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Aortic Disease

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NOTES

Use a modified parasternal long-axis view (one intercostal space cranial) to see more of the ascending aorta.

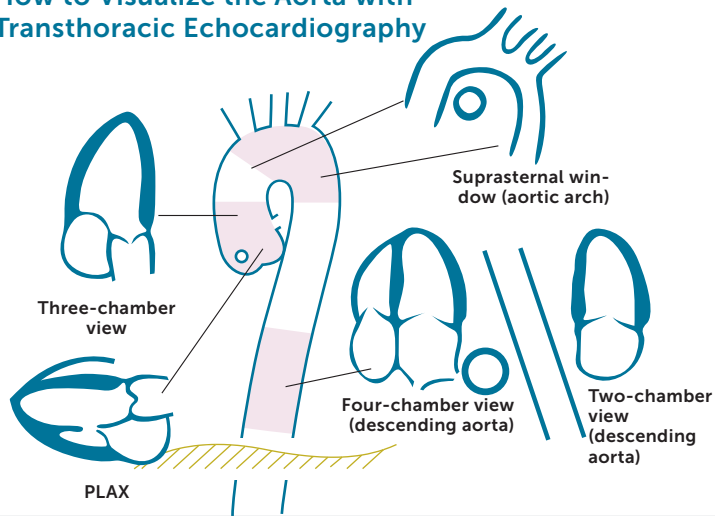
Every echo report should include a description of the ascending aorta (normal/dilated) with corresponding measurements.

Even with TEE it may be difficult to see cranial segments of the ascending aorta.

The aortic diameter is slightly larger in systole than in diastole.

IMAGING OF THE AORTA

How to Visualize the Aorta with Transthoracic Echocardiography



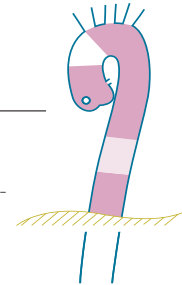
Transoesophageal Echo (TEE)

BETTER RESOLUTION

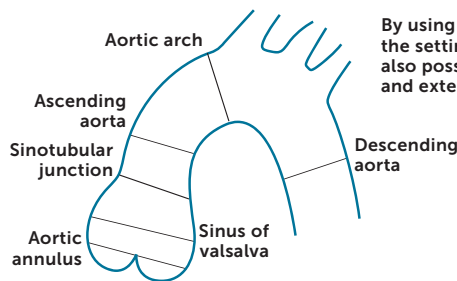
The esophagus is close to the aorta. We may therefore use higher transducer frequencies, which translate into better resolution.

MORE SEGMENTS

TEE is much better for the assessment of the descending thoracic aorta

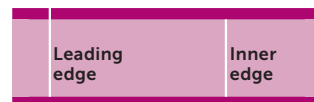
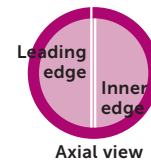


Where and How to Measure

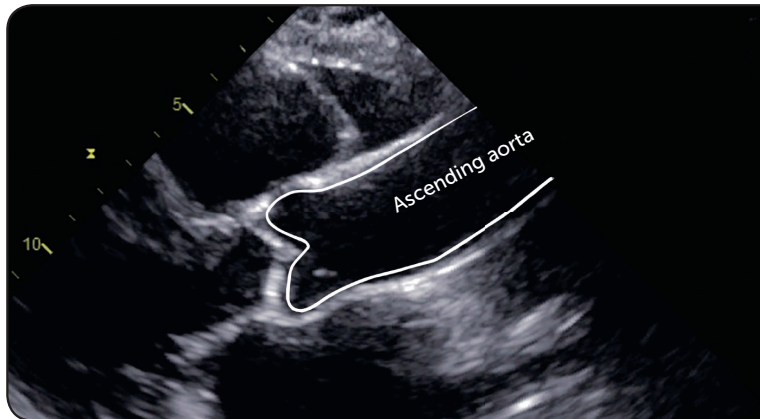


By using several measurements (in the setting of aortic dilatation), it is also possible to determine the shape and extension of aortic aneurysms.

The aorta can be measured on a long- and/or short-axis view. Most reference values were obtained with the leading edge method. However, to correlate measurements better with other imaging modalities (CT, MRI), measurements of the inner diameters (inner edge to inner edge) are applied to an increasing extent. The difference between these measurements methods is minimal and insignificant, thanks to improved image resolution.



BASICS



NOTES

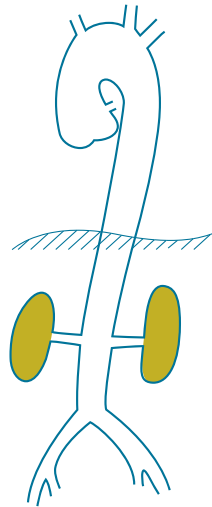
VISUALIZATION OF THE ASCENDING AORTA – modified PLAX/2D

The more cranial portions of the ascending aorta can be better visualized by moving the transducer up one intercostal space and more laterally.

Size of the Aorta

	Diameter	Diameter/BSA
Aortic annulus	20-31mm	13 mm/m ²
Sinus of valsalva	29- 45mm	19 mm/m ²
Sinotubular junction	22-36mm	15 mm/m ²
Ascending aorta	22-36mm	15 mm/m ²
Aortic arch	22-36mm	
Descending aorta	20- 30mm	
Abdominal aorta	18- 28mm	

ESC 2010



The size of the aortic is strongly related to body surface area (in particular height) and age.

AORTIC ANEURYSMS

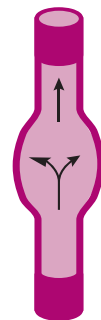
Definitions

True aneurysm

Localized dilatation > 50% of the reference segment (circumscribed or diffuse aneurysms)

Aortic ectasia

Arterial dilatation of less than 150% of the normal arterial diameter



NOTES

Any increase in the diameter of the aorta is related to (blood) pressure, the size of the aorta, and the thickness of the wall (law of Laplace).

To quantify aneurysms of the ascending aorta, always use a parasternal long- and short-axis view. In the presence of an aneurysm of the ascending aorta, also image from a suprasternal window to determine whether the aortic root is involved. Ascending aortic aneurysms are sometimes visualized best from a right parasternal approach.

Look at the shape of the ascending aorta: something is wrong when there is no narrowing at the sinotubular junction.

ANEURYSM OF THE ASCENDING AORTA – PLAX/2D

Patient with bicuspid valve, aortic stenosis and aneurysm of the aortic root and the ascending aorta. There is no narrowing at the sinotubular junction.

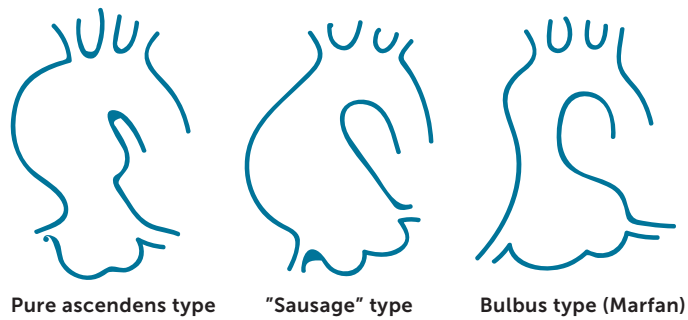
Progressive dilatation of the aorta continues even after aortic valve replacement in patients with bicuspid valves. Follow such patients closely.

AORTIC ANEURYSMS

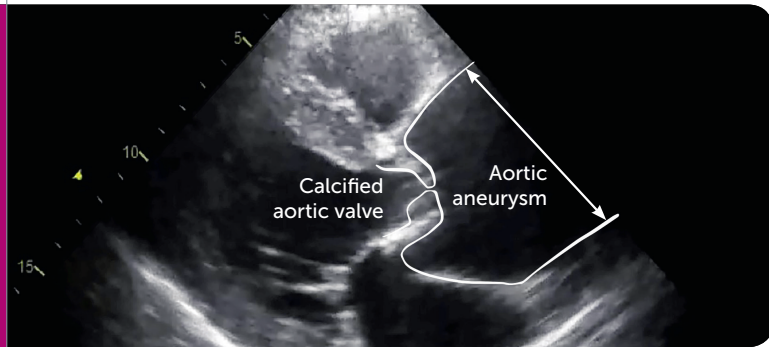
Incidence – Facts

- Death – aneurysm = 0.7/100,000 per year
- Death – dissection = 1.5/100,000 per year
- No difference between prevalence in men and women
- Thoracic aneurysms >6 cm are subject to a rupture and dissection risk of 6.9% per year.

Forms of Aneurysms



In the setting of aneurysms the aorta changes its orientation (to the right); it may even be elongated.



Bicuspid Aortic Valve and Aneurysm

- Dilatation of the aorta may be present in patients with congenital abnormal valves (e.g. bicuspid).
- 9-fold higher risk of dissection in the presence of bicuspid valves.
- 6–10% of all dissections occur in the setting of bicuspid valves.



AORTIC ANEURYSMS

NOTES

Inherited Disorders Affecting the Aorta

- Marfan
- Ehlers Danlos (type IV)
- Familial forms of connective tissue disorders
- Annulo-aortic ectasia
- Loeys-Dietz syndrome

Inherited disorders also include so called "overlap syndromes".

Marfan Syndrome – Cardiac Manifestations

- Aortic dilatation
- Aortic dissection
- Aortic regurgitation (annular dilatation)
- Mitral valve prolapse
- Pulmonary artery dilatation
- Large aortic valve cusps

Aortic disease/dissection is the main cause of morbidity and mortality in Marfan syndrome.

Inflammatory Diseases of the Aorta

- Syphilis
- Staph. aureus infection
- Kawasaki disease
- Giant cell arteritis
- Takayasu arteritis

Infections may trigger non-infectious vasculitis by generating immune complexes or by cross-reactivity. Inflammation may result in aortic dilatation and ostial stenosis of major branches.

Risk of Rupture – Stratification Based on Aortic Size

Low risk	$\leq 2.75 \text{ cm/m}^2$	4%/year
Moderate risk	2.75 – 4.25 cm/m^2	8%/year
High risk	$\geq 4.25 \text{ cm/m}^2$	20%/year

Indications for Aortic Surgery (ACC Class I)

- Asymptomatic patients with an ascending aortic diameter or an aortic sinus diameter $\geq 55\text{mm}$
- Patients with Marfan syndrome with an aortic diameter between 40-50 mm
- Patients with a growth rate of more than 0.5 cm/year in an aorta less than 5.5 cm in size
- Patients undergoing aortic valve repair, with an aortic aneurysm $\geq 4.5 \text{ cm}$ in size

ACC 2010

Use other imaging modalities (mitral regurgitationI and CT) for precise measurements and for decision-making. Use the technique you are most familiar with.

NOTES

The false lumen is usually larger than the true lumen, with slower flow, and often with thrombi.

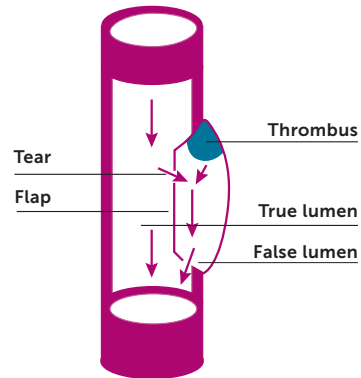
Intimal flaps may prolapse through the aortic valve. Also look for intimal flaps in the aortic arch (using a suprasternal window).

AORTIC DISSECTION

Aortic Dissection

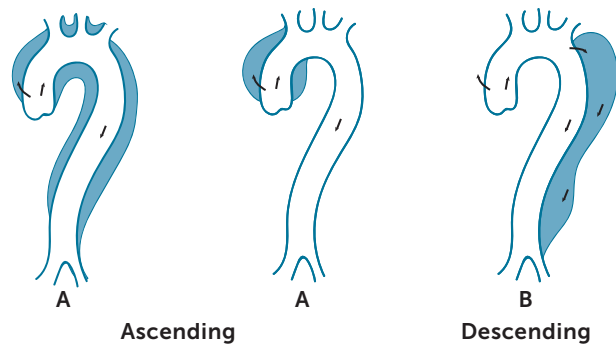
Characteristics:

- Intima (media) disruption/ intimal flap – true + false lumen
- Spiral-shaped dissections may occur, sometimes involving branches (coronaries!, supraortic branches)
- 2.6–3.5 cases per 100,000 persons/year
- 2/3 males



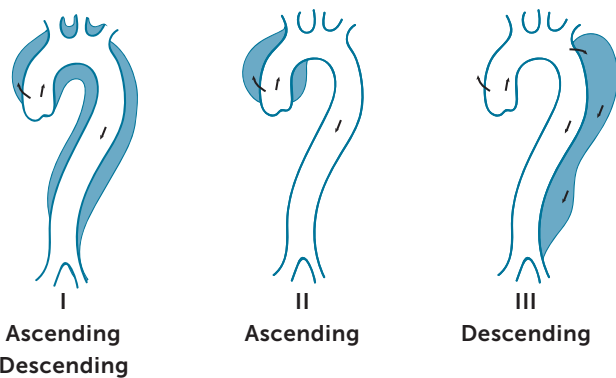
Classifications of Aortic Dissection

Stanford classification



Type A involves the ascending aorta, type B only the descending aorta

DeBakey classification



Type I involves the ascending and the descending aorta, type II only the ascending aorta and type III only the descending aorta.

AORTIC DISSECTION

Risk Factors for Dissection

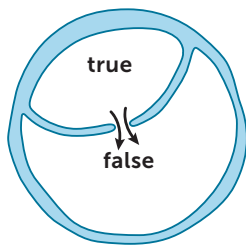
- Aortic aneurysm
- Marfan + other connective tissue disorders
- Atherosclerosis
- Iatrogenic (e.g. left heart catheter, heart surgery cannulation)

NOTES

Untreated dissection of the ascending aorta is associated with a mortality rate of 90% within 1 year (rupture into the pericardium, mediastinum, or left pleural cavity).

Aortic Dissection

Classic dissection



Complications of dissection

- Aortic rupture
- Branch vessel dissection (coronaries)
- Expansion
- Intramural hematoma
- Aortic regurgitation
- Rupture with pericardial tamponade
- Leriche syndrome

The intima/media is detached (flap), and divides the aorta into a true and a false lumen.

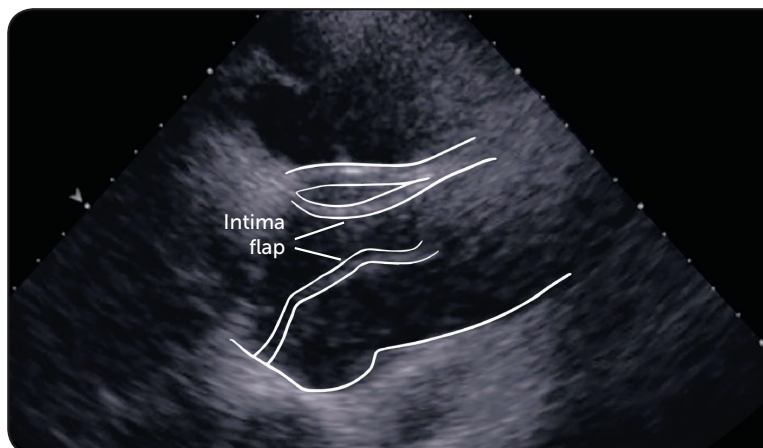
TTE in Aortic Dissection

- Sensitivity = 77–80%
 - Specificity = 93–96%
- Always confirm dissection by using other imaging modalities.

Aortic regurgitation in dissection

- Dilatation of the root
- Bicuspid valves
- Prolapse of the intimal flap

Beware of reverberations of the aortic wall or adjacent structures. They may mimic an intimal flap. A true intimal flap is marked by motion independent of the aortic wall.



DISSECTION OF THE ASCENDING AORTA – PLAX/2D

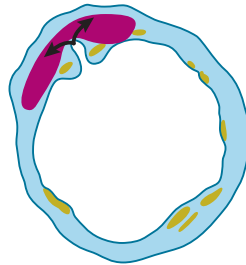
Highly mobile intimal flap in the ascending aorta, denoting aortic dissection. This flap is almost circumferential and thus visualized both anteriorly and posteriorly.

NOTES

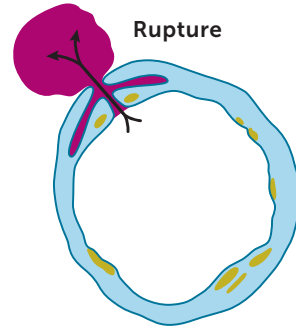
AORTIC DISSECTION

Aortic Syndromes

Intramural hematoma



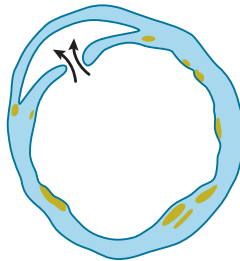
Bleeding into the aortic wall (such as after plaque rupture) causes an intramural hematoma.



Rupture

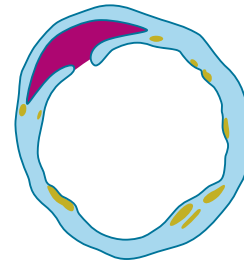
Plaque rupture, penetrating ulcers, and intramural hematoma may lead to aortic rupture.

Localized dissection



Localized dissection is usually a result of atherosclerosis. Dissection is limited to a circumscribed region.

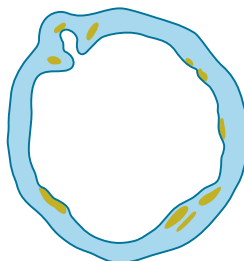
"Healed" dissection



The false lumen of dissection may thrombose and eventually heal.

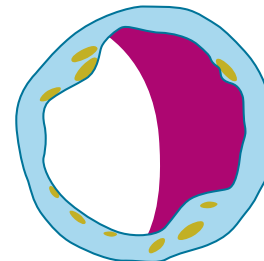
Aortic syndromes are no benign condition. The bear a high risk of rupture. Further evaluation with CT/mitral regurgitation is mandatory.

Penetrating ulcer



Rupture of an atherosclerotic plaque results in a penetrating ulcer.

Intraluminal thrombus



Regional thickening of the aorta > 7 mm (circular shape) (DD: thrombus in false lumen, intramural hematoma)

AORTIC DISSECTION

Aortic Plaque

- Patients with atherosclerotic plaques in the aorta are subject to a high risk of coronary artery disease and myocardial infarction.
- Increased risk of embolism/stroke (plaque in the ascending aorta/aortic arch).
- Increased risk of aortic dissection.
- Increased risk of aortic syndromes.

NOTES

Plaque size is important for risk stratification. When the plaque size is > 4 mm, the risk of stroke is significantly increased. (OR=9.1)

Typical Locations of Plaques in the Aorta

- Aortic arch
- Cranial segments of the descending aorta

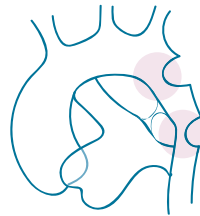


TTE is also Capable of demonstrating plaques /especially in the ascending aorta). Capable of demonstrating plaques/especially in the ascending aorta).

AORTIC COARCTATION (COA)

Facts

- 5–10% of all congenital defects
- Predominantly men
- Higher blood pressure at the upper extremities compared to the lower extremities
- Located distal to the subclavian artery
- Increased risk of intracranial hemorrhage



Kinking may lead to flow turbulence (seen in color Doppler), thereby mimicking CoA = pseudocoarctation

Echo Features

- Left ventricular hypertrophy
- Narrowing of the aorta
- Turbulent flow is visible on color Doppler
- Elevated CW Doppler gradient in the aorta
- The presence of a systolic and an additional diastolic gradient denotes hemodynamic significance of obstruction

The suprasternal view is the most valuable window to identify coarctation. Quantification is based on the maximal velocity/gradients (measured with CW Doppler) and the presence of a systolic AND diastolic gradient.

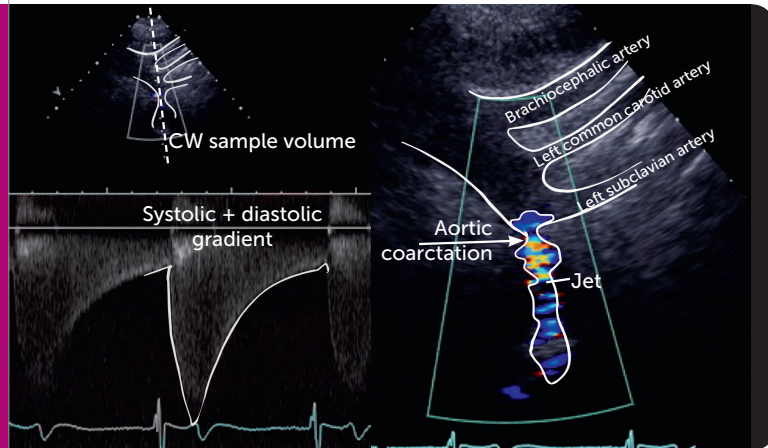
Doppler measurements usually overestimate gradients in comparison to hemodynamic assessment.

NOTES

AORTIC COARCTATION –
suprasternal view/Color
and CW Doppler

Turbulent flow in the descending aorta (left) denotes the location of coarctation. The Doppler spectrum (right) shows a systolic and diastolic gradient (>4 m/s), suggesting severe coarctation.

AORTIC DISSECTION



Patients with hemodynamically relevant forms of CoA also have left ventricular hypertrophy.

Coarctation – Associated Abnormalities

- Bicuspid aortic valve
- Persistent ductus arteriosus/ventricular septal defect
- Hypoplasia of the aortic arch
- Left ventricular outflow tract obstruction