Aorta
How to Deal with Different Multi-modality measurements?

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GUIDELINES AND STANDARDS

Multimodality Imaging of Diseases of the Thoracic Aorta in Adults: From the American Society of Echocardiography and the European Association of Cardiovascular Imaging

Endorsed by the Society of Cardiovascular Computed Tomography and Society for Cardiovascular Magnetic Resonance

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J Am Soc Echocardiogr 2015;28:119-82

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Circulation

2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM Diagnosis and Management of Patients With Thoracic Aortic Di American College of Cardiology Foundation/American Heart As Practice Guidelines, American Association for Thoracic Surgery Radiology, American Stroke Association, Society of Cardiovascu Society for Cardiovascular Angiography and Interventions, Soc Radiology, Society of Thoracic Surgeons, and Society for V

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European Journal of Echocardiography (2010) 11, 645–658 doi:10.1093/ejechocard/jeq056

RECOMMENDATIONS

Echocardiography in aortic diseases: EAE recommendations for clinical practice

Arturo Evangelista[1*], Frank A. Flachskampf[2], Raimund Erbel[3], Francesco Antonini-Canterin[4], Charalambos Vlachopoulos[5], Guido Rocchi[6], Rosa Sicari[7], Petros Nihoyannopoulos[8], and Jose Zamorano[9] on behalf of the European Association of Echocardiography

Circulation

JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association

2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines

Rick A. Nishimura, Catherine M. Otto, Robert O. Bonow, Blase A. Carabello, John P. Erwin III, Robert A. Guyton, Patrick T. O'Gara, Carlos E. Ruiz, Nikolaos J. Skubas, Paul Sorajja, Thoralf M. Sundt III and James D. Thomas

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Thoracic Aortic Aneurysm

- Responsible for 2000 deaths/yr in the US.
- Is the result of degeneration of the extracellular matrix in the media (elastic and collagen fibers)
- Caused by
  - Hypertension
  - Trauma
  - Inflammatory Diseases
  - Genetic Disorders of the Connective Tissue

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What to look for?

- Normal Aortic size in the adult:
  - Ao root < 40 mm
  - Ascending Ao < 37 mm
  - Descending Aorta < 28 mm
- These values are, however, very variable.

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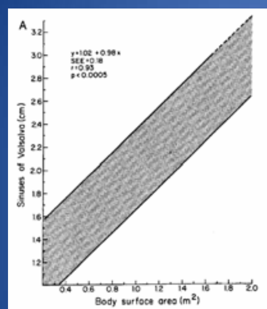
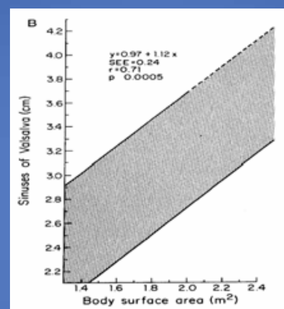
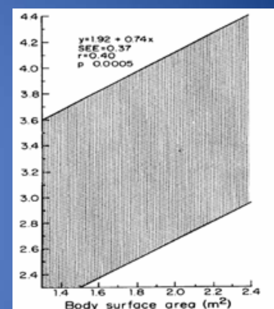
Aortic size to be adjusted by body size and age







< 20 yo 20-40 yo >40 yo

Roman M et al. Am J Cardiol 1989;64:507

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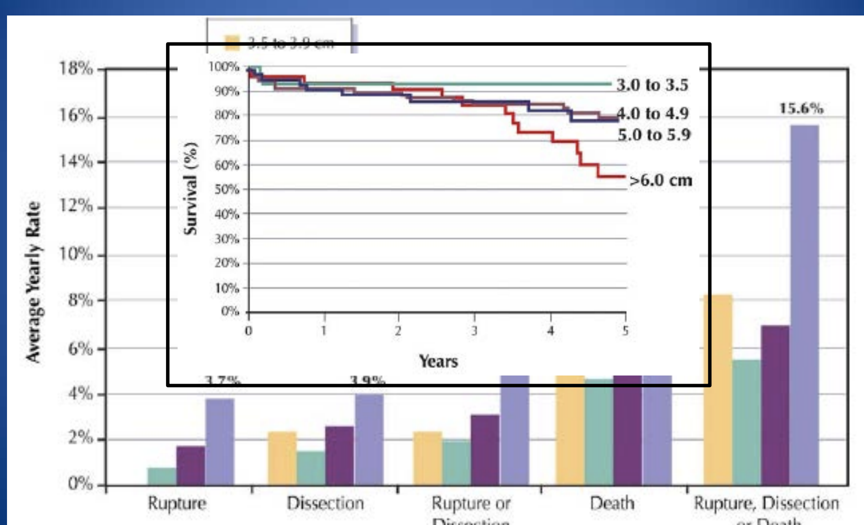
Complications and Asc Ao size

Importance of accurate measurements



Elefteriades, JACC 2010;55:841

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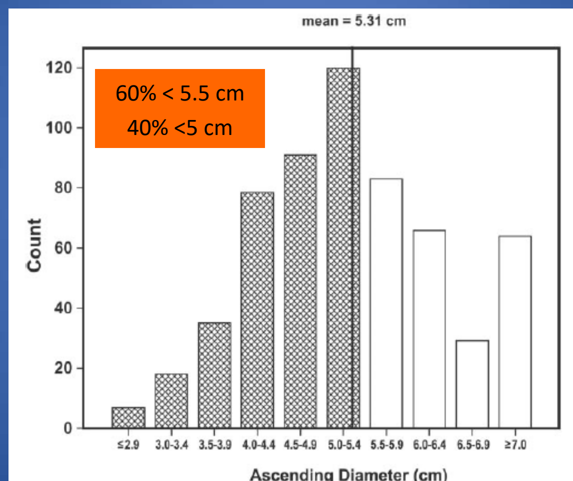
Asc Aortic size at time of Type A Dissection



Pape et al for IRAD. Circulation 2007;116:1120

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Measuring the Aorta

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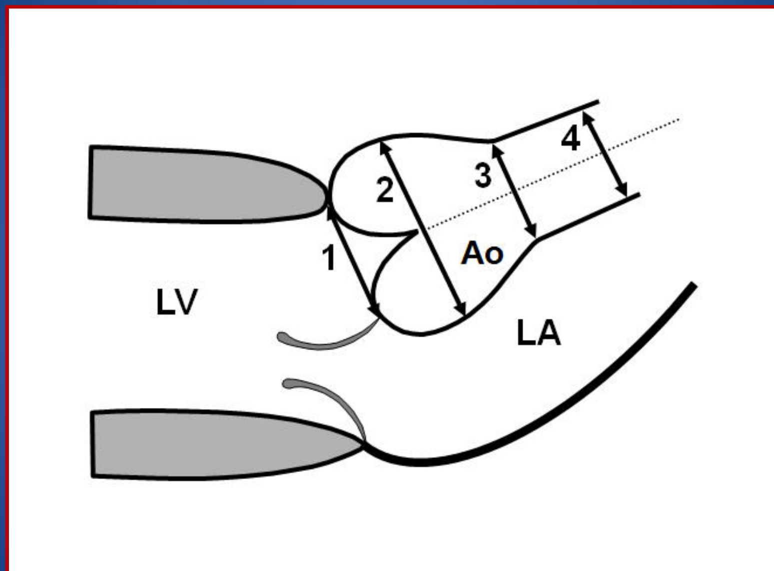

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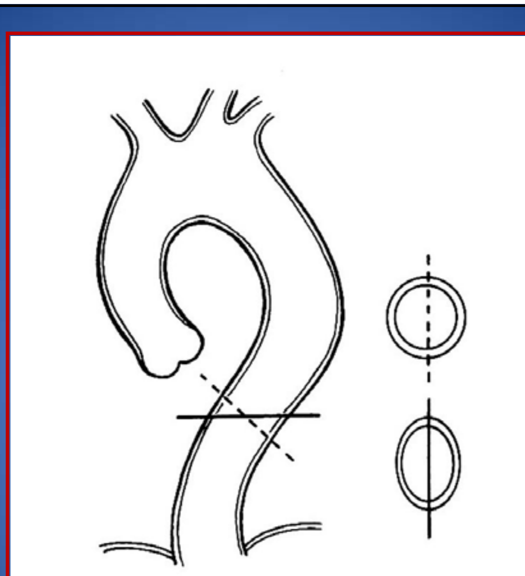

Measure perpendicular to the long-axis of the aorta

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Measurement Options

- **Inner edge-inner edge**
- **Outer-outer**
- **Leading edge-leading edge**

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Recommended time to measure the aortic root

~~A. End-systole~~

B. End-diastole

- Greater reproducibility
(Ao pressure more stable in late diastole)

- End-diastole easy to ID by QRS

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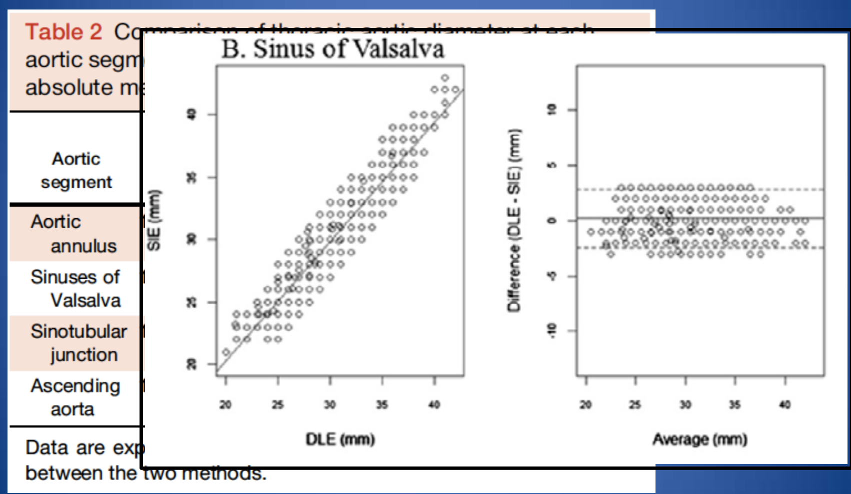
Differences in Measurement timing and technique are small



Bossone, Yuriditsky, Asch et al. J Am Soc Echocardiogr 2016;29:166-72

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Which test to order?
TTE vs TEE vs CT vs MRI

- Reproducibility is similar in all modalities. A variation error in aortic measurements of ≅ 3mm should be assumed
- Consider:
  - 2D vs 3D methods
  - Gated imaging to select timing of the cardiac cycle
  - Blind spots / area of interest
  - Frequency of required follow-up
  - Additional benefit of each technique
  - Contraindications for each modality
  - Availability and expertise at each center

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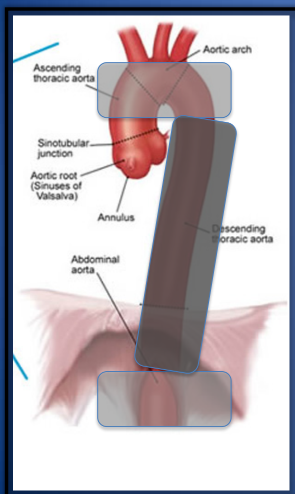
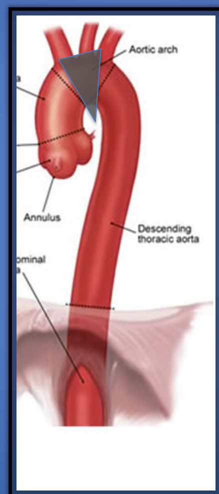
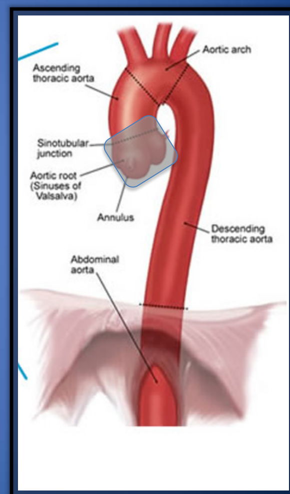
TTE



TEE



CT and MRI



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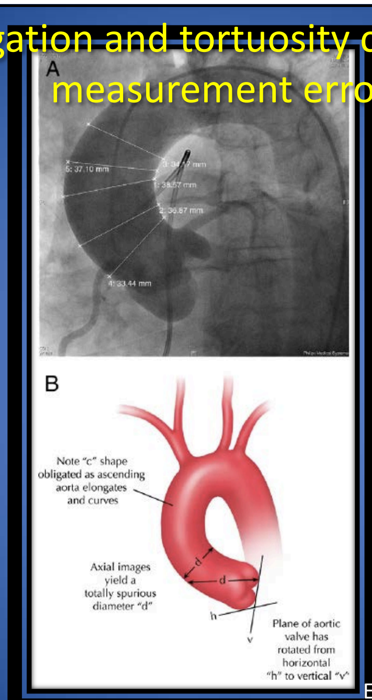
Elongation and tortuosity can induce measurement errors



Elefteriades, JACC 2010;55:841

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Importance of Imaging technique

Mendoza D, Weinsaft J et al. Ann Thorac Surg, 2011;92:904

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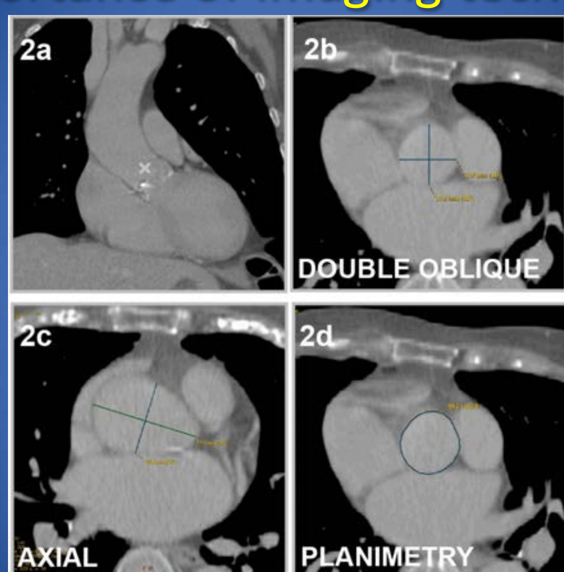
Importance of Imaging technique



Mendoza D, Weinsaft J et al. Ann Thorac Surg, 2011;92:904

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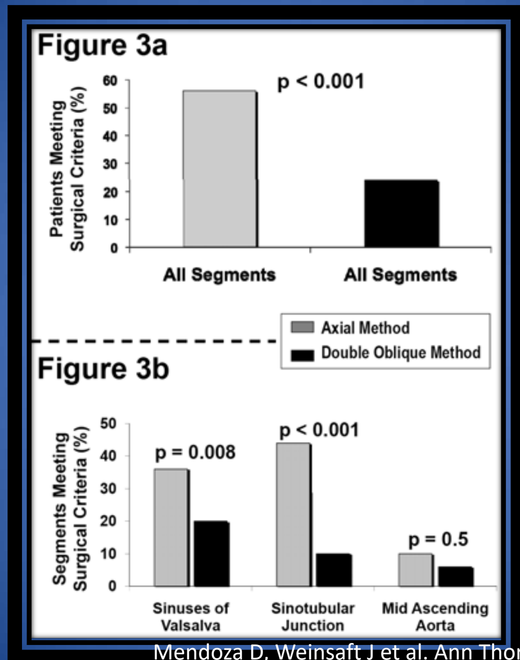

Mendoza D, Weinsaft J et al. Ann Thorac Surg, 2011;92:904

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- Most importantly, measurements are very variable with each imaging modality and even within each modality.
- For proper follow-up, it is critical to use the same modality and compare side to side images.

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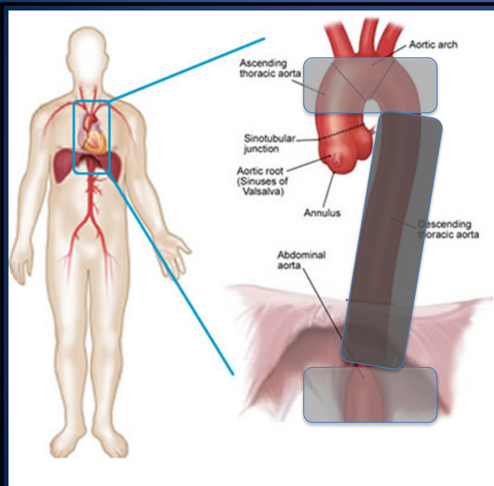
TTE



Strengths:
- Aortic Root, AI
- Standardized measurements
- Availability
- Safety
- Great Screening tool for
  - Ascending aorta
  - Arch
  - Abdominal aorta

Weaknesses:
- All other segments

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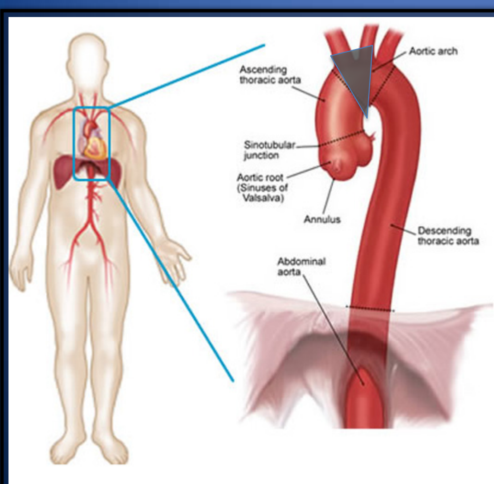
TEE



Strength:
- Accurate measurements
- Other cardiac structures

Weaknesses
- Blind spot: Arch and vessels
- No landmarks
- Tortuous Aorta
- Frequent follow-ups
- Semi- invasive

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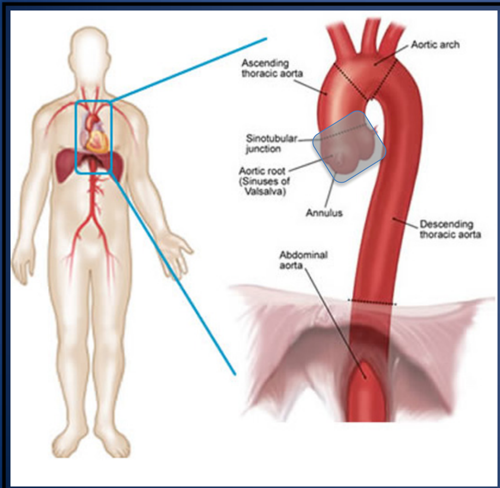
CT



Strength:
- 3D – Multiplanar
- Entire aorta and branches
- Landmarks/site

Weaknesses:
- Need for contrast
- Radiation
- Ao Root (non-gated)
- Cross-sections (axial CT)

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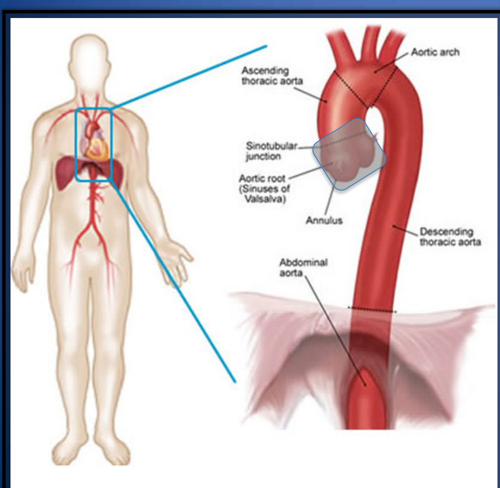
MRI



Strength:
- 3D – Multiplanar
- Entire aorta and branches
- Aortic walls
- Landmarks/site
- No contrast
- No Radiation

Weaknesses:
- Contrast (MRA)
-Ao Root (non-gated)

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How do we measure the Aorta?

- Echo:
- - Adults: Leading to leading edge, diastole
- - Pediatrics: Inner to inner edge, systole
- CT / MRI:
- - External to external. Largest or Systole
- - Different if contrast or non-contrast, gated or non-gated, etc
- There is even variation between institutions or within institutions for different techniques

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Echo vs CT measurements

- Goal: To compare aortic measurements between echo and CT following the predetermined protocol.
- 189 cases without grafts were identified with echo and CT performed within 30 days, and no events in-between

diff	Frequency	Cumulative Frequency
Same Day	88	88
Within one day	29	117
Within two days	13	130
Within three to thirty days	59	189

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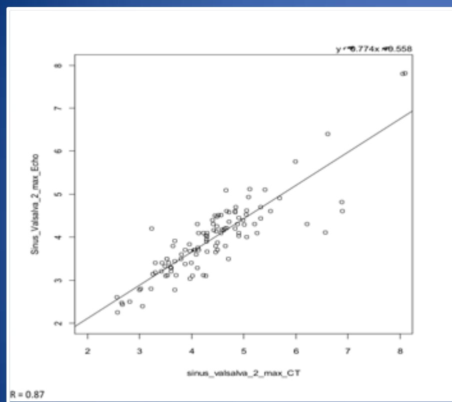
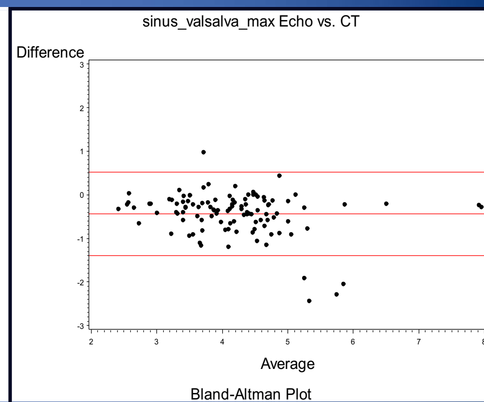
SV = good correlation





N= 109
ICC=0.82

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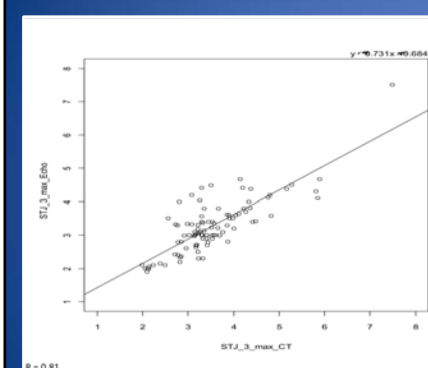
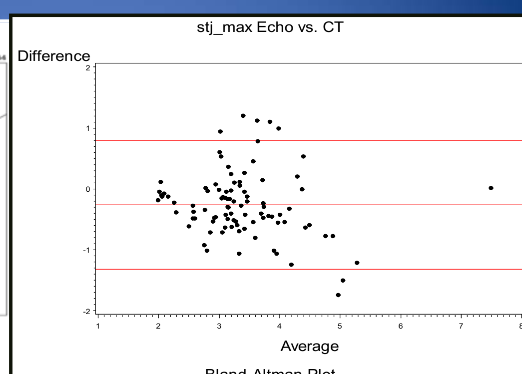
STJ = good correlation

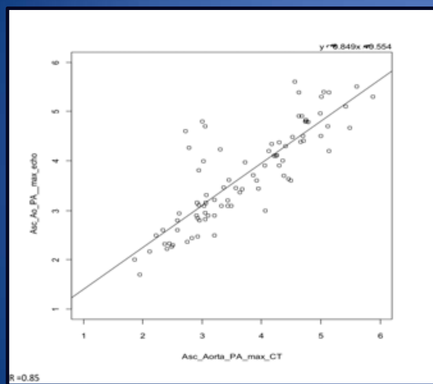


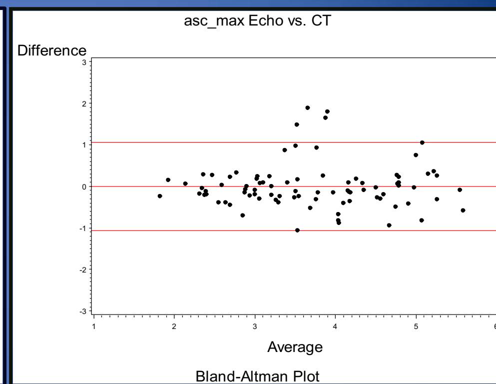


N= 94
ICC=0.75

30

Asc Aorta = good correlation





N=87
ICC=0.77

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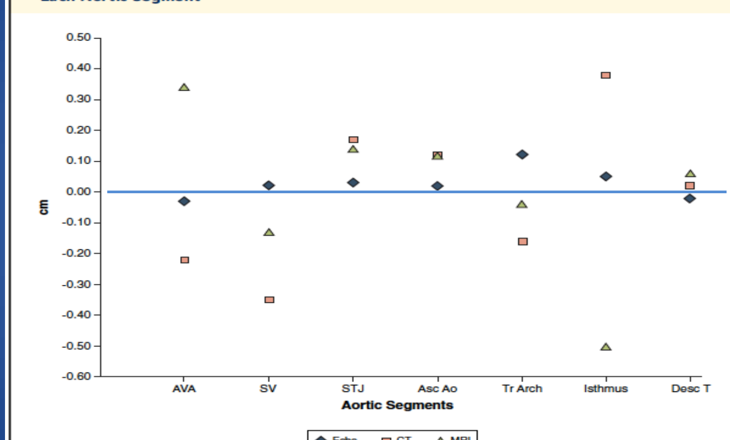
Standardization of measurements is critical for reproducibility

FIGURE 1 Adjusted Mean of Differences (in cm) by Imaging Modality at Each Aortic Segment



Variation between clinical centers and Core lab was lower for Echo than CT / MRI

Asch FM, GenTAC invest. JACC img 2016;9:219-26

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Thoracic Aortic Aneurysms

It is not just about Aortic dimensions!

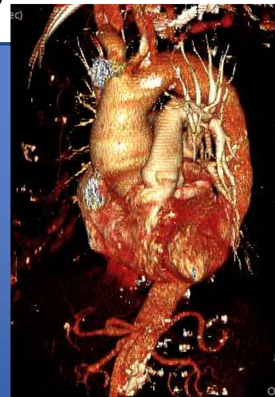

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Table 15 Etiologies of TAAs

1. Marfan syndrome
2. BAV-related aortopathy
3. Familial TAA syndrome
4. Ehlers-Danlos syndrome type IV (vascular type)
5. Loeys-Dietz syndrome
6. Turner syndrome
7. Shprintzen-Goldberg (marfanoid-craniosynostosis) syndrome
8. Noninfectious aortitis (e.g., GCA, TA, nonspecific arteritis)
9. Infectious aortitis (mycotic syndrome)
10. Syphilitic aortitis
11. Trauma
12. Idiopathic

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Table 16 Goal of imaging of TAAs

1	Confirm diagnosis
2	Measure maximal diameter of the aneurysm
3	Define longitudinal extent of the aneurysm
4	Measure the diameters of the proximal and distal margins of the aneurysm
5	Determine involvement of the aortic valve
6	Determine involvement of the arch vessel(s)
7	Detect periaortic hematoma or other sign of leakage
8	Differentiate from aortic dissection
9	Detect mural thrombus

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You want to explore the ENTIRE Aorta,
AT LEAST ONCE

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Table 17 Recommendations for choice of imaging modality for TAA

Modality	Recommendation	Advantages	Disadvantages
CT	First-line	• First-line technique for staging, surveillance • Contrast: enhanced CT and MRI very accurate for measuring size of all TAAs (superior to echocardiography for distal ascending aorta, arch, and descending aorta) • All segments of aorta and aortic branches well visualized	• Use of ionizing radiation and ICM • Cardiac motion can cause imaging artifacts
MRI	Second-line	• Ideal technique for comparative follow-up studies • Excellent modality in stable patients • Preferred for follow-up for younger patients • Avoids ionizing radiation • Can image entire aorta	• Examination times longer than CT • Benefits from patient cooperation (breath hold) • Limited in emergency situations in unstable patients and patients with implantable metallic devices • Benefits from gadolinium
TTE	Second-line	• Usually diagnostic for aneurysms effecting aortic root • Useful for family screening • Useful for following aortic root disease • Excellent reproducibility of measurements • Excellent for AR, LV function	• Distal ascending aorta, arch, and descending aorta not reliably imaged
TEE	Third-line	• Excellent for assessment of AR mechanisms • Excellent images of aortic root, ascending aorta, arch, and descending thoracic aorta	• Less valuable for routine screening or serial follow-up (semi-invasive) • Distal ascending aorta may be poorly imaged • Does not permit full visualization of arch vessels • Limited landmarks for serial examinations
Aortography	Third-line	• Reserved for therapeutic intervention • Useful to guide endovascular procedures	• Invasive; risk for contrast-induced nephropathy • Visualizes only aortic lumen • Does not permit accurate measurements

LV, Left ventricular.

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Summary

- Advances in imaging techniques have greatly increased our understanding of thoracic aortic diseases
- Indications for specific modality depends on:
  - Accuracy for specific diseases
  - Availability
  - Cost/benefit ratio
- TTE used most often for aortic root assessment

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Summary

- CT-scan → high resolution of entire aorta including arch, mesenteric, and renal vessels
- MRI → greatest morphologic and dynamic information without radiation, but less widely available
- TEE → optimal procedure for guidance in OR safely performed in critically ill patients, even those on ventilators

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NBE Question

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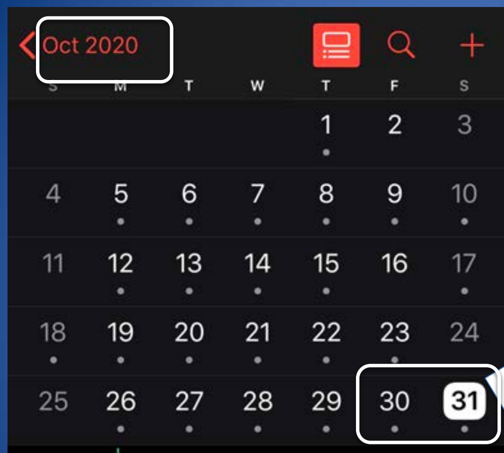

What happens in Guadalajara, Jalisco?

a) Dia de Muertos (Day of the dead) celebrations
b) World Summit of Echocardiography 2020
c) The Echo world Enjoying Jalisco, the land of Tequila and Mezcal
d) All are correct

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SAVE the Date

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ASE American Society of Echocardiography

PREVENIR ES NUESTRA META

EACVI European Association of Cardiovascular Imaging

AAE

DIC

JSE

SASE

SISIAC LA IMAGEN DE LAS AMERICAS

SONECOM

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Thank you

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