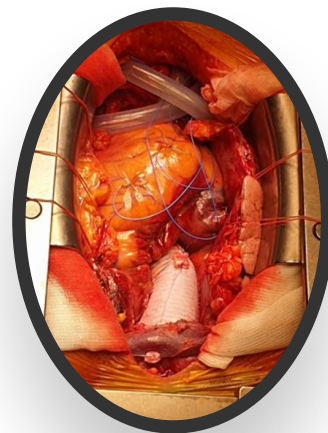
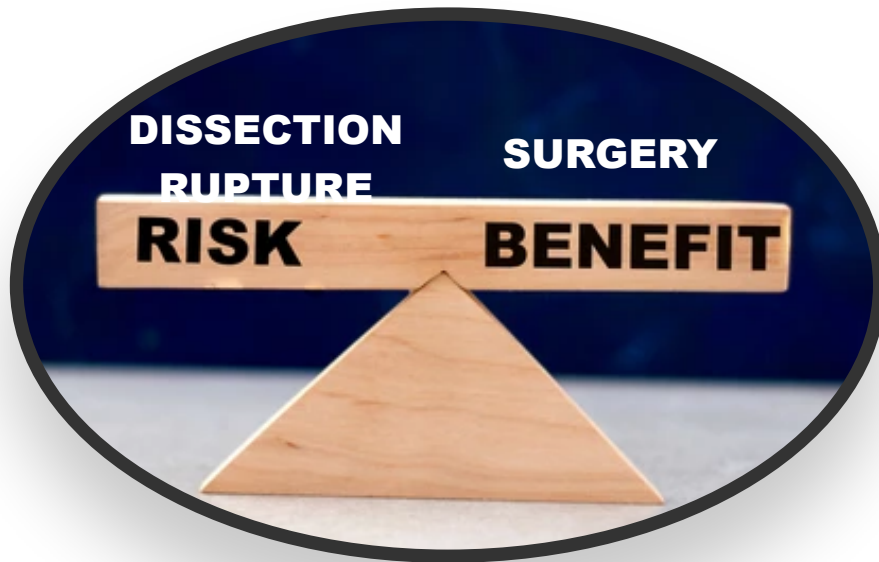
- officially recognized as the 24th human organ, with its own structure and physiology



Preemptive surgery

The ideal diameter for elective operation would ideally be the point at which the natural history surpasses the elective surgical risk

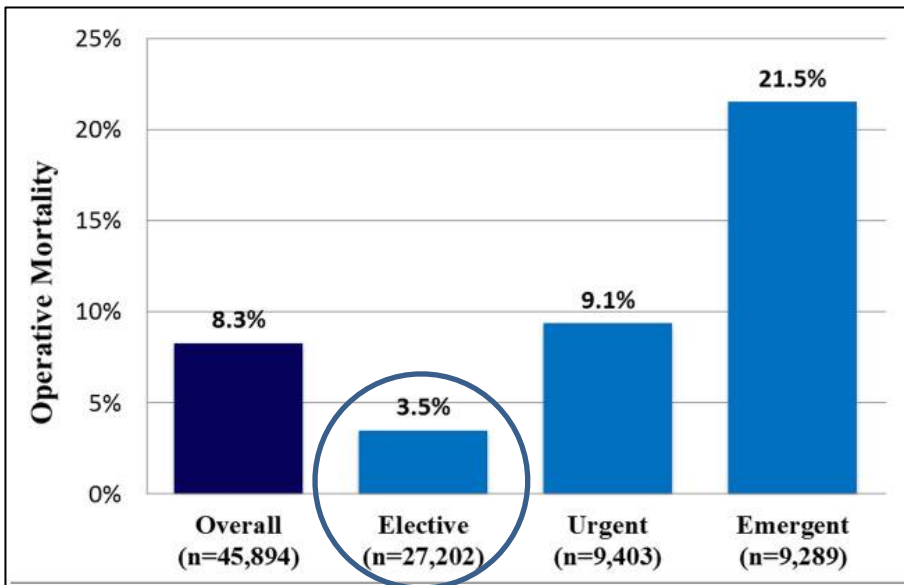
Not
Yet



Contemporary Results for Proximal Aortic Replacement in North America

Judson B. Williams, MD, MHS,*† Eric D. Peterson, MD, MPH,*‡ Yue Zhao, PhD,*
Sean M. O'Brien, PhD,* Nicholas D. Andersen, MD,†‡ D. Craig Miller, MD,§ Edward P. Chen, MD,||
G. Chad Hughes, MD†

Durham, North Carolina; Stanford, California; and Atlanta, Georgia



Current outcomes for ascending aorta and arch replacement are excellent for elective repair;

however

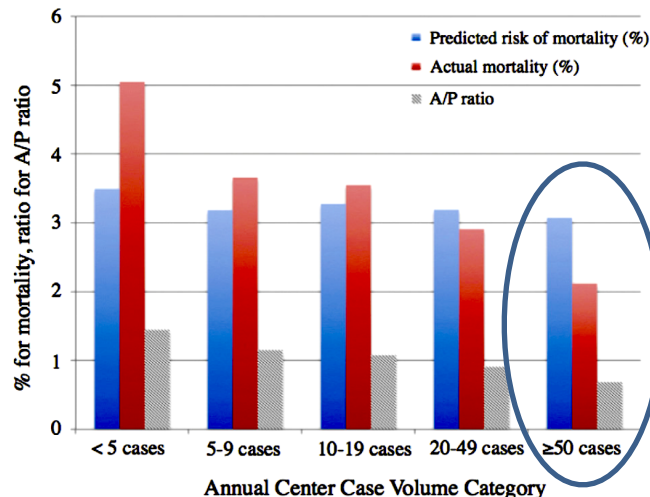
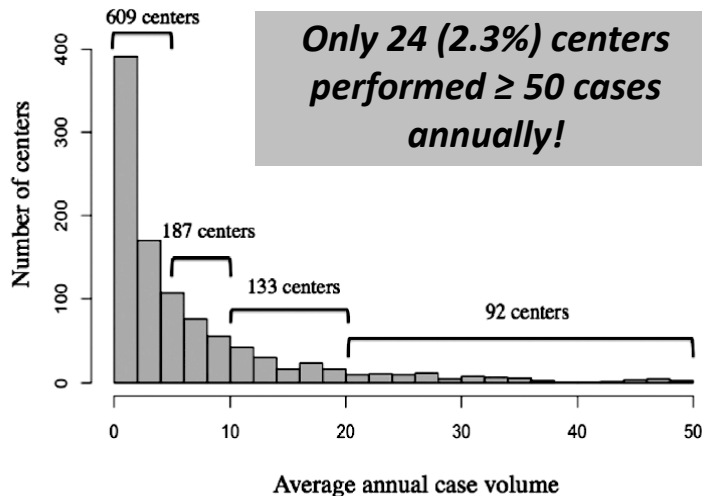
results deteriorate for non-elective status, suggesting that **increased screening and/or lowering thresholds** for elective intervention could potentially improve outcomes



Perioperative Risk Profiles and Volume-Outcome Relationships in Proximal Thoracic Aortic Surgery

Makoto Mori, MD, Kayoko Shioda, DVM, MPH, Xiaofei Wang, PhD, Abeel A. Mangi, MD, James J. Yun, MD, PhD, Umer Darr, MD, John A. Elefteriades, MD, and Arnar Geirsson, MD

Section of Cardiac Surgery, Yale School of Medicine, New Haven; Department of Epidemiology of Microbial Diseases, Yale School of Public Health, New Haven; and Department of Statistics and Data Science, Yale School of Graduate Arts and Sciences, New Haven, Connecticut

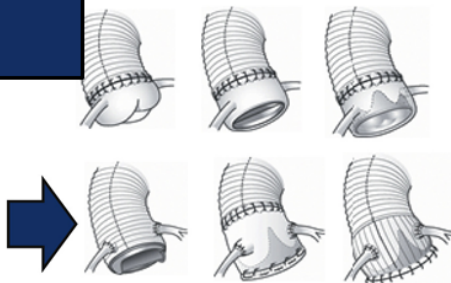


Excellent outcomes of elective proximal aortic repair

Mean age 63 ± 12 years (range 18-86 years)

Proximal aortic
operations
n = 1800

Excluding
Acute operations
Symptomatic patients
Redo procedures
Marfan



Ascending repl.
Bentall
Wheat
David

Death 0.9%

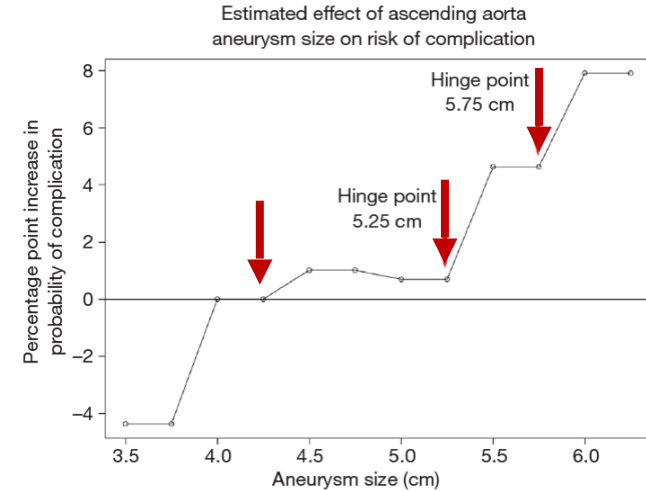
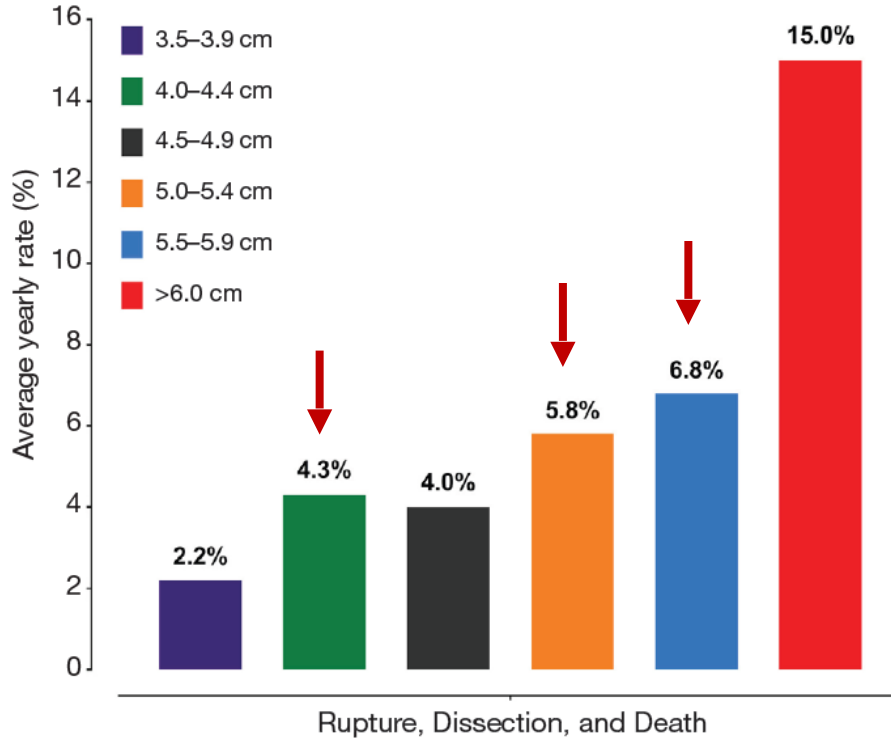
Stroke
0.4%

AKI 4.6%

More patients could
be considered for
prophylactic proximal
aortic surgery



Surgical replacement is indicated when the risk of spontaneous rupture or dissection surpasses the risk of significant complications associated with surgical intervention

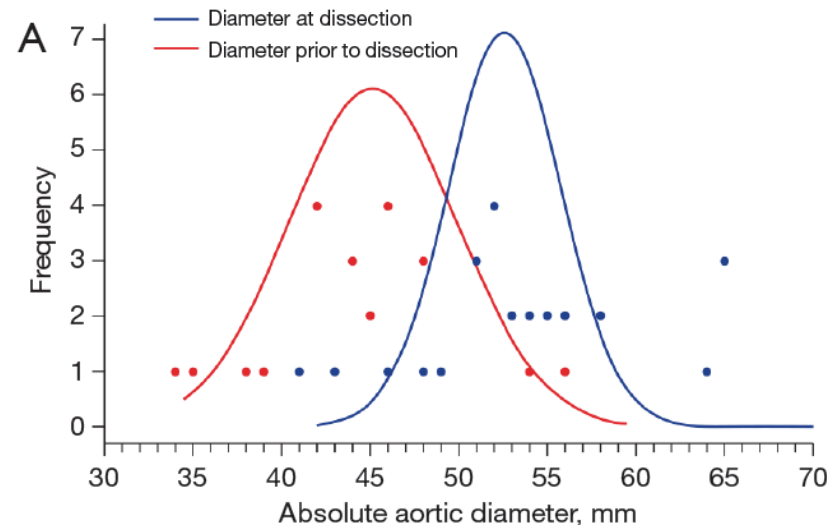
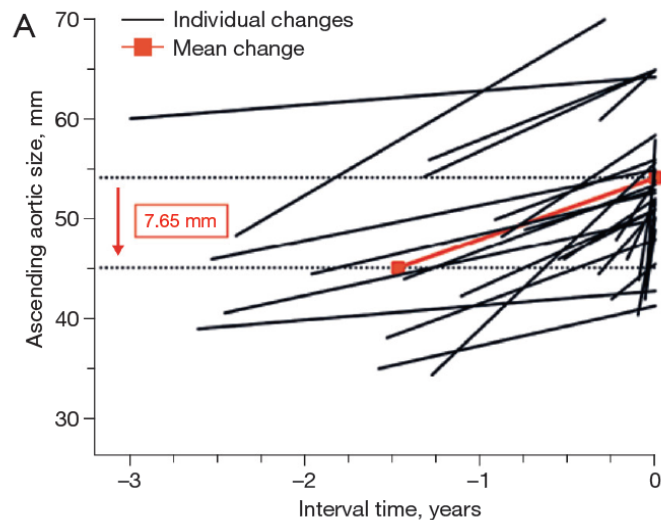


**More, rather than one,
“hinge points”**

Zafar MA, Li Y, Rizzo JA, et al. Height alone, rather than body surface area, suffices for risk estimation in ascending aortic aneurysm. JTCVS 2018;155:1938-50



?True aortic size just prior to the dissection?



Ascending aorta increases in size by approximately **7.65 mm** consequent to an acute type A dissection

Mansour AM, Peterss S, Zafar MA, et al. Prevention of Aortic Dissection Suggests a Diameter Shift to a Lower Aortic Size Threshold for Intervention. *Cardiology* 2018;139:139-46





55

52

50

45

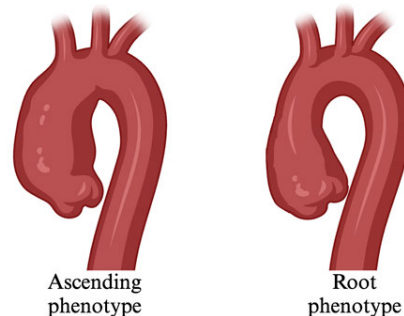
2024 Guidelines

Phenotype

Low-surgical-risk setting
Experienced Aortic Team

Shared decision with the Patient

- *patient's lifestyle*
- *occupation*
- *compliance with medical therapy and surveillance*
- *psychological aspects*



Recommendations	Class ^a	Level ^b
55 Surgery for an ascending aortic aneurysm located at the root or tubular tract, either with TAV or BAV, is recommended when the maximum aortic diameter is ≥ 55 mm.	I	B
50 Surgery for BAV-related aortopathy with 'root phenotype' is recommended when the maximum aortic diameter is ≥ 50 mm.	I	B
Surgery for TAV-associated aneurysms with 'root phenotype' should be considered when the maximum aortic diameter is ≥ 50 mm in a low-surgical-risk setting. ^d	IIa	B
52 In patients with low surgical risk ^e and 'ascending phenotype' dilatation, both with TAV and BAV, surgical treatment should be considered when the maximum aortic diameter is > 52 mm.	IIa	C

Marfan syndrome

50	In patients with Marfan syndrome, surgery on the aortic root or ascending aorta is recommended at a diameter of ≥ 50 mm.	I	B
45	In patients with Marfan syndrome and high-risk features,* surgery on the aortic root or ascending aorta should be considered at a diameter of ≥ 45 mm.	IIa	B



In patients with low surgical risk and 'ascending phenotype' BAV-related aortopathy, surgery should be considered at a maximum diameter ≥ 50 mm if any of the following is present:

- age <50 years
- short stature (<1.69 m)^f
- ascending aortic length >11 cm^g
- aortic diameter growth rate >3 mm/year
- family history of the acute aortic syndrome
- aortic coarctation
- refractory hypertension
- shared decision with the patient^h
- concomitant non-aortic valve cardiac surgery

IIa

C

In patients with non-syndromic TAV with 'ascending phenotype', in a low-surgical-risk setting,^d surgery may be considered at a maximum diameter ≥ 50 mm if any of the following is present:

- age <50 years
- short stature (<1.69 m)^f
- ascending aortic length >11 cm^g
- aortic diameter growth rate >3 mm/year
- refractory hypertension
- shared decision with the patient^h

IIb

C

Concomitant/associate surgery

Surgery for aortic dilatation in TAV patients undergoing non-aortic valve cardiac surgery should be considered at a root or ascending diameter ≥ 50 mm.		Ila	C
Surgery for aortic dilatation in patients undergoing aortic valve surgery should be considered at a root or ascending diameter ≥ 45 mm.	45	Ila	C
Surgery for aortic root dilatation in patients undergoing surgery for ascending aortic aneurysm should be considered at an aortic root diameter ≥ 45 mm.	45	Ila	C
In patients with young age, a family history of the acute type A aortic dissection or known HTAD who are undergoing ascending replacement, a lower threshold than 45 mm may be considered for concomitant root replacement on an individual basis.		Ilb	C



TAV

55

Recommendations for surgery in aortic root and ascending aorta dilatation associated with tricuspid aortic valve

Surgery is recommended in patients with dilatation of the aortic root or ascending aorta with a tricuspid aortic valve and a maximum diameter of ≥ 55 mm.

I

B

52

Recommendations for surgery in aortic root and ascending aorta dilatation associated with tricuspid aortic valve

In patients with dilatation of the tubular ascending aorta who can be offered surgery with low predicted risk, ascending aortic replacement should be considered at a maximum diameter > 52 mm.

IIa

B

45

In patients undergoing surgery for tricuspid aortic valve disease who have concomitant dilatation of the aortic root or ascending tubular aorta, and low predicted surgical risk, ascending aorta or root replacement should be considered at a maximum diameter ≥ 45 mm, otherwise ≥ 50 mm.

IIa

B

50

In patients undergoing non-aortic-valve cardiac surgery who have concomitant dilatation of the ascending aorta or aortic root with a maximum diameter ≥ 50 mm, concomitant aortic surgery should be considered.

IIa

C



BAV
HTDA

50

Recommendations for bicuspid aortic valve-associated aortopathy management

Surgery for bicuspid aortopathy of the root phenotype is recommended when the maximum aortic diameter is ≥ 50 mm.

I

B

50

Recommendations for aortic surgery in Marfan syndrome

Surgery is indicated in patients with MFS who have aortic root disease with a maximal aortic sinus diameter ≥ 50 mm.

I

B





ESC

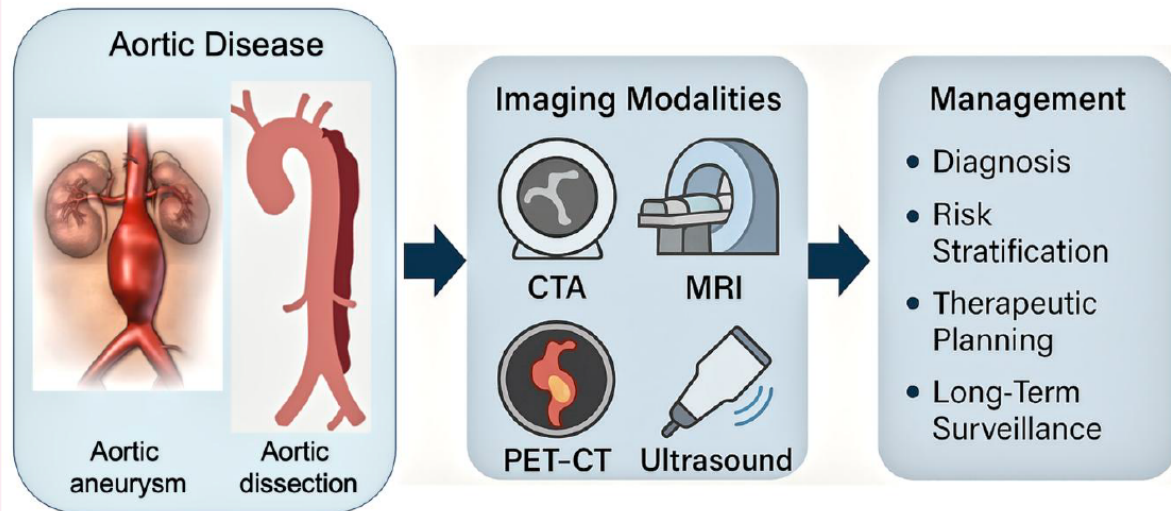
European Society
of Cardiology

European Heart Journal - Imaging Methods and Practice (2025) 3, qyaf108
<https://doi.org/10.1093/ehjimp/qyaf108>

INVITED REVIEW

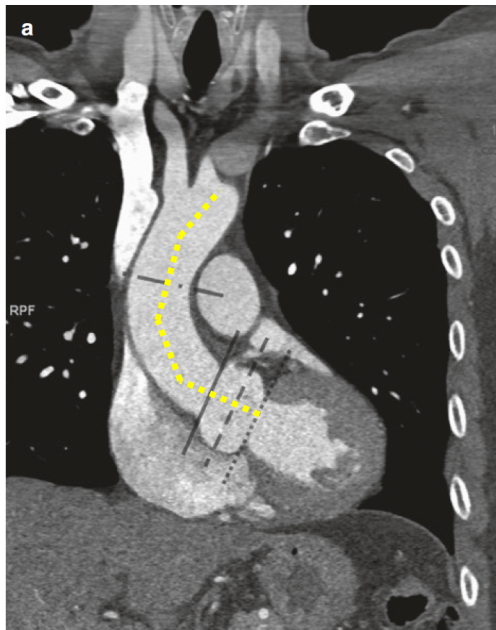
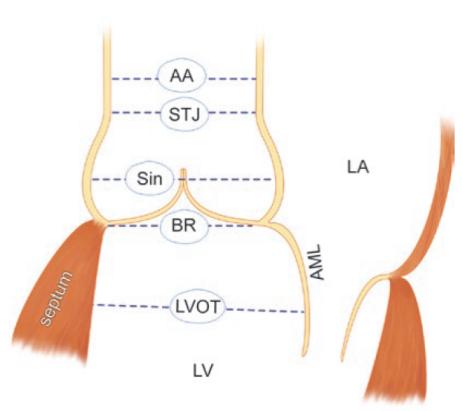
Graphical Abstract

Aorta Unveiled: The Crucial Role of Imaging in Diagnosing and Managing Aortic Disease



Diameters and measurements for gauging of the aortic root

CCT is recommended to assess the maximum diameter at 4 levels, as in echo



It is recommended to measure diameters using the **inner-inner-edge technique** at **end diastole**

on the strictly **orthogonal plane to the centerline** orientated to the axis of blood flow of the corresponding segment.

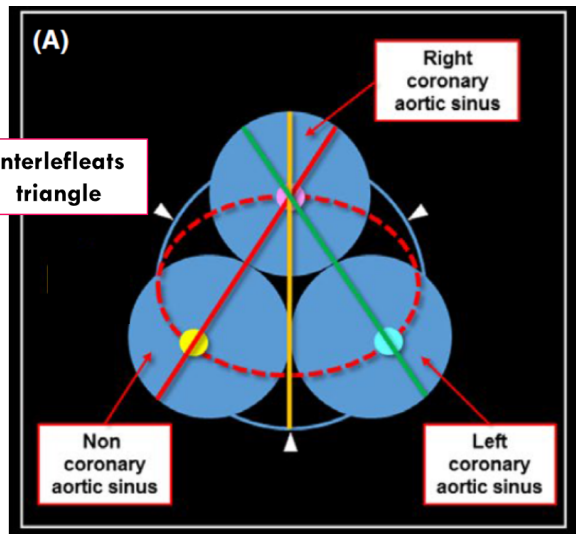


Multiplanar reformats



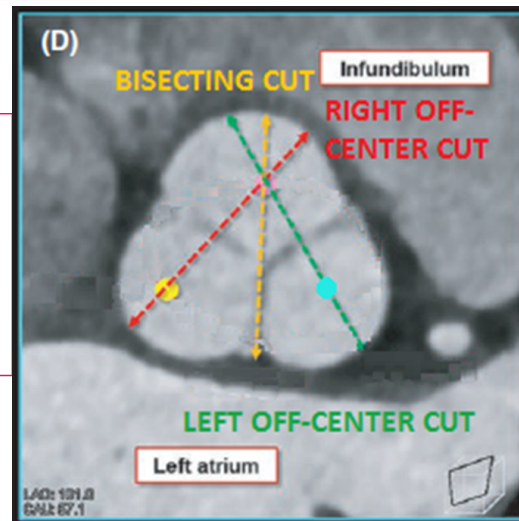
The differences between bisecting and off-center cuts of the aortic root: The three-dimensional anatomy of the aortic root reconstructed from the living heart

Shumpei Mori MD, PhD¹ | Robert H. Anderson BSc, MD, FRCPath² | Natsuko Tahara MD¹ | Yu Izawa MD¹ | Takayoshi Toba MD¹ | Sei Fujiwara MD, PhD¹ | Shinsuke Shimoyama MD³ | Yoshiaki Watanabe MD³ | Tatsuya Nishii MD, PhD³ | Atsushi K. Kono MD, PhD³ | Satoru Takahashi MD, PhD³ | Ken-ichi Hirata MD, PhD¹



Red dotted ellipse indicates the virtual basal ring (nadirs of semilunar hingelines)

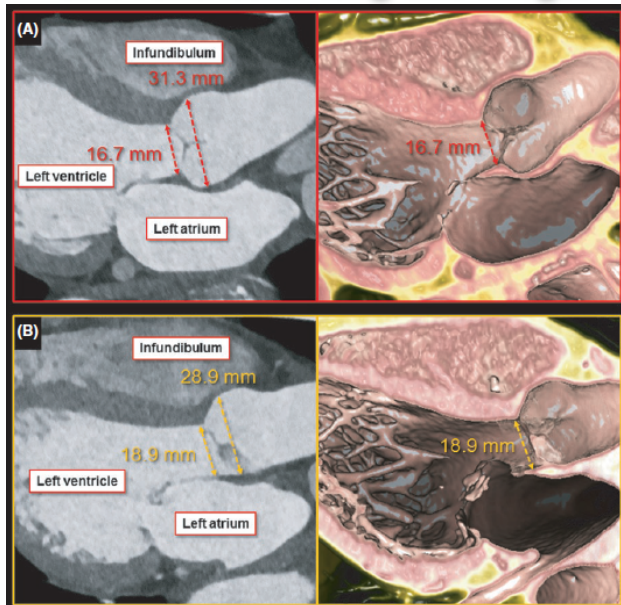
Yellow>BISECTING CUT
Red>RIGHT-OFF CENTER CUT
Green>LEFT-OFF CENTER CUT



Echocardiography. 2017 Mar;34(3):453-461



Left ventricular long-axis images



Right off-center cut

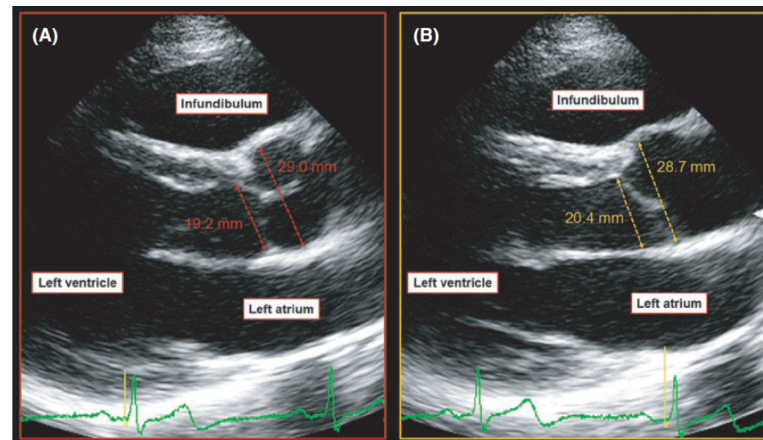
Bisecting cut

Maximum root diameter should be taken from **sinus-to-sinus diameter** rather than sinus-to-commissure diameter, as it correlates more closely to long-axis leading-edge-to-leading-edge echo maximum diameters (ESC guidelines)

Sinus of Valsalva diameter (mm)

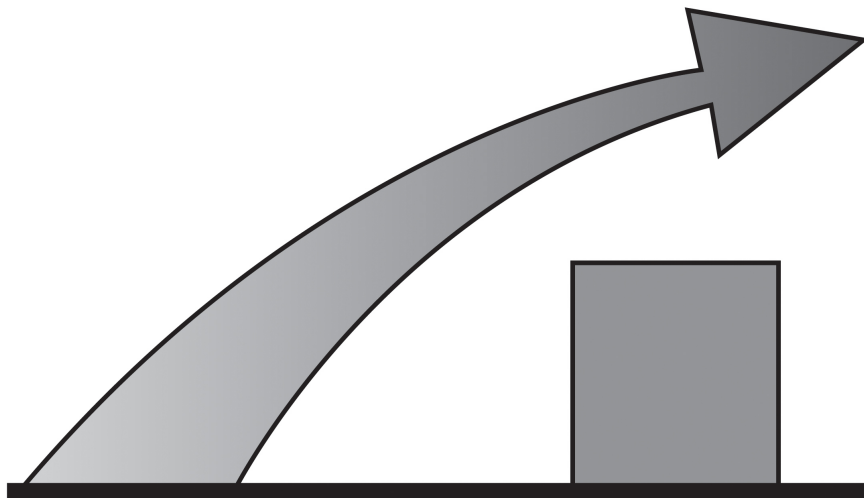
Bisecting cut	30.4 ± 3.7
Right off-center cut	33.6 ± 4.0
Left off-center cut	33.2 ± 4.3

This study shows the diameters of the sinuses of Valsalva to be, in general, **a mean of 2 mm larger when measured using off-center cuts**, in particular the right off-center cut which corresponds to the echocardiographic diameter (RC-NC)



Echocardiography. 2017 Mar;34(3):453-461





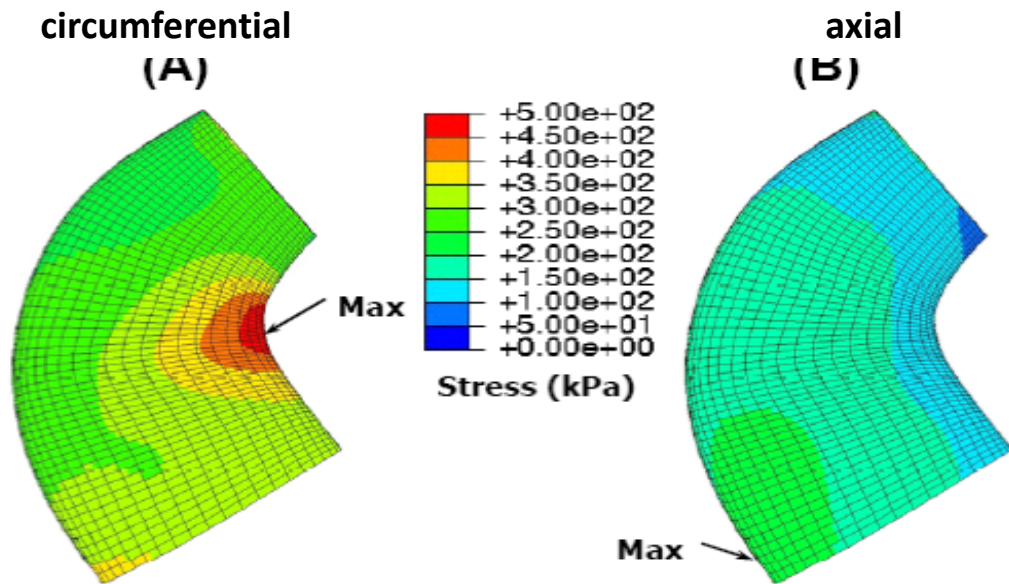
Review Article on Thoracic Surgery

J Vis Surg 2018;4:124

“Getting beyond diameter”: when to replace the aorta?

Maryam Tanweer¹, Mohammad A. Zafar¹, Ayman Saeyeldin¹, Anton A. Gryaznov^{1,2}, Alexander J. Puddifant¹, Young Erben³, Bulat A. Ziganshin^{1,4}, John A. Elefteriades¹



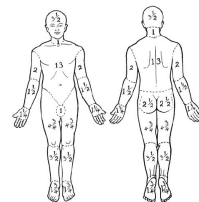


The curvature of dilated ascending aorta causes substantial variations in stress component magnitudes and may be important in determining the risk of rupture or dissection



Indexed values

- **Aortic diameter and BSA (aortic size index)**



- **AHI (aortic size indexed to the height of a patient)**



- **Aortic Cross-Sectional Area/Height Ratio**



Aortic diameter and BSA (aortic size index ASI)

Davies RR. Ann Thorac Surg 2006;81:169-177

Table 5. Risk of Complications by Aortic Diameter and Body Surface Area With Aortic Size Index Given Within Chart

	Aortic Size (cm)									
	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
BSA										
1.30	2.69	3.08	3.46	3.85	4.23	4.62	5.00	5.38	5.77	6.15
1.40	2.50	2.86	3.21	3.57	3.93	4.29	4.64	5.00	5.36	5.71
1.50	2.33	2.67	3.00	3.33	3.67	4.00	4.33	4.67	5.00	5.33
1.60	2.19	2.50	2.80	3.13	3.44	3.75	4.06	4.38	4.69	5.00
1.70	2.05	2.35	2.65	2.94	3.24	3.53	3.82	4.12	4.41	4.71
1.80	1.94	2.22	2.50	2.78	3.06	3.33	3.61	3.89	4.17	4.44
1.90	1.84	2.11	2.37	2.63	2.89	3.16	3.42	3.68	3.95	4.22
2.00	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00
2.10	1.67	1.90	2.14	2.38	2.62	2.86	3.10	3.33	3.57	3.80
2.20	1.59	1.82	2.05	2.27	2.50	2.72	2.95	3.18	3.41	3.64
2.30	1.52	1.74	1.96	2.17	2.39	2.61	2.83	3.04	3.26	3.48
2.40	1.46	1.67	1.88	2.08	2.29	2.50	2.71	2.92	3.13	3.33
2.50	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20

□ = low risk (~1% per yr);

■ = moderate risk (~8% per yr);

■ = severe risk (~20% per yr).

White area indicates low risk, light gray area indicates moderate risk, and dark gray area indicates severe risk.

BSA = body surface area.

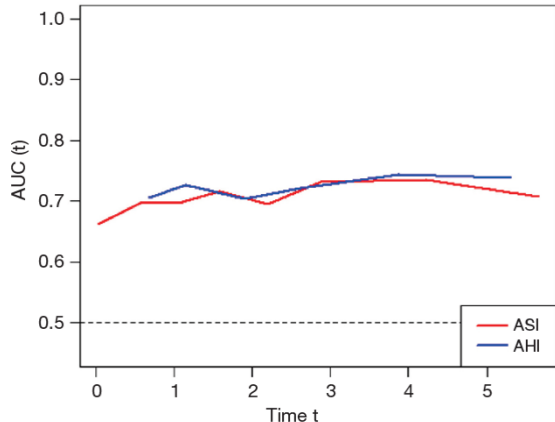
Greater than 2.75 cm/m² in the moderate risk zone



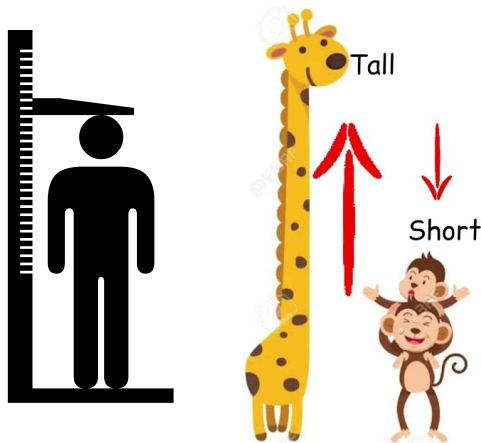
AHI (aortic size indexed to the height of a patient)

Zafar MA, Li Y, Rizzo JA, et al. Height alone, rather than body surface area, suffices for risk estimation in ascending aortic aneurysm. J Thorac Cardiovasc Surg 2018;155:1938-50.

AUC for ASI/AHI in predicting rupture, dissection, death



Height is largely genetically predetermined



		Aortic Size (cm)									
		3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
Height (inches)	Height (m)										
55	1.40	2.50	2.86	3.21	3.57	3.93	4.29	4.64	5.00	5.36	5.71
57	1.45	2.41	2.76	3.10	3.45	3.79	4.14	4.48	4.83	5.17	5.52
59	1.50	2.33	2.67	3.00	3.33	3.67	4.00	4.33	4.67	5.00	5.33
61	1.55	2.26	2.58	2.90	3.23	3.55	3.87	4.19	4.52	4.84	5.16
63	1.60	2.19	2.50	2.81	3.13	3.44	3.75	4.06	4.38	4.69	5.00
65	1.65	2.12	2.42	2.73	3.03	3.33	3.64	3.94	4.24	4.55	4.85
67	1.70	2.06	2.35	2.65	2.94	3.24	3.53	3.82	4.12	4.41	4.71
69	1.75	2.00	2.29	2.57	2.86	3.14	3.43	3.71	4.00	4.29	4.57
71	1.80	1.94	2.22	2.50	2.78	3.06	3.33	3.61	3.89	4.17	4.44
73	1.85	1.89	2.16	2.43	2.70	2.97	3.24	3.51	3.78	4.05	4.32
75	1.90	1.84	2.11	2.37	2.63	2.89	3.16	3.42	3.68	3.95	4.21
77	1.95	1.79	2.05	2.31	2.56	2.82	3.08	3.33	3.59	3.85	4.10
79	2.00	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00
81	2.05	1.71	1.95	2.20	2.44	2.68	2.93	3.17	3.41	3.66	3.90

Light green = low risk (~ 4% per year)
 Yellow = moderate risk (~ 7% per year)
 Orange = High risk (~ 12% per year)
 Red = severe risk (~ 18% per year)

Light green area indicates low risk, yellow area indicates moderate risk, orange area indicates high risk, and red area indicates severe risk.

Moderate-risk category with an AHI of 2.44 cm/m



Relationship of aortic cross-sectional area to height ratio and the risk of aortic dissection in patients with bicuspid aortic valves

Lars G. Svensson, MD, PhD,^{a,b} Kyung-Hwan Kim, MD,^{a,b} Bruce W. Lytle, MD,^{a,b} and Delos M. Cosgrove, MD,^{a,b}
Cleveland, Ohio

Surgery > 10

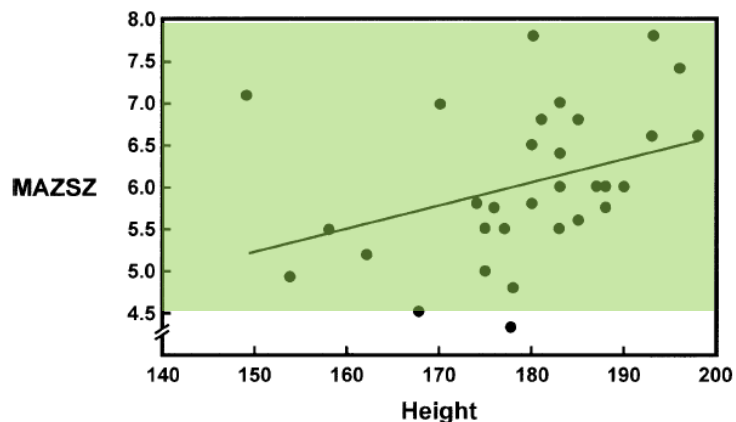


Figure 1. Relationship between aortic cross-sectional diameter and height at the size at which the aortic dissection was noted. *MAZSZ*, Maximum aortic size.

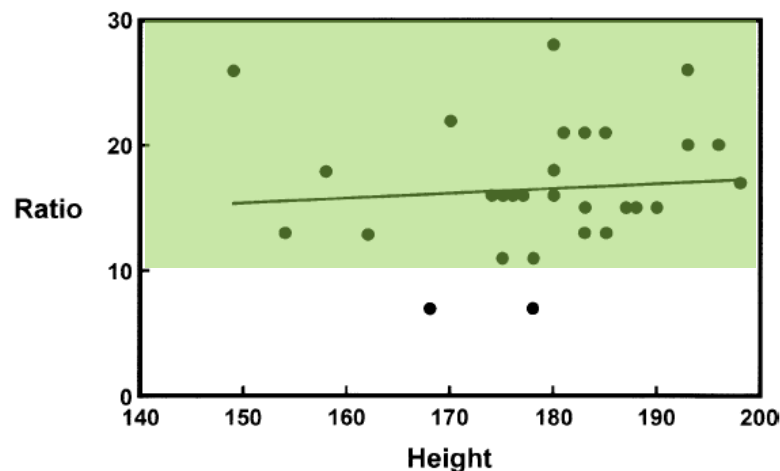


Figure 2. Relationship between ratio and height.

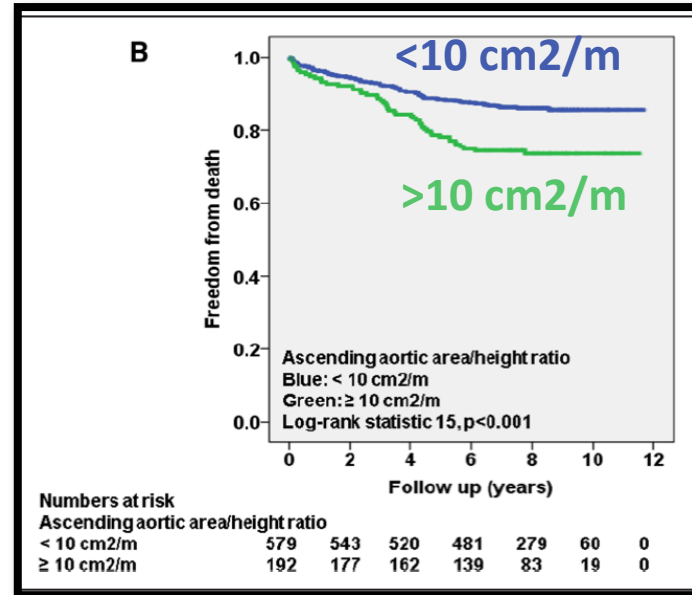
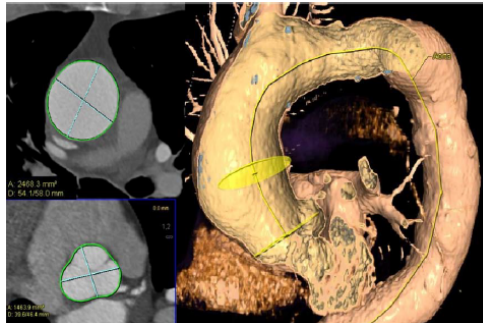


Aortic Cross-Sectional Area/Height Ratio and Outcomes in Patients With a Trileaflet Aortic Valve and a Dilated Aorta

Circulation. 2016;134:1724–1737. DOI: 10.1161/CIRCULATIONAHA.116.022995

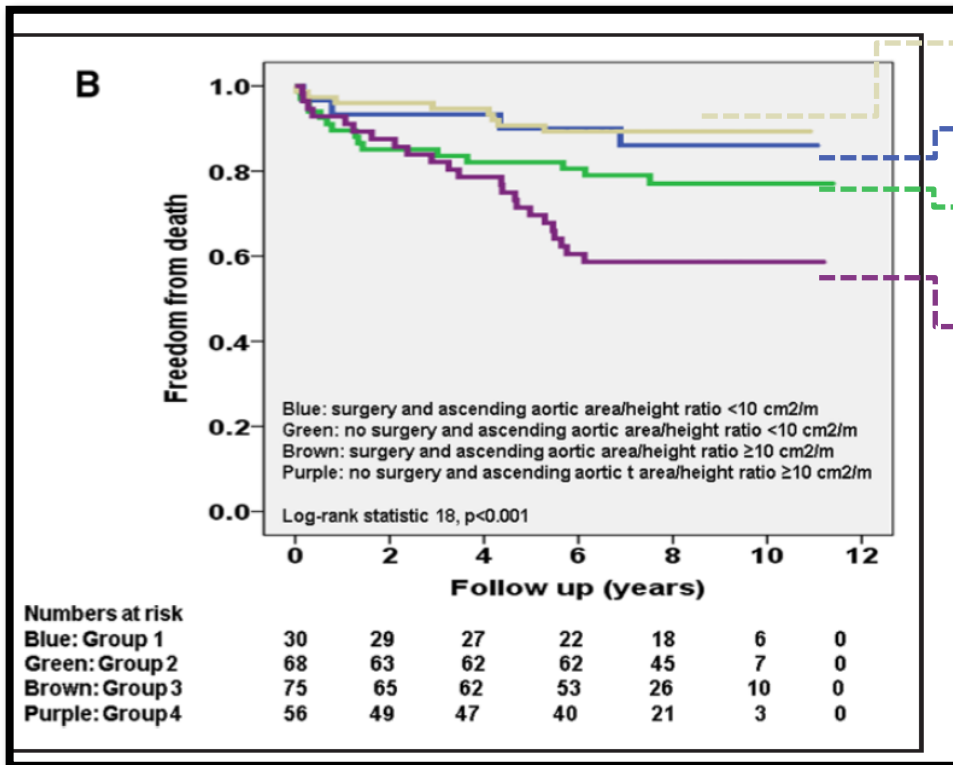
Almost half of patients not meeting the surgery criterion of aortic diameter of ≥ 5.5 cm had an abnormally high aortic root area/height ratio

Ascending aortic area/
height ratio



Survival curves of the subgroup with aortic root between 4.5 to 5.5 cm, divided into 4 subgroups

Circulation. 2016;134:1724–1737. DOI: 10.1161/CIRCULATIONAHA.116.022995



Surgery $> 10 \text{ cm}^2/\text{m}$

Surgery $< 10 \text{ cm}^2/\text{m}$

No surgery $< 10 \text{ cm}^2/\text{m}$

No surgery $> 10 \text{ cm}^2/\text{m}$



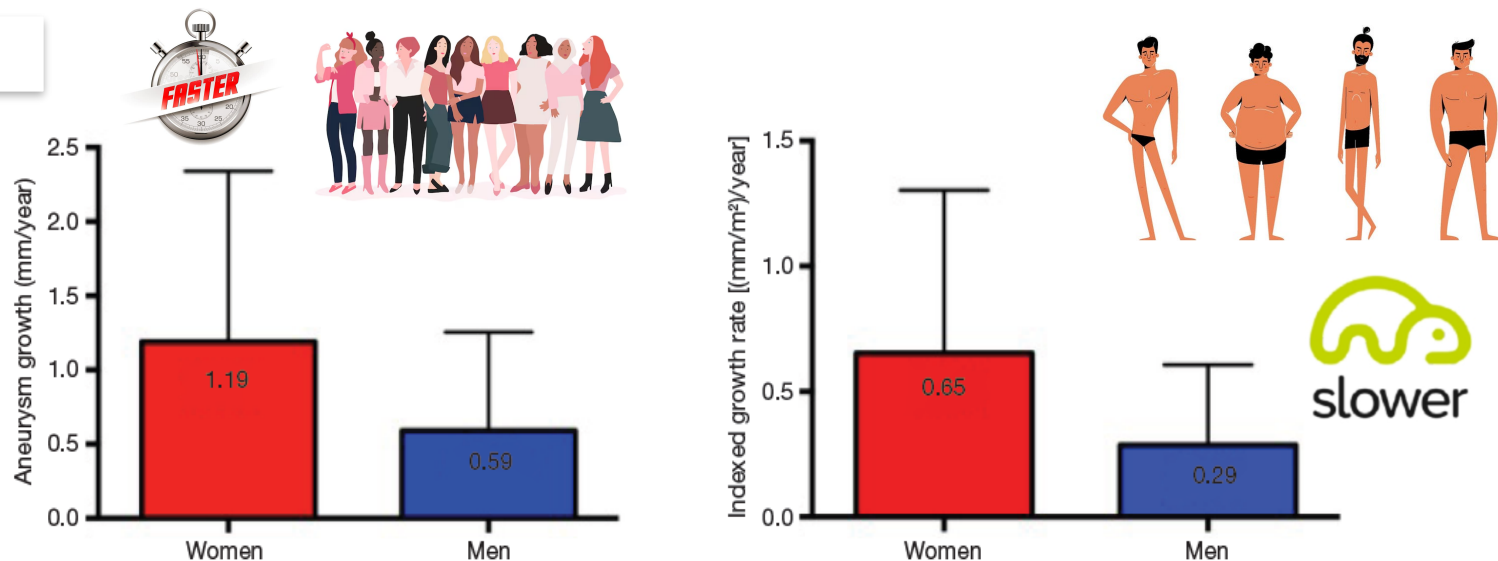
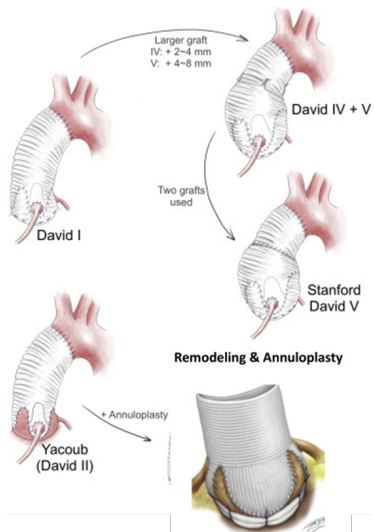


Figure 8 Aneurysm growth rates in men and women. Absolute (left) and indexed (right) aneurysm growth rates were over twice as fast in women as in men. Reprinted with permission from: Cheung K, Boodhwani M, Chan KL, *et al.* (15).

J Vis Surg 2018;4:124





Aortic root			
Decreasing order of prevalence/use	Pathologies	Imaging	Treatment
↓	• HTAD • Idiopathic MD • BAV • Iatrogenic injury	• TTE • TOE • CT • MRI	• Surgical

SURGICAL STRATEGY





Techniques

Valve-sparing aortic root replacement is recommended in patients with aortic root dilatation if performed in experienced centres and durable results are expected.

I

B

Recommendations for aortic surgery in Marfan syndrome

Surgery to replace the aortic root and ascending aorta, using the valve-sparing surgery technique, is recommended in patients with MFS or related HTAD with aortic root dilatation when anatomical features of the valve allow its preservation and the surgeon has specific expertise.

I

B

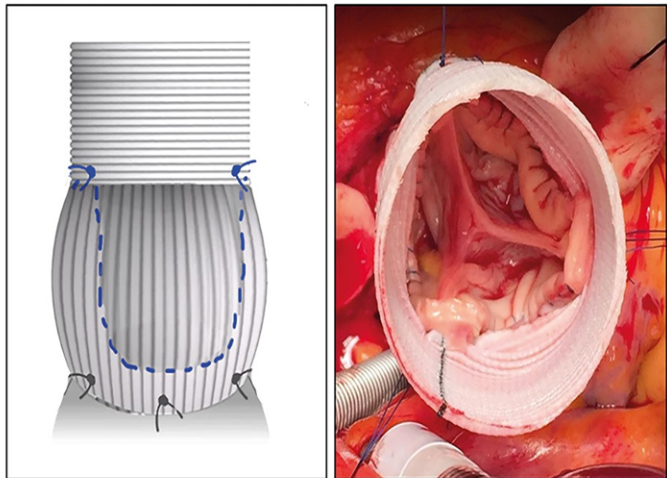
In patients with Marfan syndrome without high-risk features with a high likelihood of undergoing valve-sparing aortic root replacement and very low surgical risk, surgery on the aortic root or ascending aorta may be considered at a diameter of ≥ 45 mm when performed by an experienced aortic team.

IIb

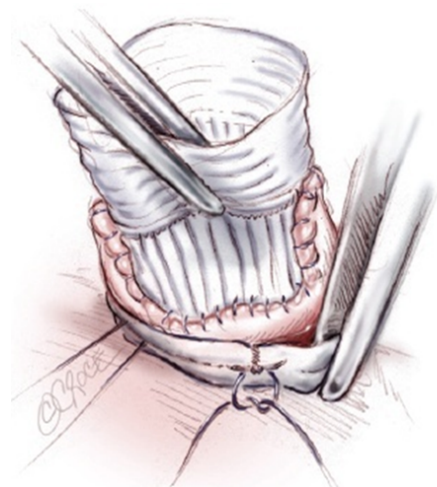
C



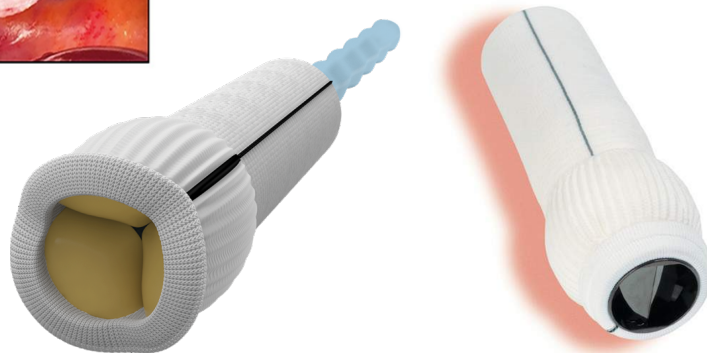
Reimplantation



Remodelling + annuloplasty



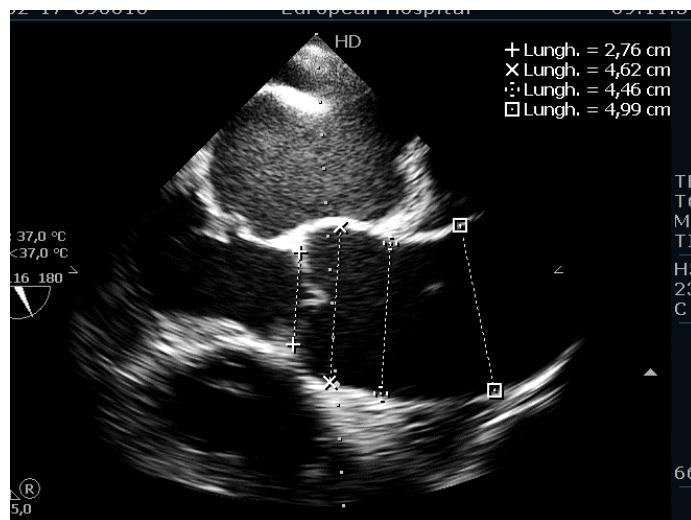
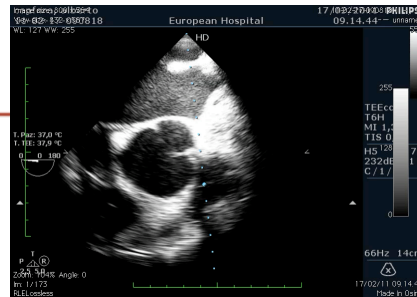
Bentall



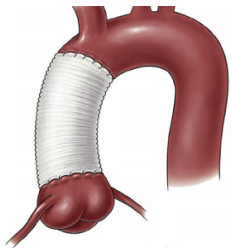
However (in 2011) what we did

- 67 years, low risk
- TAV, no regurgitation
- No annular dilatation
- Ascending phenotype
- Ascending aorta **50 mm**
- Aortic root **46 mm**

ASI 2.9
Svensson ratio 10



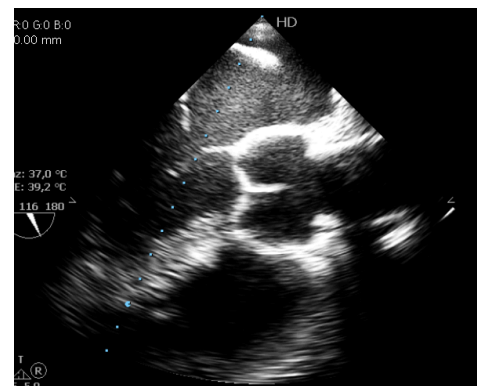
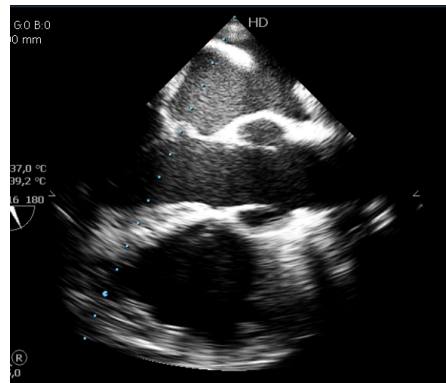
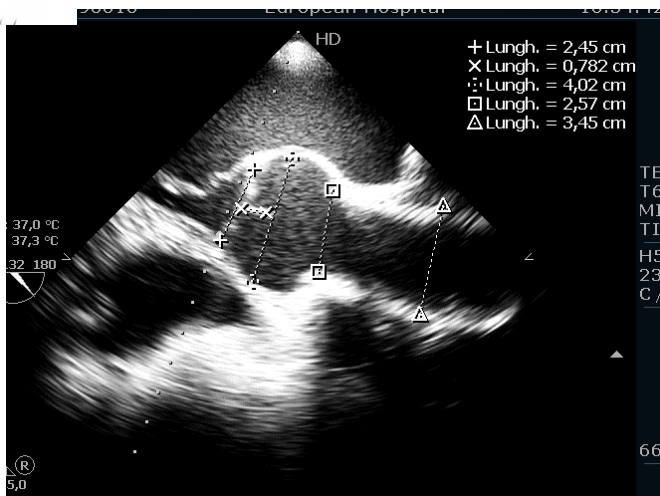
...less is more



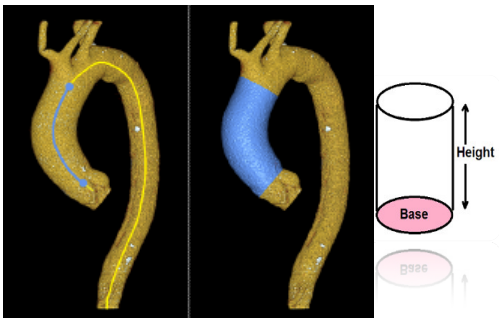
Supracoronary ascending
aortic replacement (graft 28 mm)



aortic root 40 mm



What to do



- **Specialized centers:** stronger call for multidisciplinary “aortic teams”
- carefully measure the aorta
- In young patients surgical thresholds may incorporate as well as **aortic length** and **phenotype** also **indexed values** (ASI, AHI, Svensson ratio)
- *Study on aortic histologic changes and aortic curvature might help in identifying patients at risk*



At centers with experienced surgeons, the threshold for surgical intervention could be lowered



What to do

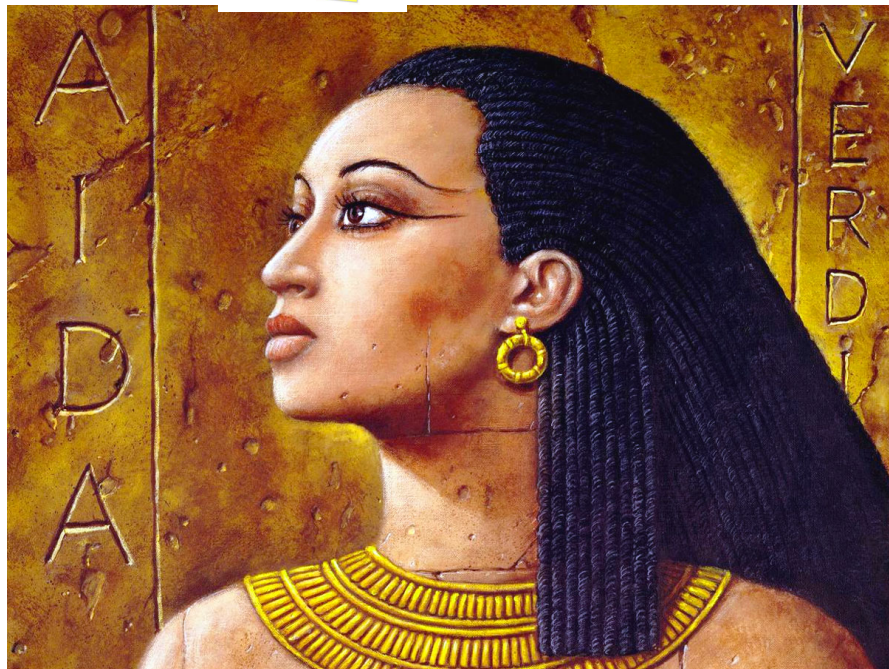


- **Valve-sparing aortic root replacement** is reasonable if the valve is suitable for repair and when performed by experienced surgeons in a Multidisciplinary Aortic Team
- **Elective preemptive surgery** at a small aortic root diameter increases the chance of receiving a valve sparing procedure
- *However, sometimes less is more*



Not
Yet

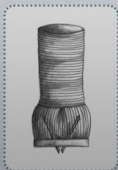
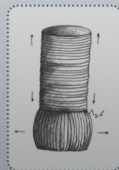
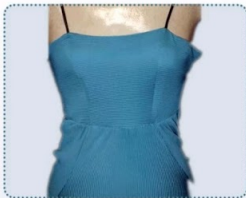
AIDA (Aortic International Database) score



- ☐ Age
- ☐ Sex
- ☐ Active lifestyle
- ☐ Desired pregnancy
- ☐ Height (cm)
- ☐ BSA (m2)
- ☐ HTN
- ☐ HTDA
- ☐ BAV
- ☐ TAV
- ☐ Root phe
- ☐ Ascending phe
- ☐ Aortic root (mm)
- ☐ ST junction (mm)
- ☐ Ascending (mm)
- ☐ Max aortic cross sectional area
- ☐ AD history
- ☐ Grow rate > 3mm/y
- ☐ Aortic length (cm)
- ☐ Aortic volume (ml)
- ☐ Euroscore II
- ☐ STS score
- ☐ Concomitant AV surgery
- ☐ Concomitant non AV surgery
- ☐ Surgeon/center expertise



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CELEBRATING TWENTY FIVE YEARS



145



THANK YOU

