70TH ESCVS CONGRESS & 7TH IMAD MEETING

The search for new imaging risk markers for acute type A aortic dissection: ascending aortic geometry

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70th ESCVS
7th IMAD meeting

70TH ESCVS CONGRESS & 7TH IMAD MEETING

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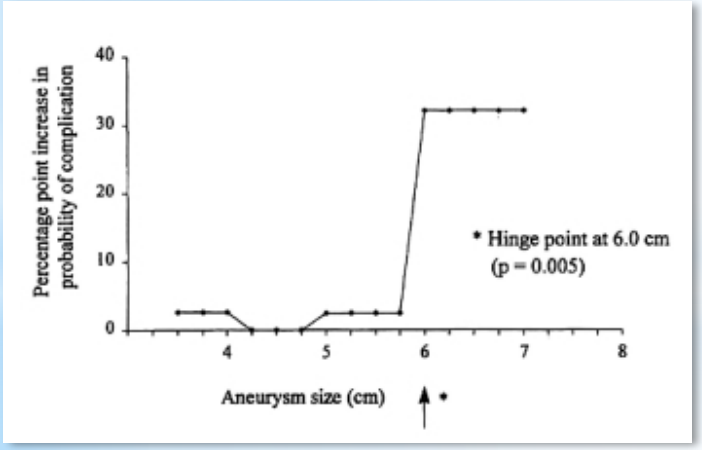
70th ESCVS
International congress of the European Society for Cardiovascular and Endovascular Surgery

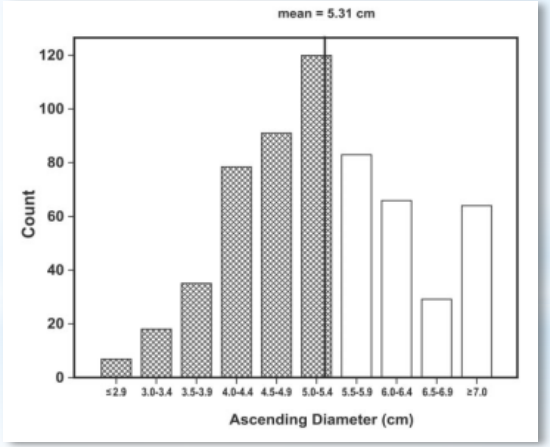
7th IMAD meeting

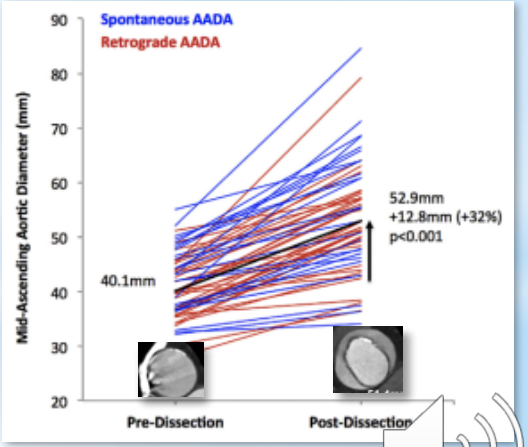
No conflict of interest

Can we improve prediction/prevention of ATAAD?

Limitations of the diameter criterion







Coady MA et al. JTCVS 1997

Pape L et al. Circulation 2007

Rylski B et al. JACC 2014

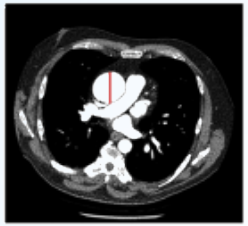
INVITED EXPERT OPINION

JTCVS 2020

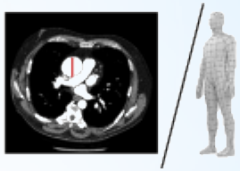
Aortic dimensions as predictors of adverse events

Leonard N. Girardi, MD, Christopher Lau, MD, and Ivancarmine Gambardella, MD

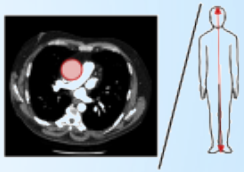
Parameter	Calculation	Recommended threshold for surgical intervention (without aortopathy)
Diameter	Diameter	5.5 cm
Aortic size index	Diameter/body surface area	>2.75 cm/m^2
Cross-sectional area index	Cross-sectional area/height	>10 cm^2/m
Aortic height index	Diameter/height	High risk >3.21 cm/m Severe risk >4.06 cm/m
Classical ascending aortic length	Length (sinotubular junction to innominate origin)	–
Extended ascending aortic length	Length (aortic annulus to innominate origin)	>11 cm
Aortic tortuosity index	Centerline distance/linear distance	–
Aortic volumetry	π[diameter/2]^2 × length	–



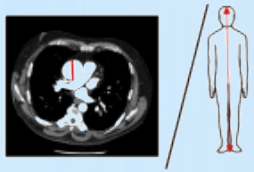
Diameter



Aortic size index = diameter/BSA



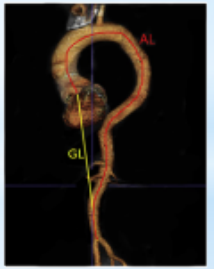
Cross-sectional area/height



Aortic height index= diameter/height

Classical ascending aortic length

Extended ascending aortic length



Aortic tortuosity index= aortic length/geometric length

Aortic volu ry

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Wu J et al.
JACC 2019

Ascending Aortic Length and Risk of Aortic Adverse Events

The Neglected Dimension

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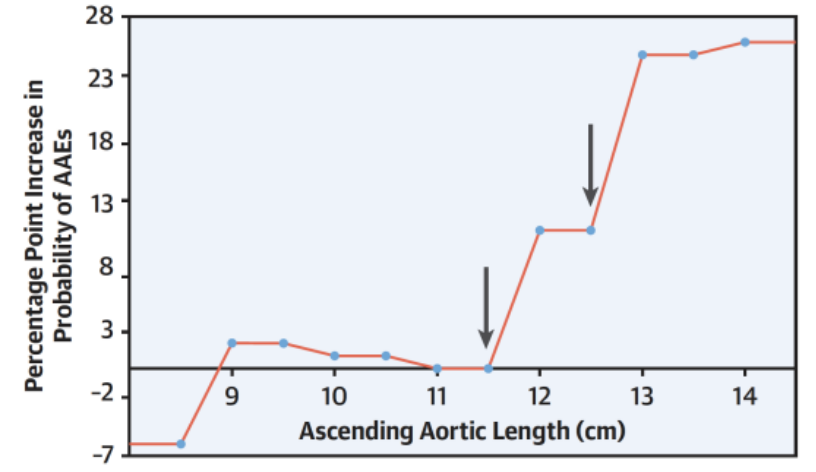
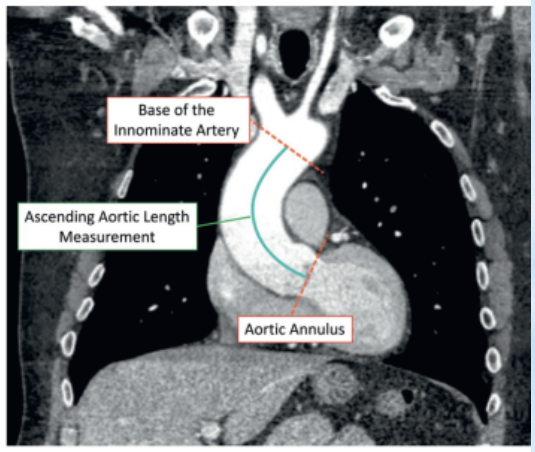
Note:
Most ATAAD intimal tears develop transversal to the aortic axis, suggesting mechanical failure of the tissue in the longitudinal direction

Thubrikar MJ, Agali P, Robicsek F. Wall stress as a possible mechanism for the development of transverse intimal tears in aortic dissections. J Med Eng Technol 1999;23:127–34



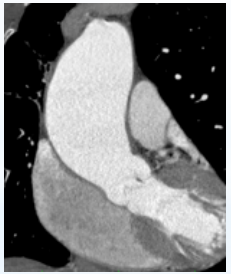


Hypothesis and Patient Population

- Elongation of the aorta can alter its geometry in different ways, in terms of **angulation of the 3 aortic segments** of root, mid-ascending, distal ascending/proximal arch
- All ECG-gated angio-CT scans of the aorta performed for routine practice between August 2018 and March 2020
- Excluded: arch and descending aneurysms or dissections, patients with previous cardiac surgery or EVG; jatrogenic ATAAD; age <18 or >89
- 180 patients overall - 3 groups:

79 pts

normal aorta (<45mm)



66 pts

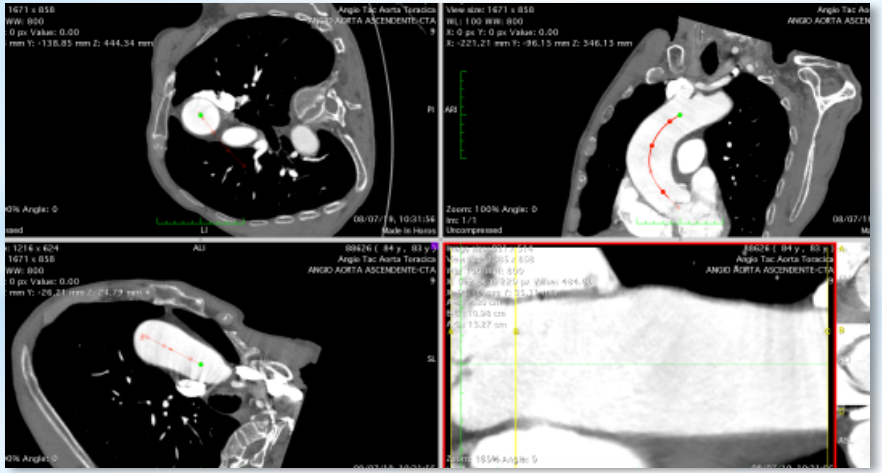
aneurysm

35 pts

ATAAD

Measurement Methods: diameters and lengths

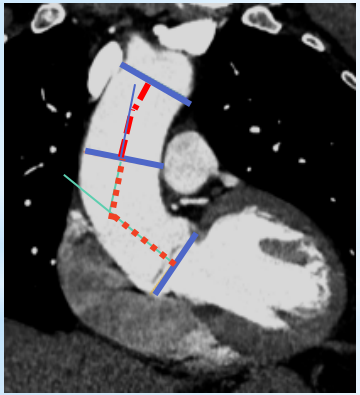
- Aortic diameters in multiplanar reconstruction (MPR) at the **root**, **STJ**, **mid-ascending** (at the centre of pulmonary trunk section), distal **ascending-arch transition** (at BCA take-off)
- Length of the **root** (from annular plane to STJ plane) and of the **tubular** ascending (from STJ plane to the take-off of the BCA) at the centreline in curved MPR*



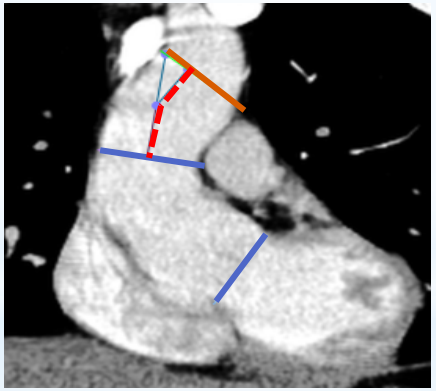
*Heuts S et al. Heart 2020

Measurement Methods: angulation

- Angles between the segments (root to mid-ascending, “Root-Asc angle”; mid-ascending to distal asc/proximal arch transition, “Asc-Arch angle”) were measured **in coronal view** using 2-D thick slab mode with volume rendering and Cobb’s Angle plug-in
- Intra- and inter-observer variability of duplicate angle measurements were verified in a small sample of pts by interclass correlation coefficient calculation and Bland-Altman plots



normal



aneurysm

ATAAD

= Root-Asc°

= Asc-Arch°

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ORIGINAL ARTICLE

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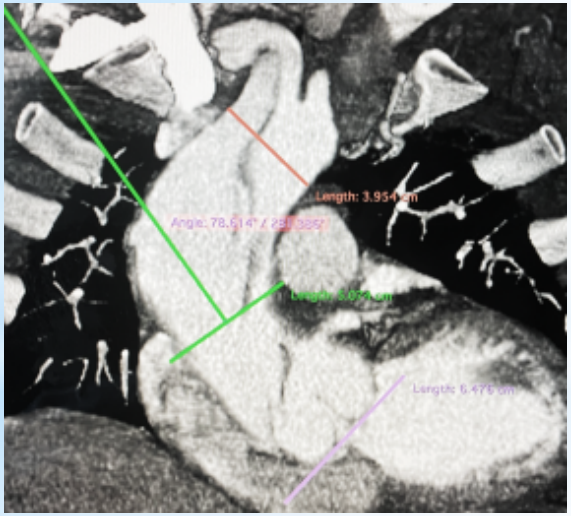
Implications of abnormal ascending aorta geometry for risk prediction of acute type A aortic dissection

Alessandro Della Corte, *Antonino Salvatore Rubino, Antonio Pio Montella, Ciro Bancone, Federica Lo Presti, Denise Galbiati, Giovanni Dialetto and Marisa De Feo

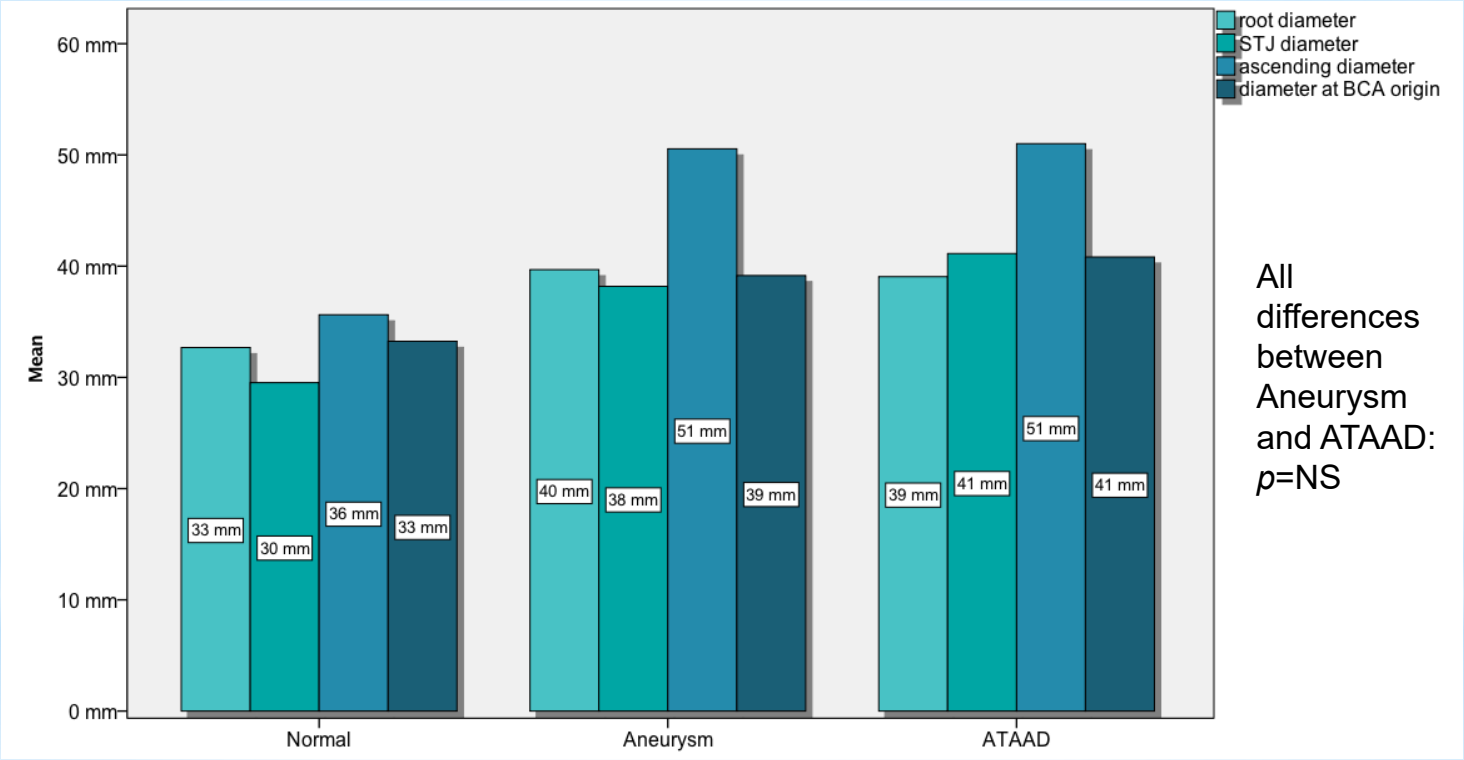
EJCTS 2021;60:978–986



Clinical characteristics

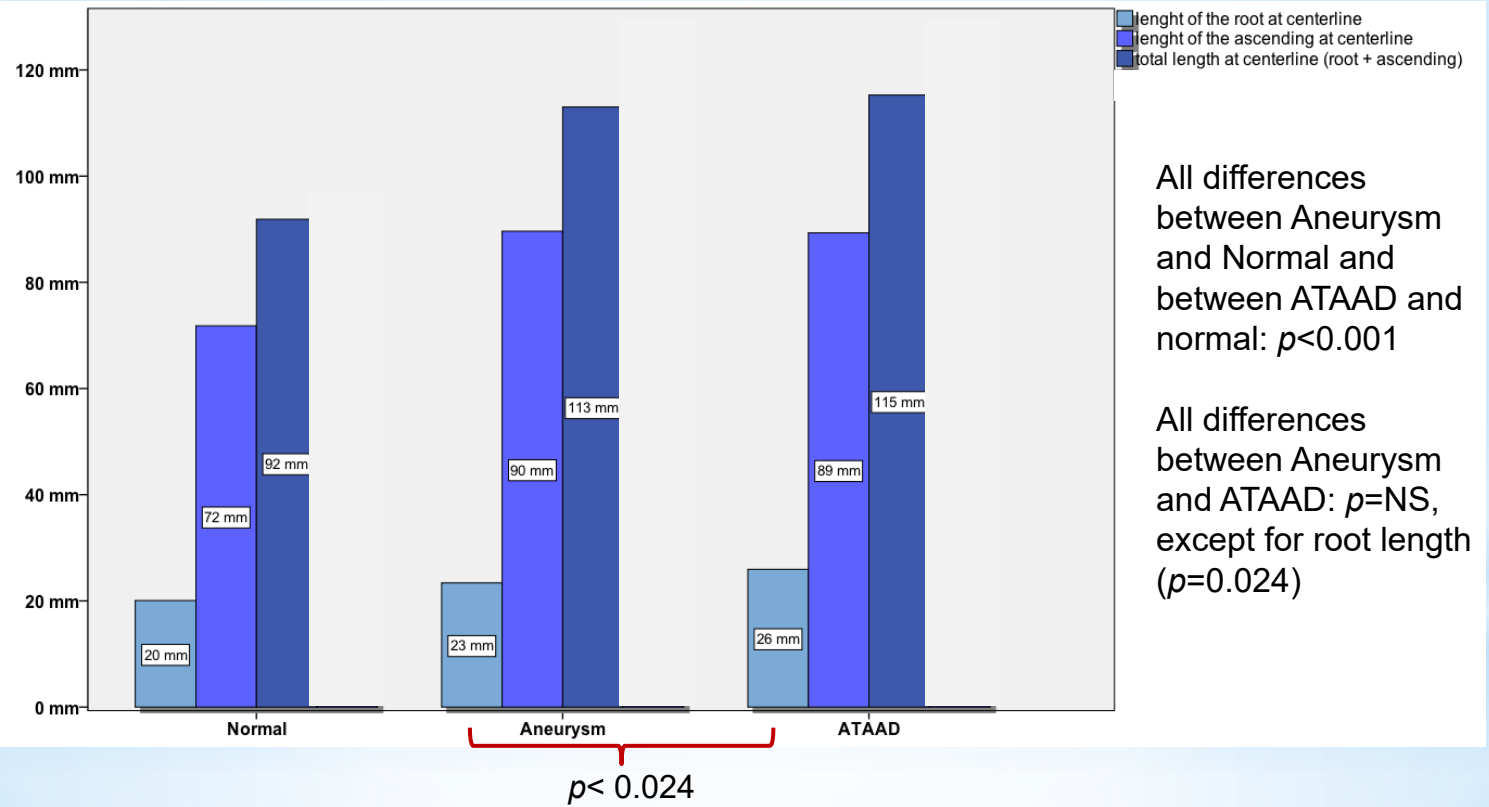
	Overall	Normal aorta	Aneurysm	ATAAD	*p* (ANOVA across the 3 groups)	*p* (T test Aneurysm vs ATAAD)
Age (yrs)	65 ± 13	69 ± 13	63 ± 13	62 ± 11	*0.005*	0.58
Sex (M)	68%	63%	73%	69%	0.48	0.81
Height (cm)	166 ± 16	164 ± 21	168 ± 11	172 ± 10	0.14	0.34
Weight (kg)	82 ± 23	83 ± 31	84 ± 21	77 ± 10	0.55	0.36
Hypertension	81%	73%	82%	94%	0.29	0.54
Bicuspid Aortic Valve	25%	20%	33%	20%	0.16	0.17
Bovine Arch	19%	16%	20%	23%	0.70	0.80
Root Phenotype*	15%	31%	12%	12%	0.23	0.60

Aortic diameters



All differences between Aneurysm and ATAAD: *p*=NS

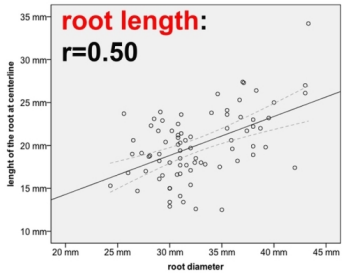
Aortic length

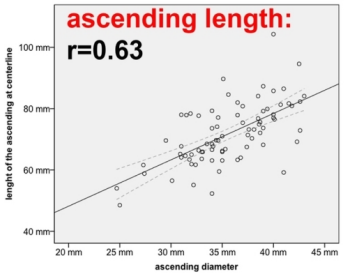


All differences between Aneurysm and Normal and between ATAAD and normal: $p<0.001$

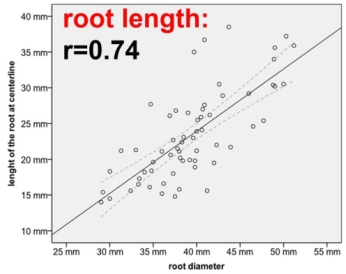
All differences between Aneurysm and ATAAD: p=NS, except for root length (p=0.024)

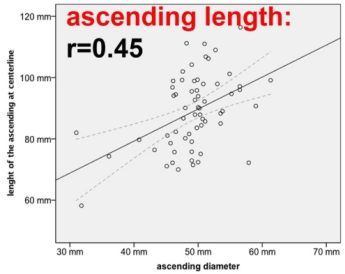
Normal Aorta



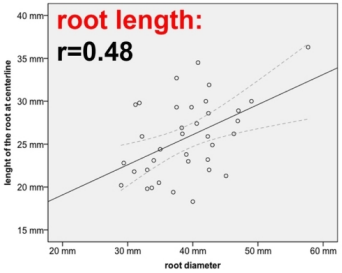


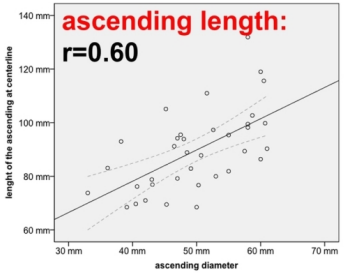
Aneurysm





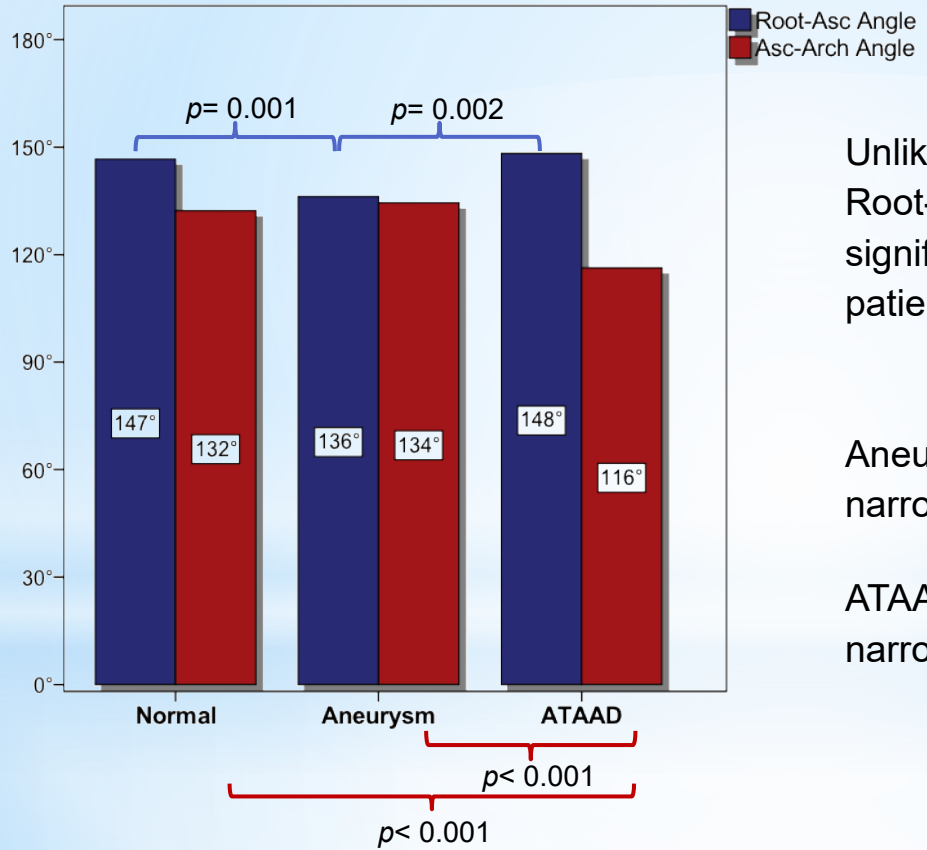
ATAAD





Measuring root length and ascending length separately seems justified also by the significant correlations that were found between each segment's length and diameter

Angulation of the aorta in aneurysms vs ATAADs

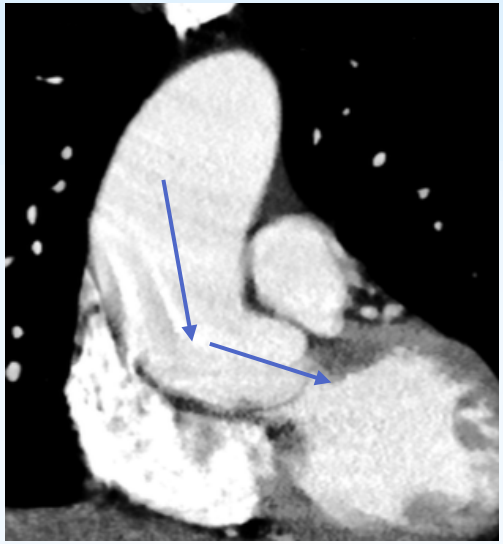


Unlike length measurements, the mean Root-Asc and Asc-Arch angles were significantly different between ATAAD patients and Aneurysm patients

Aneurysms were characterized by significant narrowing of the **Root-Asc°** alone

ATAADs were characterized by significant narrowing of the **Asc-Arch°** alone

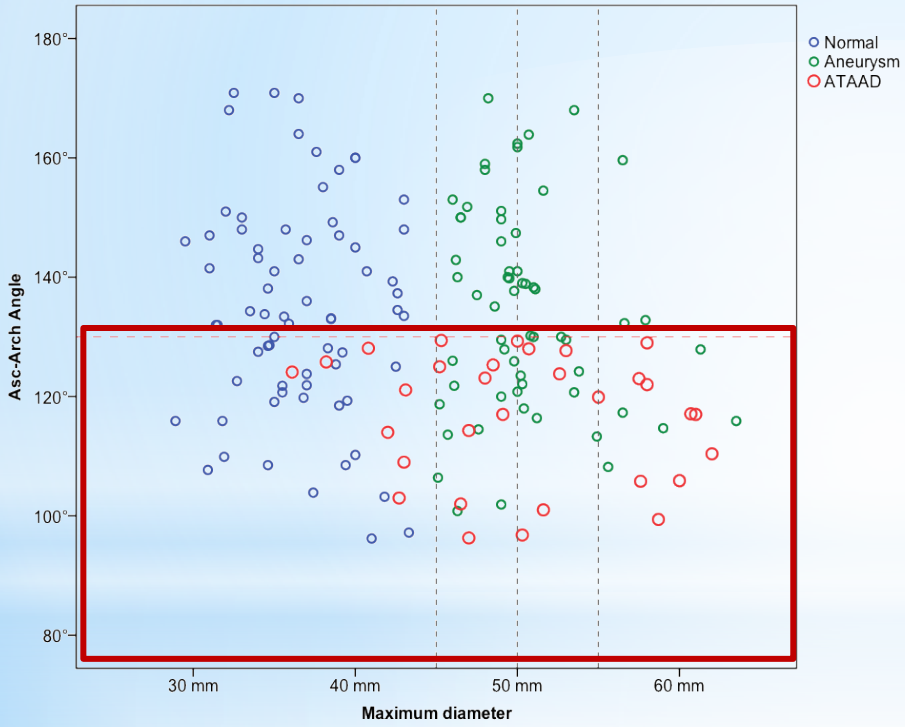
Typical geometry of elongated non-dilated **ageing** aorta



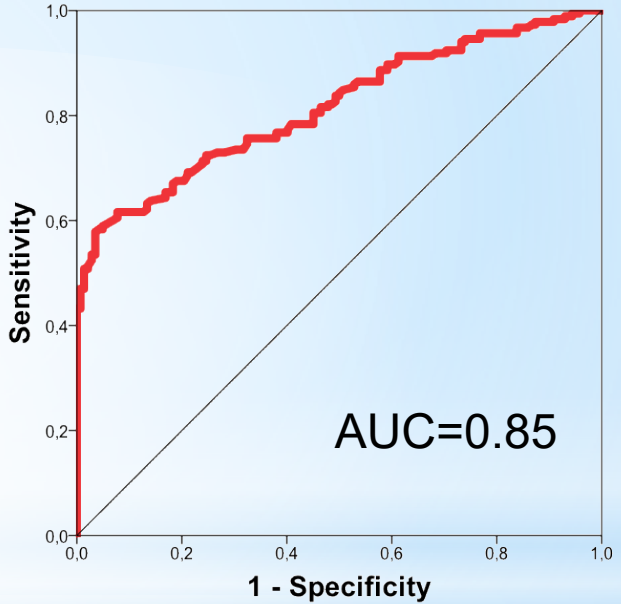
Typical geometry of elongated **aneurysmal** aorta, with narrowing of the Root-Asc angle

Typical geometry of elongated **dissected** aorta, with narrowing of the Asc-Arch angle

The cut-off of 130°



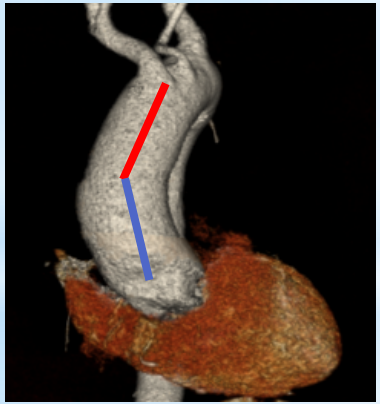
In a larger study population (n=354, including 157 ATAADs):



Youden test identified **131°** as the optimal cut-off for Asc-A h°
(sensitivity: 0.96, specificity: 0.58)

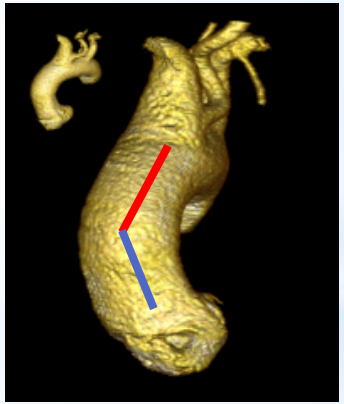
Focusing on the shape of aortic dilatation

- In the non-dissected aortas (n=145), an **Asc-Arch angle<130°**was associated with increased root length (24mm vs 20mm, p<0.001)
- In mildly to severely dilated aortas (114 pts with diameter >40mm): the root phenotype dilatation (both with TAV and BAV) was associated with significantly narrower **Asc-Arch angle** (118 vs 136 degrees) compared to the ascending phenotype

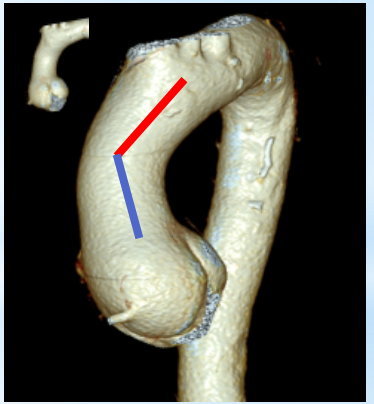


Ascending phenotype, ascending elongation AA angle= 142°

Ascending phenotype, no ascending elongation AA angle= 140°



Root phenotype, no root elongation AA angle= 126°



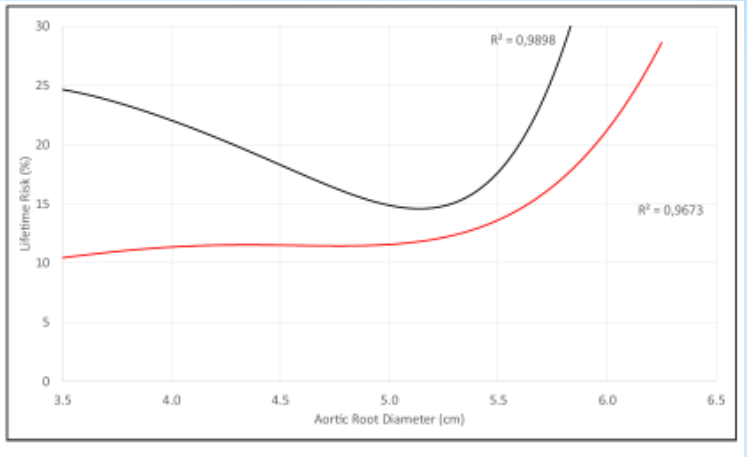
Root phenotype, root elongation AA angle= 120°

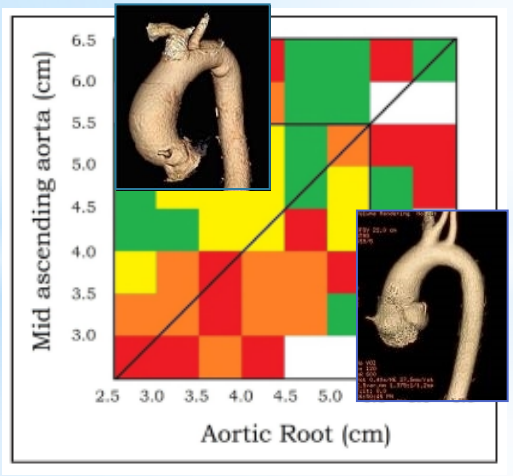
Journal of the American Heart Association **JAHA 2021**

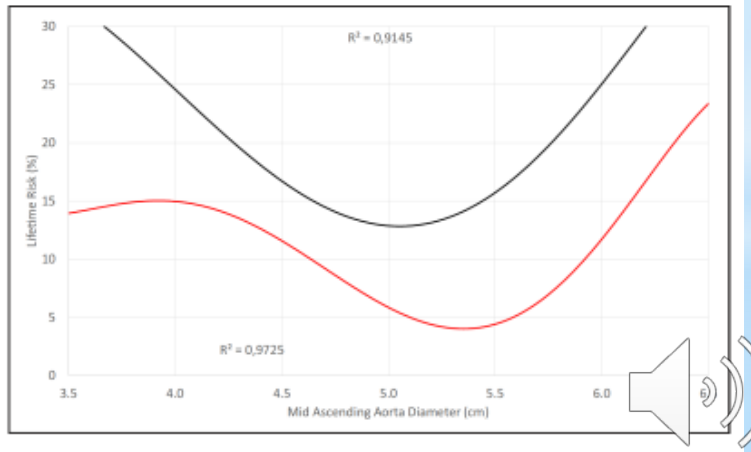
ORIGINAL RESEARCH

Root Dilatation Is More Malignant Than Ascending Aortic Dilation

Paris D. Kalogerakos, MD, PhD; Mohammad A. Zafar, MD; Yupeng Li, PhD; Sandip K. Mukherjee, MD; Bulat A. Ziganshin, MD, PhD; John A. Rizzo, PhD; John A. Elefteriades, MD, PhD (Hon)







Conclusions:

- The aorta undergoing elongation can present either increased root-to-ascending or ascending-to-arch angulation
- The Asc-Arch angle narrowing is associated with ATAAD
- In dilated aortas, increased root length, as observed in root phenotype dilatations, is associated with narrower Asc-Arch°
- The Asc-Arch angle might represent a morphological marker of the risk of ATAAD
- Being a very sensitive criterion, it could be used in combination with the diameter, which is more specific but less sensitive