

Introduction

- A Transcatheter Aortic Valve Replacement (TAVR) is a minimally invasive surgical procedure used to replace a narrowed aortic valve that fails to open properly (aortic stenosis).
- Aortic valve stenosis is the most commonly acquired valvular heart disease.
- Computed Tomography Angiography (CTA) is the choice imaging method for pre-TAVR patients and is done to evaluate and plan for the procedure.
- A CTA TAVR study evaluates the aortic valve, aorta, and iliofemoral arteries to ensure the selection of appropriate candidates, prosthesis types, and treatment approach. (Abbona, 2020)

Computed Tomography (CT)

- Uses a sequence of X-ray images and computer algorithms to generate cross-sectional images of the body.
- Offers more in-depth images compared to conventional X-rays.
- Is utilized across various medical scenarios such as assessing individuals with internal injuries resulting from trauma such as motor vehicle accidents.
- Helps visualize nearly all regions of the body and serves diagnostic, therapeutic, and preparatory purposes in medical, surgical, or radiation treatments.
- Various uses include diagnosing muscle and bone disorders, pinpointing tumor, infection, or blood clot location, guiding procedures such as surgery, biopsy, and radiation therapy, and detecting and monitoring diseases and conditions such as cancer, heart disease, lung nodules and liver masses. (Rollins et al., 2019)

CT Scanner



Figure 1. CT scan (Mayo Clinic, 2022, para. 1)

Angiography

- Computed Tomography Angiography (CTA) is a type of CT scan that involves an injection of a contrast agent to produce images of blood vessels and tissues throughout the body.
- Contrast is injected through an intravenous (IV) line started in the patient's arm or hand.
- Patients may need this exam if they have an abnormality that involves the blood vessels of the brain, heart, lungs, kidneys, or other parts of the body.
- Various reasons for a CTA include: locating an aneurysm; blood vessels that have become narrowed by atherosclerosis; abnormal brain blood vessel formations; mildly damaged blood vessels; blood clots in leg veins that have traveled to the lungs; and to evaluate tumors fed by blood vessels.
- A CTA study is also used during TAVR planning as it helps to highlight areas of the aorta. (Johns Hopkins Medicine, 2024)

Aorta Anatomy

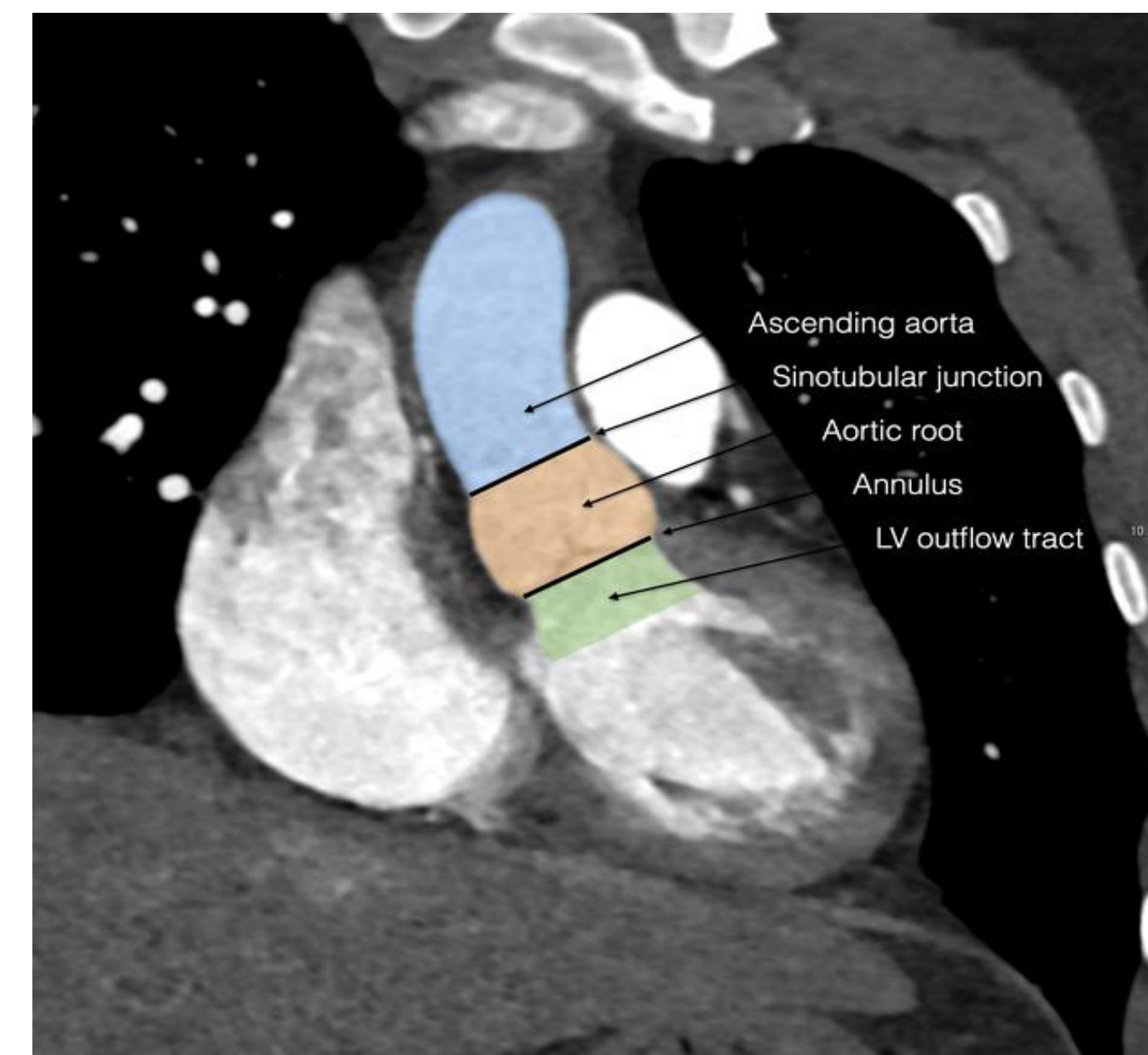


Figure 2. CTA aortic root anatomy (Sharma, 2024, p. 1)

Electrocardiography Gating (ECG)

- Acquisition method that only scans during a specific portion of the cardiac cycle. This technique is often used to obtain images void of pulsation artifact.
- There are various ECG gating protocols based on the patient's condition that can be broken into prospective and retrospective based:
 - Prospective
 - stable sinus rhythm and a heart rate of fewer than 60 beats a minute
 - stable sinus rhythm and a heart rate of fewer than 70 beats a minute
 - Retrospective
 - atrial fibrillation/arrhythmia
 - TAVR

(Murphy, 2023)

Planning of a Transcatheter Aortic Valve Replacement

- A CTA TAVR study is able to evaluate the aortic valve, aorta, and iliofemoral arteries. This is valuable to ensure that appropriate candidates are selected. It also helps to determine prosthesis types and treatment approaches.
- After CTA TAVR images are acquired, they are postprocessed and analyzed by cardiothoracic radiologists. The images are reconstructed into axial, coronal, and sagittal images that are accompanied by structured reports that contain measurements to aid during patient selection and procedure planning.
- Important measurements include the diameters and perimeters of the annular area which are larger during the systolic phase. This systolic assessment is recommended in order to avoid under sizing of the aortic valve prosthesis. (Abbona, 2020)

What Are Radiologists Looking For?

WHAT TO REPORT?			
AORTIC ROOT		VASCULAR	
1. Valve morphology.	2. Aortic annulus dimensions. <ul style="list-style-type: none"> - Cardiac cycle phase assessed (systole/ diastole). - Area (mm²). - Perimeter (mm). - Maximum and minimum diameters (mm). 	1. Aorta. <ul style="list-style-type: none"> - Calcifications. - Tortuosity. - Relevant pathologies (aneurysm, thrombosis...). 	3. Access location in the common femoral artery. <ul style="list-style-type: none"> - Femoral artery bifurcation level. - Calcifications.
3. Zone landing calcium zone.	4. Right and left coronary ostial heights (mm).	2. Iliofemoral territory. <ul style="list-style-type: none"> - Minimum diameter of the vasculature. - Tortuosity. - Calcifications (extension and location). 	4. Evaluation of other access routes. <ul style="list-style-type: none"> - Subclavian artery. - Transaortic. - Transcaval.
5. Valsalva diameter (mm).	6. Sinotubular diameter (mm).	CARDIAC FINDINGS	
7. Sinotubular junction height (mm).	8. Ascending aorta diameter.	1. Left ventricular hypertrophy.	
		2. Left atrial appendage and ventricle wall thrombi.	
		3. Other important cardiac findings.	
		NON CARDIAC FINDINGS	
		1. Extra-cardiac pathologies.	
		2. Relevant incident findings.	

Figure 3. depicts what a radiologist is assessing (Pontes et al., 2022, The Report)

Complications

- While a TAVR is minimally invasive compared to traditional open-heart surgery, there are several complications that may occur.
- Complications include the valve replacement being mispositioned or dislocated, the coronary ostia being blocked, or limiting the mitral valve mobility.
- An additional complication that can be assessed with CT is paravalvular aortic regurgitation/paravalvular leak. This occurs when the aortic valve implant is not flush with the annular wall. This allows blood to leak around the prosthesis. CT can be used for confirmation of paravalvular leak. (Sharma, 2024)

Measurements

- In a cardiac CTA, for assessment of the aortic root, most measurements are made in systole.
- Systole is when the annulus is at its largest in most patients.
- Measurements are also made in diastole to evaluate the morphology of the aortic valve and the coronary arteries.
- The measurements of the aortic annulus that are reported are the maximum diameter, minimum diameter, area, and perimeter. (Pontes et al., 2022)

Aortic Annulus Measurements

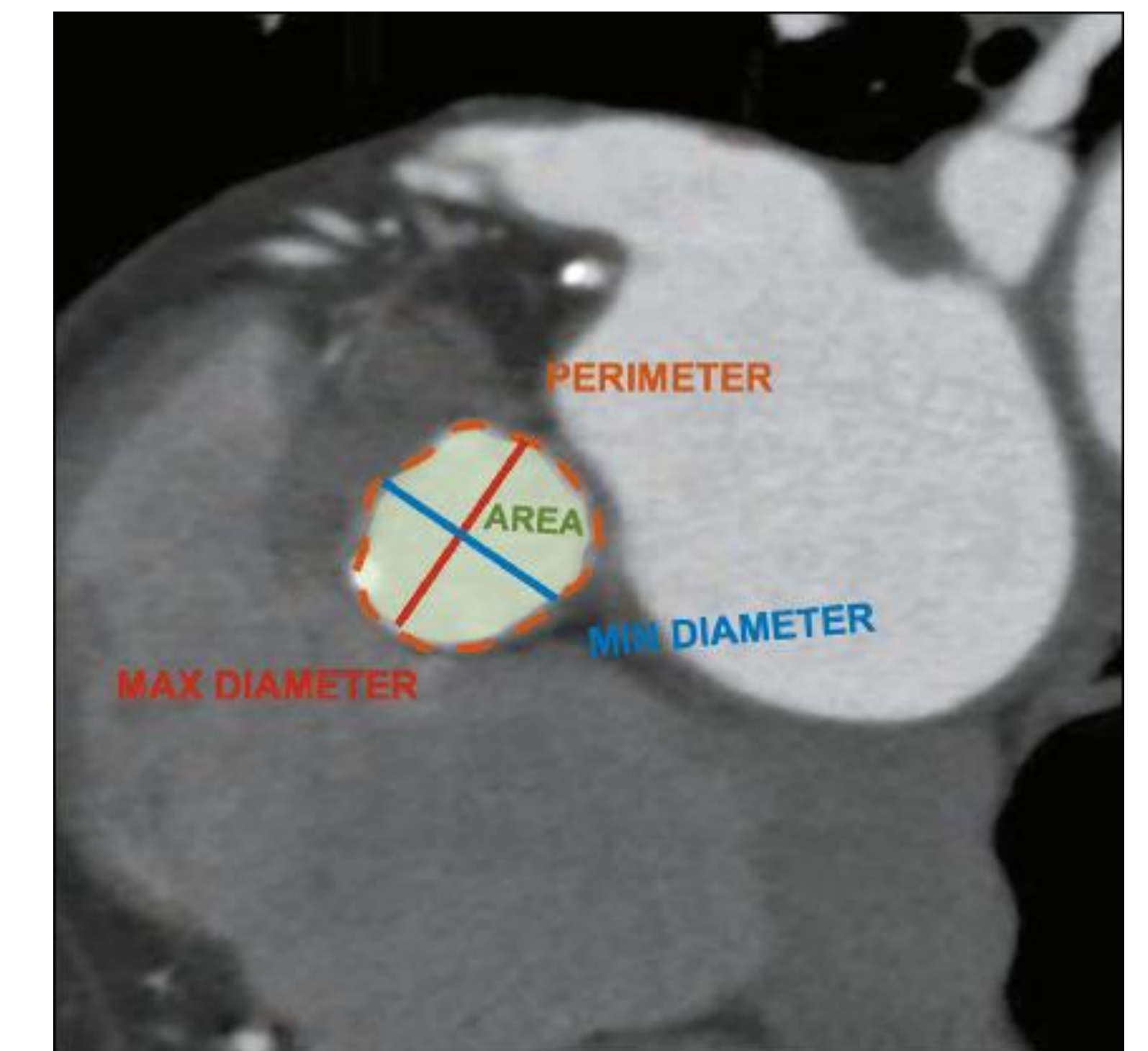


Figure 4. Aortic annulus with required measurements (Pontes et al., 2020, p. 1)

Statistics

- “Over the course of the past fourteen years, it is estimated that TAVRs have been performed in 300,000 patients in 65 countries” (Cribier, 2016, p. 1).
- “It is also estimated that the number of TAVRs done increases by roughly 40% each year” (Cribier, 2016, p. 1).
- “Symptomatic aortic stenosis has a survival rate of 60% and 32% at one and five years respectively” (Cribier, 2016, p. 1).
- “Aortic valve stenosis is the most commonly acquired valvular heart disease” (Abbona, 2020, p. 1).

Conclusion

- A Transcatheter Aortic Valve Replacement is a minimally invasive procedure used to treat patients with aortic stenosis.
- A pre-TAVR CTA study is used to assess the patient and plan for the TAVR procedure.
- CT can also be used to assess complications that may occur from a TAVR procedure. (Kondoleon, 2023)