Transesophageal Echocardiography

Multimedia Manual

✓ 2027 Edition

A Perioperative Transdisciplinary Approach

240 MCQs

Chapter 1

Principles of 2D and 3D ultrasound

Q1: What is the frequency of ultrasound (US) waves?

A) ≥10,000 Hz
B) ≥20,000 Hz
C) ≥30,000 Hz
D) ≥40,000 Hz

Answer: B

Sound waves with frequencies above the audible range of ≥ 20,000 Hertz (Hz) comprise US. Sound is a mechanical wave that propagates in a medium through molecular interaction by successive molecular compressions and rarefactions.

Q2: What type of wave does ultrasound experience in solids?

A) Transverse waves
B) Longitudinal waves
C) Both transverse and longitudinal waves
D) Neither transverse nor longitudinal waves

Answer: C

Solids, such as biological tissues, can experience both transverse and longitudinal waves.

Q3: What is sonoelasticity imaging used for?

A) To measure the speed of ultrasound in a medium
B) To measure the speed of light in a medium
C) To measure the viscoelastic properties of biological tissues
D) To measure the acoustic properties of a medium

Answer: C

Research suggests that shear waves may become clinically useful in characterizing the viscoelastic properties of biological tissues, and in sonoelasticity imaging and dynamic elastography.

Q4: What is the typical frequency of ultrasound usually used in medical imaging?

A) 2-5 MHz
B) 2-10 MHz
C) 2-15 MHz
D) 2-20 MHz

Answer: C

The frequency of US used for medical imaging ranges from 2 to 15 MHz, although it can be higher for some special imaging techniques.

Q5: What is the time interval of a cycle inversely related to?
A) Duration
B) Frequency
C) Source
D) Energy

Answer: B

The time interval, or the duration of a cycle, is the period (τ), which inversely relates to the frequency ($f=1/\tau$), thus a higher frequency implies a shorter period at each propagation speed.

Q6: How does ultrasound interact with a medium?
A) It is reflected or scattered
B) It is absorbed and then reemitted
C) It is absorbed and then reflected
D) It is scattered and then reemitted

Answer: A

As US interacts with a medium, there is an absorption of most of the transmitted energy while the rest reflects or scatters. When US interacts with structures smaller than the wavelength, non-specular reflection or scattering.

Q7: What is typical of parenchymal tissue smaller than the wavelength when it interacts with ultrasound?
A) Absorption of the ultrasound
B) Reflection of the ultrasound
C) Non-specular reflection or scattering
D) Reemission of the ultrasound

Answer: C

As US interacts with a medium, there is an absorption of most of the transmitted energy while the rest reflects or scatters. When US interacts with structures smaller than the wavelength, non-specular reflection or scattering.

Q8: What is the main effect of ultrasound interacting with a medium?
A) Reflection
B) Scattering
C) Absorption
D) Reemission

Answer: C

As US interacts with a medium, there is an absorption of most of the transmitted energy while the rest reflects or scatters. When US interacts with structures smaller than the wavelength, non-specular reflection or scattering.

Q9: What is the range of pixel values for a grayscale ultrasound image?

A) 0 to 255
B) 0 to16
C) 0 to 24
D) 0 to32

Answer: A

Simple US images appear in grayscale, with a pixel value ranging from 0 to 255 (8 bits).

Q10: Which modality has the highest temporal resolution?

A) 2D imaging
B) 3D imaging
C) Color Doppler imaging
D) Mmode

Answer: D

Refreshing of B-mode images with a frame rate of 30–90 images/s limits visualizing rapidly moving structures, such as heart valves. Thus, some prefer M-mode because of the higher temporal resolution, which can be below 1 millisecond.

Chapter 2
Doppler and Strain

Q1: What is the Doppler effect used for?
A) To measure the motion of the heart
B) To measure the velocity of the sound waves
C) To measure the intensity of the sound waves
D) To measure the frequency of the sound waves

Answer: B

Doppler echocardiography interrogates blood flow characteristics (velocity, direction) by comparing the ultrasound frequency emitted to the ultrasound frequency received by the transducer.

Q2: What happens to the sound waves when they are emitted from a moving object?
A) They are compressed
B) They are amplified
C) They are distorted
D) They are dissipated

Answer: A

When the emitting source is in motion, regardless of its speed, the sound waves are “compressed” in front of the transmitter, which is “catching up” with the transmitted waves it has produced.

Q3: What is the best way to measure the Doppler effect?
A) With a high-frequency ultrasound beam
B) With a low-frequency ultrasound beam
C) With an obliquel ultrasound beam
D) With a perpendicular ultrasound beam

Answer: B

Reducing the emitting frequency of the transducer, f_0, or increasing the pulse repetition frequency (PRF) can help to limit aliasing.

Q4: The best 2D image is obtained with
A) High-frequency transducer and an interrogating beam perpendicular to the structure
B) Low frequency transducer and an interrogating beam perpendicular to the structure
C) High-frequency transducer and an interrogating beam parallel to the structure
D) Low-frequency transducer and an interrogating beam parallel to the structure

Answer: A

The best 2D image occurs with a high-frequency transducer (>5 MHz) and an interrogating beam perpendicular to the structure.

Q5: The Doppler shift is maximal when

A) The ultrasound beam is parallel to the flow and when the emitting frequency is low
B) The ultrasound beam is parallel to the flow and when the emitting frequency is high
C) The ultrasound beam is perpendicular to the flow and when the emitting frequency is low
D) The ultrasound beam is perpendicular to the flow and when the emitting frequency is high

Answer: A

The maximal frequency shift occurs when the transducer orientation is parallel to blood flow: if the angle is 0, the cosine is 1. The lower, the emitting frequency, the greater the velocity of the target.

Q6: What type of filter is used to eliminate heart structures in Doppler systems?

A) High-pass filter
B) Low-pass filter
C) Band pass filter
D) Notch filter

Answer: A

In normal Doppler systems, echoes from the heart structures appear as “noise” and a high-pass filter eliminates frequencies below 200 Hz. Alternatively, a low-pass filter eliminates high frequencies (noise) to enhance tissue velocities.

Q7: What is the frequency of echoes from heart structures?

A) >80 db
B) <200 Hz
C) >200 Hz
D) <80 db

Answer: B

All moving structures and elements can induce a Doppler shift when hit by an ultrasound (US) wave. Blood cell velocities represent a high-frequency, low-amplitude signal compared with the velocity of surrounding tissue, which has a dense high-amplitude (>80 decibels) but slow-moving low-frequency (<200 Hz) echoes.

Q8: What type of signal is represented by blood cell velocities?

A) High-frequency, low-amplitude
B) Low-frequency, low amplitude
C) High-frequency, high-amplitude
D) Low-frequency, low-amplitude

Answer: A

All moving structures and elements can induce a Doppler shift when hit by an US wave. Blood cell velocities represent a high-frequency, low-amplitude signal compared with the velocity of surrounding tissue, which has a dense high-amplitude (>80 decibels) but slow-moving low-frequency (<200 Hz) echoes.

Q9: What is displayed on a color bar?

A) Color properties such as hue, saturation and intensity
B) Higher velocities in dark colors
C) Lower velocities in brighter tones
D) An emphasis on red and blue colors only

Answer: A

The bar displays the color properties, such as hue (number of primary colors red, blue, or green), saturation (amount of white contained), and intensity (brightness). Lower velocities have dark colors located closer to the color bar's baseline. Higher velocities have brighter tones near the end of the scale. The numbers seen at both ends of the color scale bar represent the limit of the recordable mean velocity, or Nyquist limit

Q10: What is the purpose of a color map?

A) To identify the pattern of color in use
B) To display the color properties
C) To show the velocity of colors
D) To indicate the amount of primary colors

Answer: A

Color maps identify the pattern of colors in use and appear as the color bar on the screen

Chapter 3
Transducers 2D and 3D

Q1: What is the origin of the word ‘Piezoelectric’?
A) Greek
B) Latin
C) French
D) Spanish

Answer: A
The word piezoelectric derives from the Greek words “piezo” meaning to press and “electron” meaning amber (a gemstone).

Q2: What is meant by piezoelectric effect?
A) Phenomenon whereby some materials are able to generate an electric current when deformed by mechanical pressure or stress.
B) The same materials, when submitted to an alternating electrical current, change shape and can be made to vibrate, deform, and generate sound wave pulses.
C) All of the above
D) None of the above

Answer: C
The piezoelectric effect is the phenomenon whereby some materials (quartz, ceramics, lithium sulfate, and others) can generate an electric current when deformed by mechanical pressure or stress. The same materials, when submitted to an alternating electrical current, change shape, and can vibrate, deform, and generate sound wave pulses, which is opposite to the first principle.

Q3: What is the basis of an ultrasound transducer’s construction and function?
A) The piezoelectric effect
B) Ultrasound waves
C) Electrical stimulation
D) Hardened sap

Answer: A
Pezoelectric effect forms the foundation for transducer construction and function. Applying this principle to clinical echocardiography gives an understanding of how an ultrasound (US) transducer generates US waves through electrical stimulation, and how mechanical stimulation produces an electrical current from the returning US echoes.

Q4: What type of transducer is used in clinical echocardiography today?

A) Linear array
B) Convex array
C) Annular array
D) Phased array

Answer: D

Almost all imaging transducers used in echocardiography are transducer arrays that contain many elements in a specific configuration. Transesophageal echocardiography (TEE) transducers are phased array, comprising 64 to 256 piezoelectric elements.

Q5: What is the term used to describe array transducers?

A) Focusing
B) Steering
C) Phasing
D) Matching

Answer: C

A transducer assembly comprises an element, or a set of piezoelectric elements, with damping and matching material in a case. The term phasing applies to array transducers (phased array) and implies both focusing and steering of the US be.

Q6: How many piezoelectric elements are found in 2D trans-oesophageal (TEE) transducers?

A) 32-64
B) 64-128
C) 128-256
D) 64-256

Answer: D

2D transesophageal echocardiography (TEE) transducers are phased array, comprising 64 to 256 piezoelectric elements.

Q7 As transducer frequency increases, which of the following is correct:

A) Tissue penetration increases and axial resolution increases
B) Tissue penetration decreases and axial resolution increases
C) Tissue penetration decreases and axial resolution decreases
D) Tissue penetration increases and axial resolution decreases

Answer: B.

Good axial resolution depends on a shorter wavelength and spatial pulse length, which comes from using high frequency transducers. As transducer frequency increases, the penetration decreases but the axial resolution increases. Note that spatial resolution is the minimum reflector separation required to discriminate between two objects, so the smaller the resolution the better the imaging.

Q8 From a practical point of view, what is the best way to increase the temporal resolution?

A) Increase the depth of field
B) Decrease the depth of field
C) Decrease the width of the image sector
D) B and C

Answer: D.

Temporal resolution is the ability to detect an object that is moving over time and is quantified by frame rate in TEE. Increased temporal resolution can be accomplished by narrowing the image sector width and decreasing the depth of field.

Q9 Which element is true regarding ultrasound resolution?

A) Lateral resolution is proportional to the diameter (d) or aperture of the element
B) Elevational resolution is unrelated to side lobe formation
C) Axial resolution improves by decreasing both the wavelength (or increasing the frequency) and the number of cycles per pulse
D) Contrast resolution improves by reducing the number of bits per pixel with lower number of gray shades.

Answer B

Lateral resolution is inversely related to the diameter of the element. Lateral resolution represents the ability to discriminate between two objects lying perpendicular to the US beam direction (scan line). It is determined by the beam width: if the spatial separation between two objects is greater than the beam width, two distinct echoes appear when the beam scans across them. Reducing the beam diameter through focusing improves the lateral resolution. At the focal zone, probe frequency or wavelength (λ), the focal length (L) and the diameter (d) or aperture of the element, determine the lateral resolution.

$$\text{Lateral resolution} = \text{beam width} = \frac{2.4\lambda L}{d}$$

Elevational resolution is the ability to separate reflectors that are in different 2D planes. The sound beam has a thickness of 3 to 10 mm, depending on the depth and the specific transducer. Structures may be present in the beam thickness or side lobes and may represent artifacts on the display. Echoes arising from near the edge of the beam appear as if they are in the main beam.

Axial resolution improves by decreasing both the wavelength (or increasing the frequency) and the number of cycles per pulse. The latter is determined by the damping material in the transducer and, currently, the user cannot change this.

Contrast resolution refers to the ability to discriminate subtle echo-strength (or intensity) differences between two adjacent reflectors. Depending on the respective difference in amplitude signal of separate echoes, the US system assigns a different shade of gray as a different number of bits per pixel. Weak echoes have darker shades of gray, while strong reflectors are at the white end

of the scale. Contrast resolution improves by increasing the number of bits per pixel or by having a greater number of gray shades available.

Q10 Which for of 3D imaging provides the best spatial resolution
A) 3D Zoom
B) 3D color Doppler
C) 3D full volume
D) 3D live

Answer: D

3D image generation implies a balance between temporal resolution, spatial resolution and 3D volume. The spatial resolution depends on the line density. Increased spatial resolution or 3D volume will be at the expense of reducing temporal resolution. 3D Zoom has an intermediate 3D volume, temporal resolution and spatial resolution.
3D color flow imaging has an intermediate 3D volume but because of the superimposed color Doppler the poorest spatial and temporal resolution. 3D full volume has the largest 3D volume, low temporal resolution and intermediate spatial resolution. 3D live-mode has the lowest sector size, 20-30 HZ temporal resolution and high spatial resolution.

Chapter 4
Normal Anatomy and Flow

Q1: Which sentence of the followings is correct?

A) Clockwise rotation of the probe will view right-sided structures and anteflexion of the probe will view the cardiac apex
B) Clockwise rotation of the probe will view right-sided structures and anteflexion of the probe will view the heart base
C) Clockwise rotation of the probe will view left-sided structures and anteflexion of the probe will view the cardiac apex
D) Clockwise rotation of the probe will left-sided structures and anteflexion of the probe will view the heart base

Answer: B

Rotation, clockwise to view rightward structures and counterclockwise for leftward structures. Anteflexion and retroflexion of the probe tip, to view structures at the heart base or the apex

Q2: To obtain Transgastric level in TEE, the average distance from the incisors should be:

A) 25–28 cm
B) 29–33 cm
C) 34-37cm
D) 38–42 cm
E) >42 cm

Answer: D

Standard imaging plane levels (with their average distance from the incisors) include upper or high esophageal (25–28 cm), mid-esophageal (ME) (29–33 cm), lower or deep esophageal and gastroesophageal (GE) junction (34–37 cm), transgastric (TG) (38–42 cm), and deep TG (> 42 cm) windows. (See Figure 4.4)

Q3: Which view of the followings is the best to visualize the right atrial appendage (RAA)?

A) Mid-oesophageal 4 chamber view
B) Mid-oesophageal short-axis view
C) Mid-oesophageal 2 chamber view
D) Mid-oesophageal bicaval view
E) Mid-oesophageal 3 chamber view

Answer: D

The RAA appendage is a broad-based outpouching of the RA (**Error! Reference source not found.**) Best seen in the far field in the 90°-100° bicaval view.

Q4: Which pulmonary vein lies between the Coumadin ridge and the left atrial appendage (LAA)?

A) Right upper pulmonary vein
B) Right lower pulmonary vein
C) Left upper pulmonary vein
D) Left lower pulmonary vein

Answer: C

The left upper pulmonary vein (LUPV) limbus, pulmonary venous ridge, or "coumadin" ridge, is a wall with a bulbous end containing the vestigium of the left superior vea cava (SVC) or the Marshall ligament that separates the LUPV and LAA. (Figure 4.36)

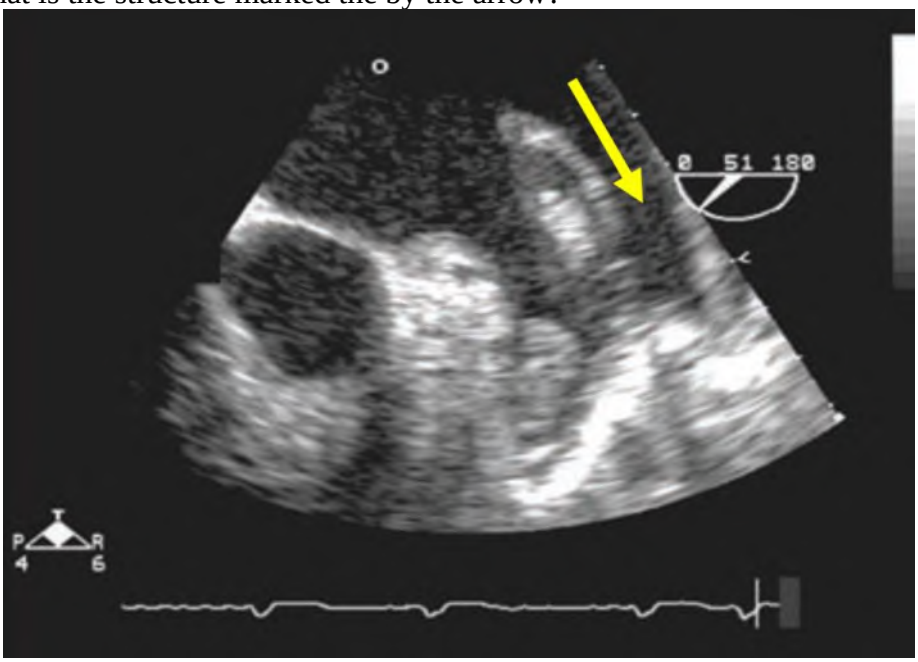
Q5: What is the best view to visualize the coronary sinus in TEE?

A) Mid-oesophageal (ME) 4 chamber view
B) ME short-axis view
C) Deep-oesophageal (DE) 2 chamber view
D) ME bicaval view

Answer: C

Inserting the TEE probe into a DE position, where a window is available near the coronary sinus ostium, can better visualize the RA (**Error! Reference source not found.**).

Q6: What is the structure marked the by the arrow?

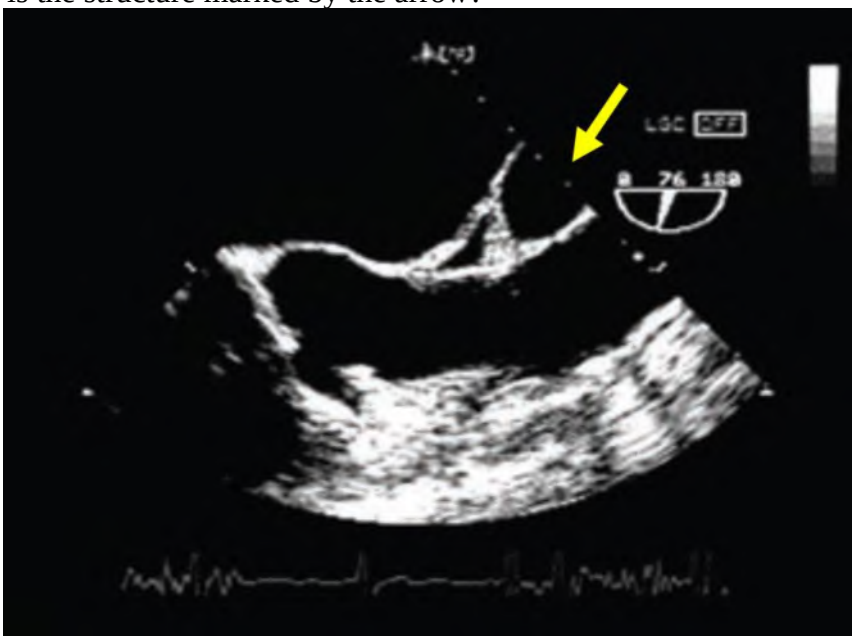


A) Left upper pulmonary vein
B) Left lower pulmonary vein
C) Right upper pulmonary vein
D) Right lower pulmonary vein

Answer: A

(See Figure 4.36)

Q7: What is the structure marked by the arrow?

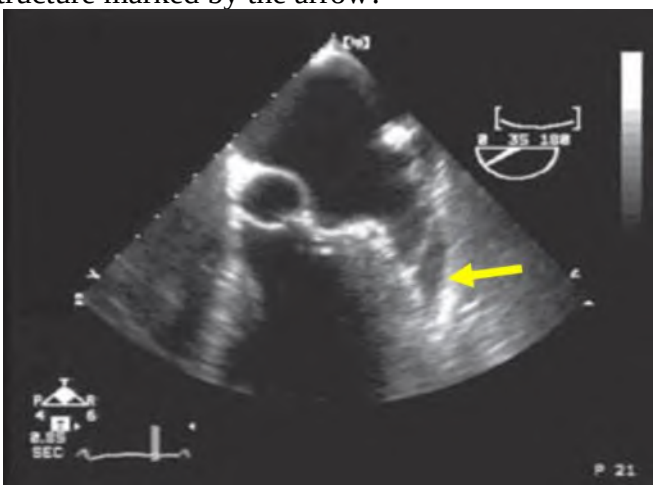


A) Transverse pericardial sinus
B) Oblique pericardial sinus
C) Aortic root abscess
D) Right pulmonary artery

Answer: D

(See Figure 4.14)

Q8: What is the structure marked by the arrow?

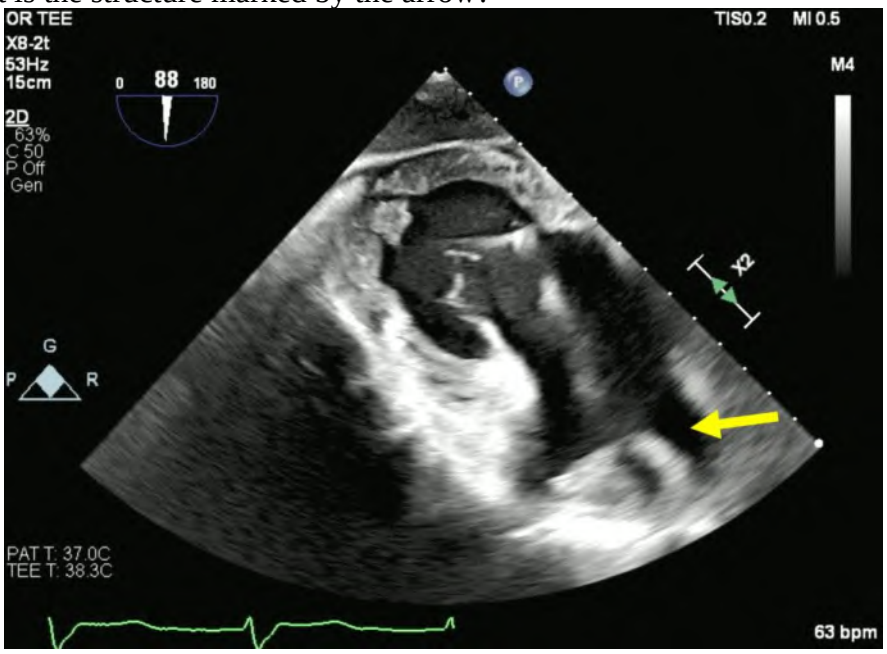


A) Left atrial appendage
B) Oblique pericardial sinus
C) Pericardial effusion
D) Right pulmonary artery

Answer: C.

A small pericardial effusion can accumulate behind the left atrial appendage that communicates with the transverse sinus. (see Figure 12.2)

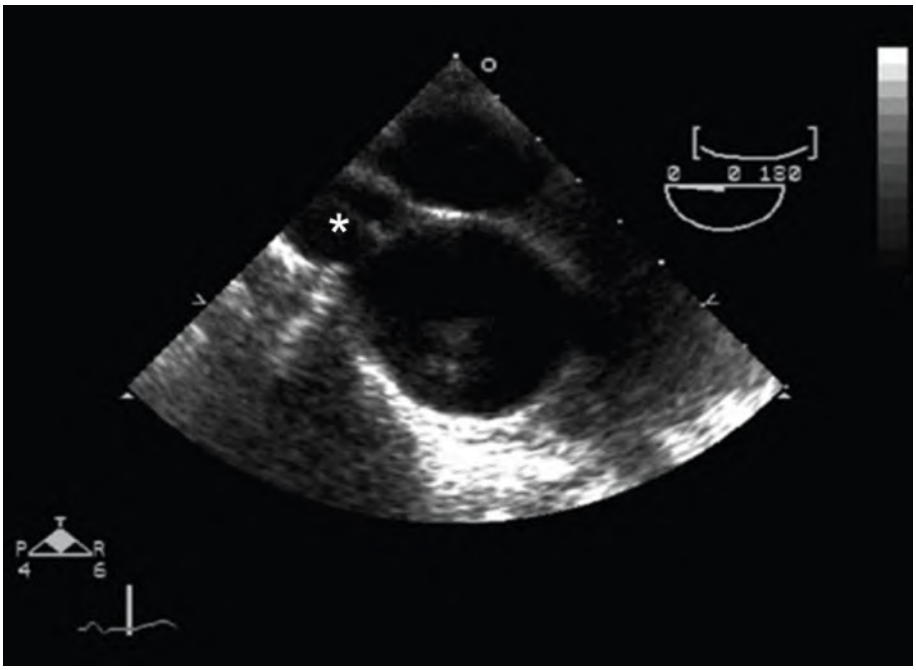
Q9 What is the structure marked by the arrow?



A) Right atrial appendage
B) Right pulmonary vein
C) Superior vena cava
D) Right pulmonary artery

Answer: C
(Figure 4.23)

Question 10: The "*" denotes which structure:



A) Superior vena cava
B) Right pulmonary artery
C) Left atrial appendage
D) Coronary sinus

Answer: A.
Superior vena cavae (Figure 4.15)

Chapter 5
Quantitative Echo: 2D, 3D and Doppler

Q1: Which sentence of the followings is correct?

A) The leading edge of a structure is defined as the portion of the border closest to the transducer, while the trailing edge is the portion furthest from the transducer
B) The Trailing edge of a structure is defined as the portion of the border closest to the transducer, while the leading edge is the portion furthest from the transducer
C) The outer edge is defined as the portion of the border closest to the center of the structure while the inner edge is the furthest from it.
D) None of the above

Answer: A

The leading edge of a structure is defined as the portion of the border closest to the transducer, while the trailing edge is the portion furthest from the transducer. In two-dimensional (2D) echocardiography, the inner edge is defined as the portion of the border closest to the center of the structure while the outer edge is the furthest from it.

Q2: Which sentence of the followings is correct?

A) The left atrium (LA) is measured at end-systole while the aortic root is measured at end-diastole
B) The LA is measured at end-diastole while the aortic root is measured at end-systole
C) Both LA and aortic root are measured at end-systole
D) Both LA and aortic root are measured at end-diastole

Answer: A

The LA is measured at end-systole and the aortic root at end-diastole.

Q3: What is the cut-off value of LVEDD that defines severe LV dilatation?

A) 6 cm in males
B) 5.9 cm in females
C) 7.5 cm in males
D) 6.2 cm in females

Answer: D

The ASE describes partition values for LV size with severe dilatation in SAX at end-diastole with a left ventricular end-diastolic dimension (LVEDD) in females of ≥ 6.2 cm and males ≥ 6.9 cm (Figure 5. 2).

Q4: All of the following sentences about ejection fraction (EF) is correct except?

A) EF is a measure of myocardial performance and represents the efficiency of the global cardiac pump to eject part of its end-diastolic volume
B) Estimation of LVEF is affected by both cardiac preload and cardiac afterload
C) Estimation of LVEF is affected by myocardial contractility
D) Ejection fraction is the mirror of cardiac output (CO)

Answer: D

Ejection fraction does not necessarily mirror CO. A patient may have a high ejection fraction but a small stroke volume (and CO) as occurs in hypovolemia.

Q5: Which one of the followings is considered correct about wall motion abnormalities?

A) Akinesia is defined as wall thickening <5%
B) Akinesia is defined as wall thickening <10%
C) Hypokinesia is defined as wall thickening <25%
D) Hypokinesia is defined as wall thickening <20%

Answer: B

Wall motion hypokinesia and akinesia are defined as <30% and <10% thickening respectively

Q6: Concentric remodelling is defined as?

A) Normal left ventricular (LV) mass with relative wall thickness (RWT) > 0.42
B) Normal LV mass with relative wall thickness ≤ 0.42
C) Increased LV mass with relative wall thickness > 0.42
D) Increased LV mass with relative wall thickness ≤ 0.42

Answer: A

Patients with normal LV mass can have either concentric remodeling (RWT > 0.42) or normal geometry (RWT ≤ 0.42). Patients with increased LV mass can have either concentric (RWT > 0.42) or eccentric (RWT ≤ 0.42) hypertrophy. (Figure 5.20)

Q7: What is the predicted right atrial pressure (RAP) is the inferior vena cava (IVC) diameter is 2.3cm with 70% collapsibility with sniffing?

A) 5-10mmHg
B) 10-14mmHg
C) 15-20mmHg
D) >20mmHg

Answer: A

If IVC diameter and sniffing do not fit the estimated RAP is 5-10 mmHg.

Q8 Which statement is adequate in this patient with a systolic arterial pressure of 100 mmHg and a right atrial pressure of 10 mmHg? (see video Chap 05_Q8)

A) The right ventricular end-systolic pressure is 70 mmHg
B) The right ventricular end-systolic pressure is 50 mmHg
C) The systolic pulmonary artery pressure is 60 mmHg
D) The systolic pulmonary artery pressure is 70 mmHg

Answer: C

This is a ventricular septal defect with a 40 mmHg pressure gradient. If we assume that the arterial systolic pressure equals the left ventricular end-systolic pressure (LVESP), then the LVESP should be 100 mmHg. As the gradient of 40 mmHg represent the difference between the LVESP and the right ventricular end-systolic pressure (RVESP)

PG = LVESP - RVESP, then the RVESP should be 60 mmHg. As the RVESP is equal to the pulmonary artery systolic pressure (PASP), then the PASP should be also 60 mmHg. (See Figure 5.24)

Q9 A 69 year old patient is undergoing MVR. Intraoperative TEE performed after CPB reveals an ASD with left to right shunt. The surgeon wants to know how significant is the shunt, These measurements are: HR = 90/min, BSA = 1.8 m^2 , main PA diam. = 2.1 cm, TVI main PA = 15.3 cm, LVOT diameter = 1.9 cm, TVI LVOT = 14.8 cm

A) The shunt is 0.8 and it is not significant
B) The shunt is 1.7 and it is significant
C) The shunt is 1.26 and it is not significant
D) The shunt is 1.0 and it is significant

Answer C

Shunt calculation requires measurement of the right ventricular or pulmonary flow (Qp) and left ventricular stroke volume or systemic flow (Qs) output and their ratio.

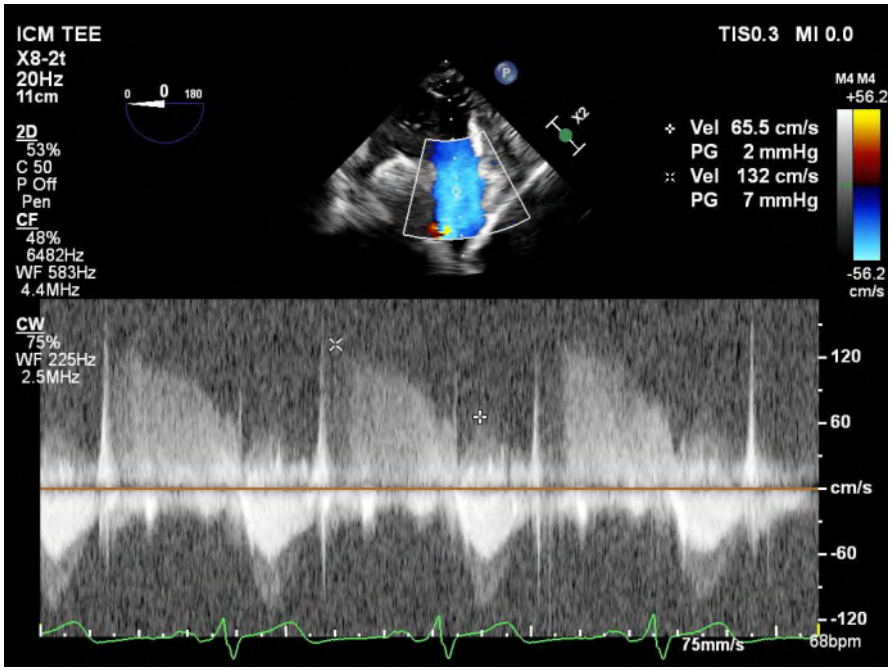
Qp = Right ventricular output: $(2.1/2)^2$ X 3.14 X 15.3 X 90= 4.76 L/min

Qs = Left ventricular output: $(1.9/2)^2$ X 3.14 X 14.8 X 90 = 3,77 L/min

Qp/Qs = 1.26 A significant left-to-right shunt is a Qp:Qs ratio ≥1.5 or that causes dilatation of right-heart chambers.

A simplified approach would be $(2.1/1.9)^2$ X (15.3/14.8) = 1.1 X 1.03 = 1.26

Q10 Which statement is true when estimating pulmonary artery pressure in a post-operative patient with a central venous pressure of 11 mmHg



A) Diastolic and mean pulmonary artery pressure of 10 and 16 mmHg
B) Diastolic and mean pulmonary artery pressure of 11 and 14 mmHg
C) Diastolic and mean pulmonary artery pressure of 13 and 18 mmHg
D) Diastolic and mean pulmonary artery pressure of 10 and 21 mmHg

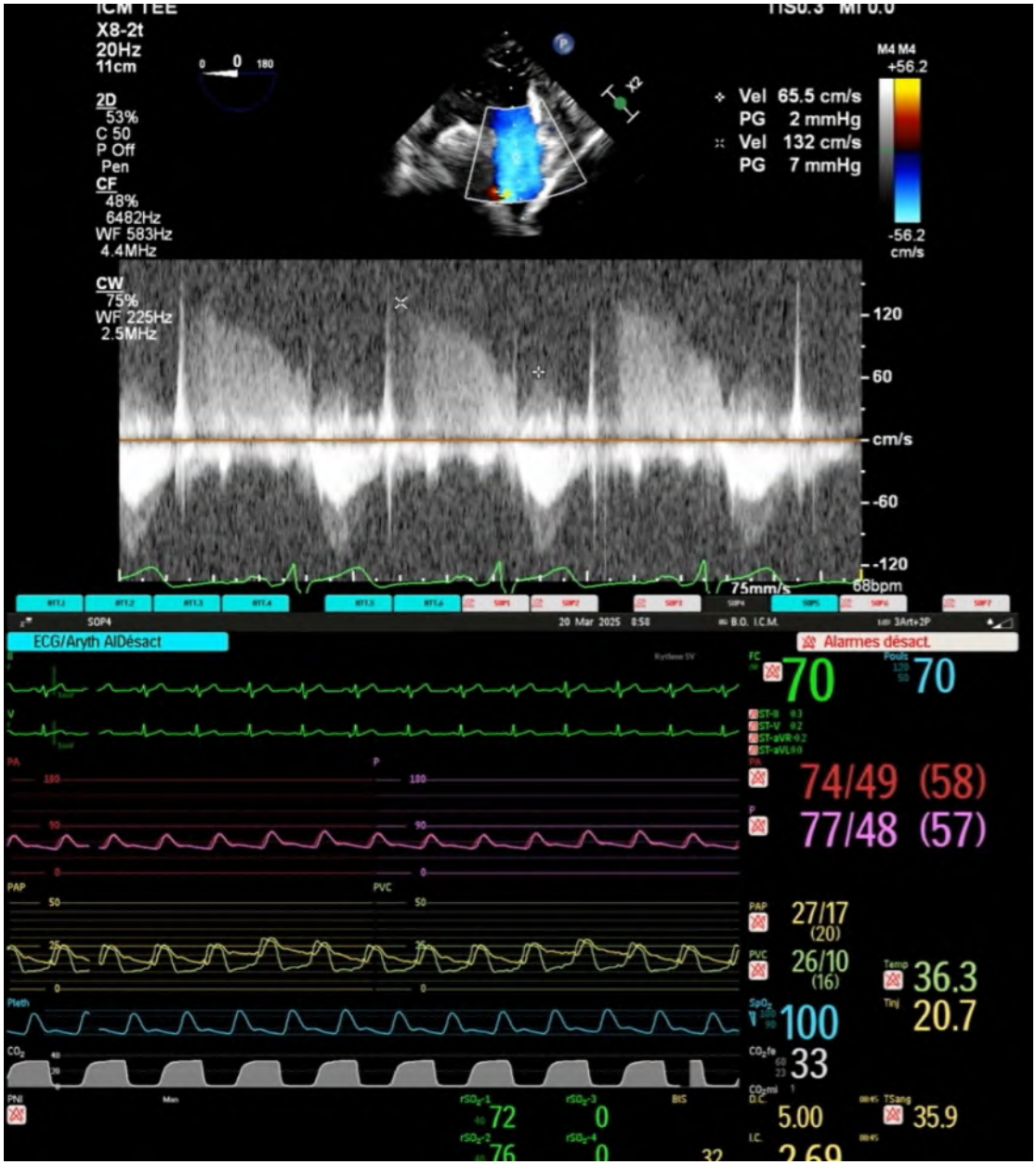
Answer: C.

A pulmonary regurgitation tracing allow estimation of the mean and diastolic pulmonary artery pressure. In this case the end-diastolic pressure gradient was 2 mmHg.

PR gradient: PAEDP – RVEDP
RVEDP = right atrial pressure (RAP)
PAEDP = PR gradient + RVEDP = PR gradient + RAP = 2 + 11 – 13 mmHg

The MPAP can be estimated using the formula
MPAP = 4 (early peak velocity)^2 + RAP
MPAP = 4 (1.32)^2 = 7 mmHg + 11 = 18 mmHg

Those values are close from those obtained simultaneously using right heart catheterization. (see video Chap05_Q10)



Chapter 6
Goal-Oriented Transthoracic and Epicardial Echocardiography

Q1: What are the basic FOCUS views?

A) Parasternal short-axis (PSAX) view, apical 4-chamber view, and subcostal short-axis view
B) Parasternal long-axis (PLAX) view, PSAX view, and subcostal 4 chamber view
C) PLAX view, PSAX view, apical4-chamber view, and apical 2 chamber view
D) PLAX view, PSAX view, Apical 4-chamber view, and subcostal 4 chamber view

Answer: D

The FOCUS examination includes important echocardiographic views, with scanning from three main areas: the parasternal, apical, and subcostal areas using 4 views (Figure 6. 2).

Q2: Which one of the following is considered incorrect?

A) Bedside transthoracic echocardiography (TTE) has good positive predictive value for the indirect diagnosis of massive pulmonary embolism (PE)
B) The presence of acute right ventricular (RV) dilatation and dysfunction, without actually imaging the embolus, is highly suggestive of PE
C) Normal RV function rule out the presence of small emboli in patients with moderate-to-high clinical suspicion for PE.
D) McConnell is 77% sensitive and 94% specific for the diagnosis of acute PE using TTE.

Answer: C

Normal RV function does not exclude a small embolus in patients with moderate-to-high clinical suspicion for PE, however, the lack of McConnell sign in these patients lowers the likelihood of hemodynamically significant PE.

Q3: Which one of the following is correct?

A) In patients with tamponade, collapse of the RV free wall is seen in early systole and the right atrium (RA) in early diastole
B) Hemodynamically significant effusion is diagnosed if the RA collapse lasts more than two thirds of the R-R interval.
C) A small amount of fluid cannot cause tamponade
D) In post-sternotomy patients, tamponade may be missed by TTE as the loculated clots may be located posterior to the heart in the far field.

Answer: D

Echocardiographic signs of tamponade show the collapse of one or more cardiac chambers. These signs are best visualized in the subcostal view. RV free wall collapse appears in early diastole and the RA in late diastole. In post-sternotomy patients, TTE may miss tamponade, as the loculated clots may be posterior to the heart in the far field. Small amount of fluid can cause tamponade if they rapidly accumulate.

Q4: Key findings in favor of hypovolemia on two-dimensional (2D) imaging include all of the following except:

A) Small hyperkinetic RV and LV
B) Decreased ejection fraction
C) Dynamic LV obstruction
D) Small inferior vena cava (IVC) (<20 mm) with wide respiratory variation

Answer: B

Key findings favoring hypovolemia on 2D imaging include (i) small hyperkinetic RV and LV, (ii) increased left ventricular ejection fraction, (iii) dynamic LV obstruction, and (iv) small IVC (<20 mm) with wide respiratory variation.

Q5: What is the appropriate ultrasound probe frequency that is used in epicardial echocardiography?

A) 2.5 MHz
B) 3 MHz
C) 5 MHZ
D) 6-15 MHz

Answer: D

When performing epiaortic and epicardial US, the structures of interest are near the transducer. This permits the use of high-frequency (6-15 MHz) phased array transducers with a small footprint.

Q6 (see video Chap6_Q6): A 59-year-old man with severe cardiovascular disease had coronary artery bypass surgery. What finding is present here?

A) Atherosclerotic aorta
B) Extracorporeal membrane oxygenation (ECMO) cannula in good position.
C) Inferior vena cava (IVC) filter in good position
D) Hyperechoic liver that requires further investigation

Answer: B.

Extracorporeal membrane oxygenation (ECMO) cannula in good position. This is an example of an ECMO cannula in the IVC. The lumen of the cannula is in the IVC with the tip at the atrio- caval junction.

Q7 (see video Chap06_Q7): Which of the following is not a feature of pericardial tamponade:

A) Right atrial diastolic collapse
B) Right ventricular diastolic collapse
C) Greater than 40% change in tricuspid valve inflow velocity with respiration on PW Doppler
D) IVC dilation

Answer: A.

Echocardiographic signs of tamponade show the collapse of one or more cardiac chambers. These signs are best visualized in the subcostal view. RV free wall collapse appears in early diastole and the RA in late diastole. Hemodynamically significant effusion occurs if RA collapse lasts more than one-third of the R-R interval.

Q8 (see video Chap06_Q8): An 82-year-old man after a knee replacement performed with spinal anesthesia and conscious sedation is in the post-op care unit. His vital signs include heart rate 96 beats/min, blood pressure 70/36 mmHg, and oxygen saturation 90%. Based on the focus cardiac ultrasound examination performed to evaluate him, what would be the best management?

A) Call cardiology to evaluate regional wall motion abnormality (RWMA)
B) Start phenylephrine infusion
C) Give 2 liters of normal saline and start dopamine
D) Start milrinone for pulmonary hypertension

Answer: B.

Start phenylephrine infusion. This left ventricle is hyperdynamic most likely due to vasodilatation from residual spinal anesthesia. Neither a wall motion abnormality nor definitive signs of pulmonary hypertension are present. Starting milrinone will further vasodilate and lower the patient's blood pressure. Dopamine has B1 agonist effect that will make the heart more hyperdynamic. Starting a short acting will further vasodilate and lower the patient's blood pressure. Dopamine has B1 agonist effect that will make the heart more hyperdynamic. Starting a short acting vasopressor is the most appropriate action.

Q9 (see video Chap06_Q9) select the correct answer regarding the epicardial view and the corresponding diagnosis.

A) Epicardial basal short-axis view in a normal left and right ventricle
B) Epicardial mid-papillary view in a patient with septal wall ischemia
C) Epicardial basal short-axis view in a patient with right ventricular volume overload
D) Epicardial mid-papillary short-axis view in a patient with pulmonary hypertension

Answer: D

This is an epicardial mid-papillary short-axis view. Note the persistent D-shape aspect of the interventricular septum and the similar right and ventricular dimension. This is consistent with right ventricular pressure overload typically secondary to pulmonary hypertension.

Q10 (see video Chap06_Q10) What is the diagnosis?

A) Normal epicardial aortic valve view but with wrong orientation
B) Normal epicardial pulmonic valve
C) Normal epicardial aortic valve view
D) Abnormal epicardial aortic valve view but with wrong orientation

Answer: A

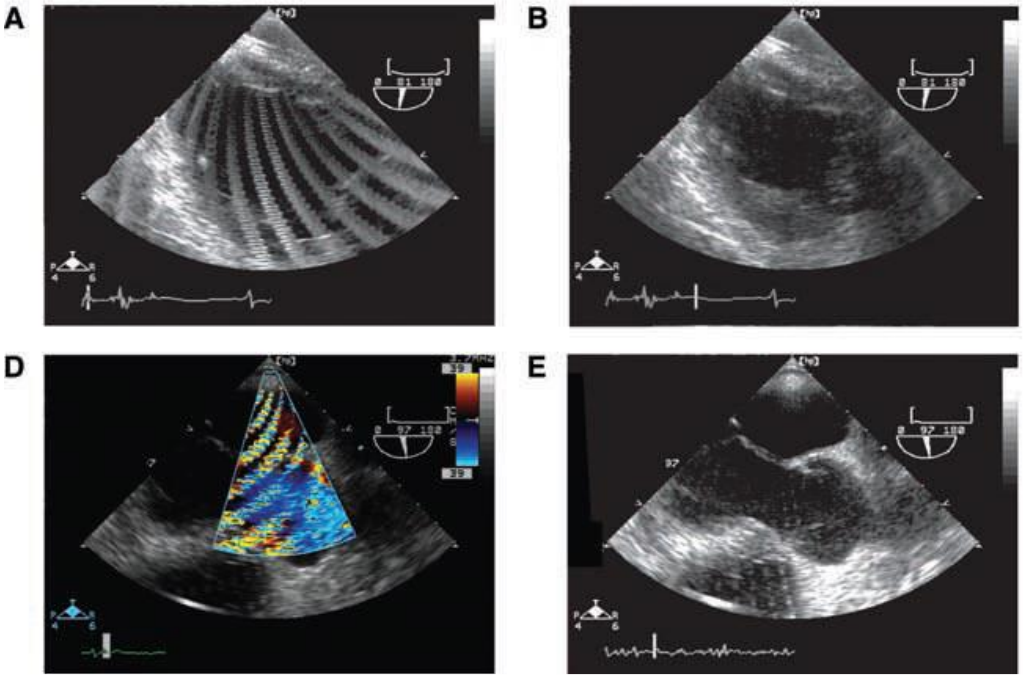
In the guidelines for performing epicardial echocardiography, the epicardial aortic valve long-axis (LAX) view is obtained from the epicardial aortic valve short-axis (SAX) view by positioning the probe upward along the right-sided surface of the aortic root with the orientation marker slightly rotated clockwise and directed to the patient's left. This orientation is similar to the aortic valve LAX views the transthoracic parasternal and mid-esophageal transesophageal orientation.

Chapter 7
Imaging Artifacts and Pitfalls

Q1: All of the following can help to confirm the presence of an image artifact except?
A) Indistinct boundaries
B) Extension across normal surrounding structures
C) Disappearance with changes in sector depth setting, imaging planes, and transducer position
D) Presence of independent motion

Answer: D
Independent motion favors a real structure. See Table 7.2

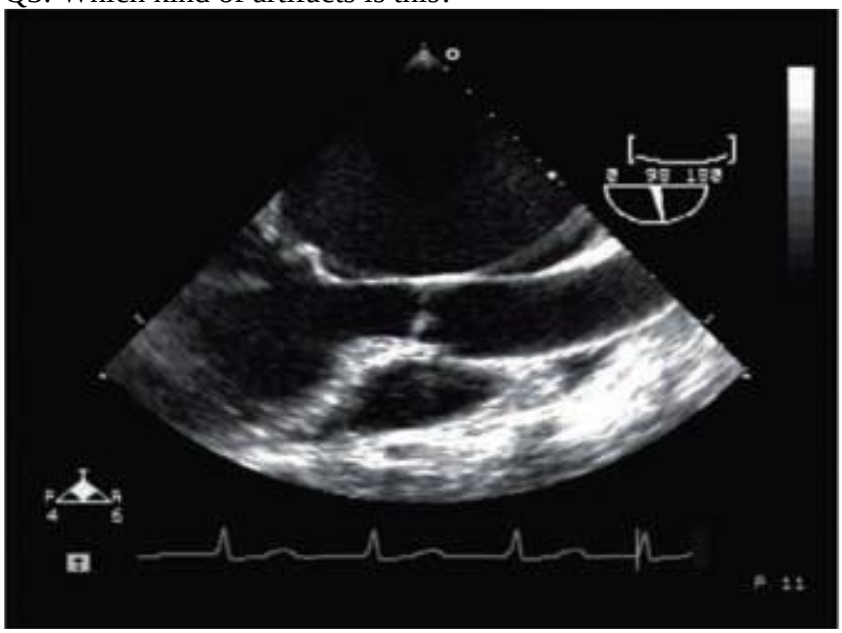
Q2: Which kind of artifacts is this?



A) Reverberation artifact
B) Refraction artifact
C) Mirror image artifact
D) Electrocautery artifact

Answer: D
Electrocautery produces a characteristic, fan-shaped interference pattern artifact precluding proper 2D and color flow imaging. This noise artifact appears only during electrocautery use and vanishes instantly when ceasing the electrocautery.

Q3: Which kind of artifacts is this?

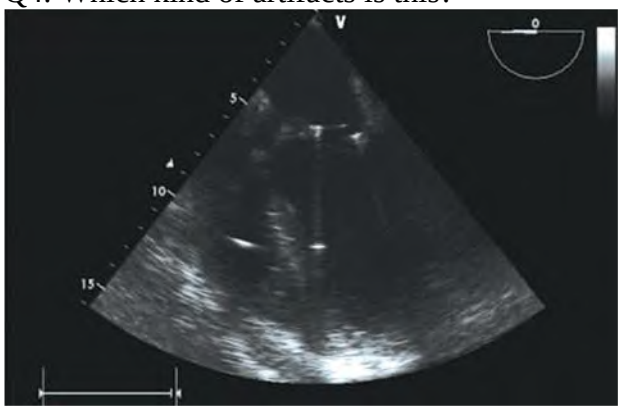


A) Reverberation artifacts
B) Side lobe artifact
C) Mirror image artifact
D) Electrocautery artifact

Answer: B

These regions of ultrasound (US) energy, lateral to the main beam in the far field, are the “side lobes”

Q4: Which kind of artifacts is this?

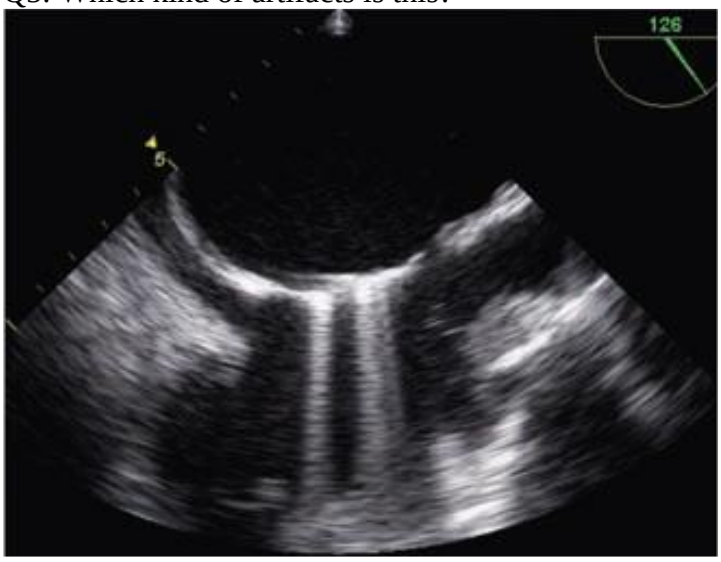


A) Reverberation artifacts
B) Side lobe artifact
C) Comet tail
D) Electrocautery artifact

Answer: C

Comet tails artefact are bright “tails” behind a strong reflector, characterized by multiple parallel bands. The mechanism is based on an acoustic impedance difference between media. It is a reverberation artifact but there are usually two or more reflectors that are very close together, and the process involves multiple round trips

Q5: Which kind of artifacts is this?

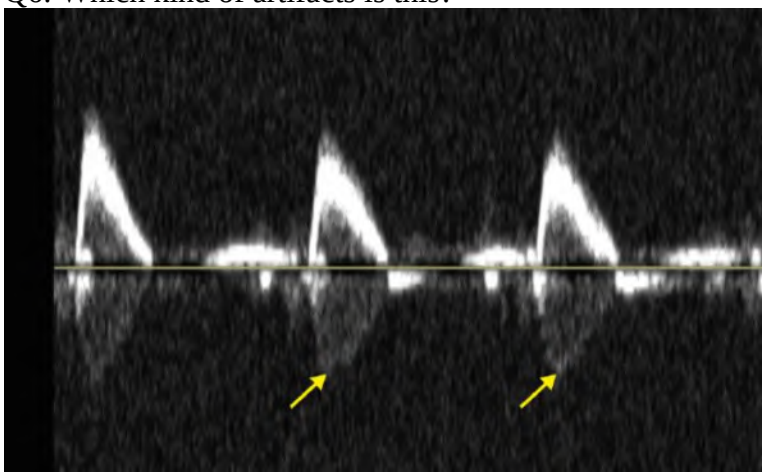


A) Ring down artifact
B) Side lobe artifact
C) Comet tail
D) Electrocautery artifact

Answer: A

Ring-down artifacts are another type of bright tail artifact in the axis of the insonated US wave. When US reaches gas bubbles, it excites the liquid trapped between the bubbles, which causes the liquid to resonate. The vibrations cause a continuous sound wave which transmits back to the receiver. There is a clearly identifiable source, and the artefact will “ring-down” as continuous or successive stacks of short horizontal bands to the end of the screen without fading.

Q6: Which kind of artifacts is this?



A) Ring down artifacts
B) Side lobe artifact
C) Comet tail
D) Cross-talk artifact

Answer: D

Quadrature channel cross-talk. This mid-esophageal (ME) descending aorta long-axis (LAX) view with pulsed-wave Doppler (PWD) shows this spectral artifact, which looks like a mirror image (arrow) of the initial signal. The phase separation circuits commonly used in echo machines cause it.

Q7: Criteria for diagnosis of this condition include:

A) Atrial septum thickness reaching ≥5 mm
B) Atrial septum thickness reaching ≥10 mm
C) Atrial septum thickness reaching ≥15 mm
D) Atrial septum thickness reaching ≥20 mm

Answer: C

A normal interatrial septum (IAS) can measure up to 7 mm with IAS thickening a common finding. Fatty deposits in the IAS may lead to high echogenicity and severe thickening of its muscular region. Lipomatous hypertrophy of the IAS has a thickness of > 15 mm

Q8 Which 3D structure is shown (see video Chap07_Q8A)

A) Ruptured mitral valve
B) Eustachian valve
C) Flail tricuspid valve
D) Reverberation artifact

Answer: B

(see video Chap07_Q8B) This is the 3D aspect of the Eustachian valve. It is a crescent-shaped ridge on the anterior aspect of the inferior vena cava (IVC) orifice. It may be redundant and appear as a thin mobile membrane undulating in the RA. Unusually large EVs can cause blood flow obstruction from the IVC.

Q9 What is the name of this artifact? (see video Chap07_Q9)

A) Blurring artefact
B) Dropout artefact
C) Blooming artefact
D) Stitching artefact

Answer: D

Stitching artefact are incorrect juxtaposition at the interface of sequential subvolumes. In this case there were 4 volumes. In order to avoid those artifacts, hold respiration and motion and switch to single-beat acquisition.

Q10 What is the abnormality (see video Chap07_Q10)

A) Mitral regurgitation
B) Atrial myxoma
C) Yo-yo artifact
D) Gain, LA smoke

Answer. D

Smoke in the left atrium with unadjusted gain can produce this 3D artifact.

Chapter 8
Equipment, Complications, Infection Control, and Safety

Q1: Which sentence of the followings is correct about the contraindications for TEE?
A) Oesophageal varices are considered an absolute contraindication for TEE
B) Oesophagitis is considered an absolute contraindication for TEE
C) Relative contraindications may not preclude TEE examination but warrant careful evaluation of the risk-benefit ratio of the procedure
D) None of the above

Answer: C

There are many relative contraindications (Table 8.5). These include various esophageal pathologies, hiatal hernia, previous gastroesophageal surgeries, bleeding diathesis, cervical abnormalities, or anatomical distortion from arthritis or radiation therapy. Relative contraindications may not preclude TEE examination but warrant careful evaluation of the risk-benefit ratio of the procedure.

Q2: Which one of the followings is considered an absolute contraindication for elective TEE?
A) Previous radiation therapy to the mediastinum
B) Neck surgery
C) Perforated viscus
D) Lack of informed consent

Answer: C

Absolute contraindications include esophageal obstruction or interruption, gastric volvulus, active upper gastro-intestinal (GI) bleeding, and perforated viscus (Table 8. 1) Before proceeding with a TEE examination, it is important to inform the patient of the aims, technique, and risks of the procedure and document informed consent in the patients' medical record. In emergency situation, if no obvious contra indication is present, TEE may be used.

Q3: Which sentence of the followings is correct as regards prophylaxis against infective endocarditis (IE) before TEE?
A) It is recommended to give amoxicillin before TEE
B) It is recommended to give clindamycin before TEE
C) A&B
D) IE prophylaxis is not recommended before TEE in the absence of active infection

Answer: D

The American College of Cardiology/American Heart Association guidelines no longer recommend antibiotic prophylaxis for nondental procedures such as TEE, esophagogastroduodenoscopy and colonoscopy in the absence of active infection.

Q4: What is the appropriate reversal agent for benzodiazepine overdose?

A) Methylene blue
B) Flumazenil
C) Naloxone
D) Protamine sulfate

Answer: B

Reversal agents for benzodiazepine and narcotic overdose, such as flumazenil and naloxone, respectively, should be readily available. Procedural sedation strategies and techniques are beyond the scope of this chapter, but sedation practice guidelines by non-anesthesiologists have addressed this topic.

Q5: What is the Incidence of mechanical complications during the TEE study?

A) Up to 1.5%
B) Up to 2.5%
C) Up to 3.0%
D) Up to 5%

Answer: C

Multiple studies show intraoperative TEE-related major mechanical complications vary between 0.2% and 3%.

Q6: What is the Incidence of complications during an emergency TEE study?

A) Up to 8.6%
B) Up to 10.6%
C) Up to 12.6%
D) Up to 15%

Answer: C

The TEE examination carried out in emergency settings has a higher complication rate of up to 12.6%. Several factors contribute to this situation, including the emergent need for TEE, the hemodynamic status of the patient, the alteration of consciousness, and the risk of aspiration from a full stomach.

Q7: Which sentence of the followings is incorrect about cleaning and disinfection of the TEE probe?

A) All TEE and endoscopic equipments must be cleaned between each patient.
B) B-Cleaning should be done by properly trained staff
C) Thorough, but gentle, mechanical cleaning under running water with soap or detergent to remove all gross organic material (secretions, saliva, and so on) from the probe.
D) Probe soaking in a bath of 1% glutaraldehyde for 60 min even in HIV patients.

Answer: D

After cleaning, immersing TEE probes in ≥ 2% glutaraldehyde for at least 20 minutes at 20°C achieves disinfection

Q8: Which of the following is not an absolute contraindication to transesophageal echocardiography?

A) Cervical spine instability
B) Esophageal stricture
C) Active upper gastrointestinal bleeding
D) Esophageal varices
E) Esophageal perforation

Answer: D

Patients with liver failure present several relative contraindications such as esophageal varices, esophagitis, and coagulopathy, nevertheless, clinicians may cautiously use TEE during liver transplantation (See Chapter 28).

Q9: What is the incidence of unrecognized esophageal laceration and perforation due to TEE manipulation?

A) 0.03-0.09%
B) 0.2%
C) 0.5%
D) 1%

Answer: A

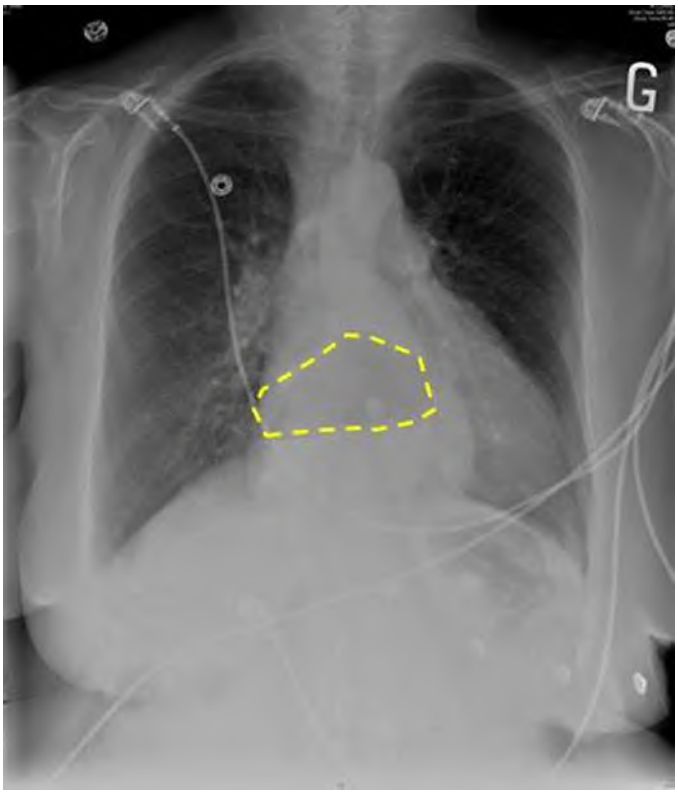
The incidence of severe upper GI tract laceration has been estimated to be 0.03-0.09% in the cardiac surgical population. Initially unrecognized, esophageal perforation can often lead to mediastinitis and has been associated with a mortality rate of 40%.

Q10 Chest radiograph prior to cardiac surgery in a 72-year-old woman. Select the appropriate statement

A) The chest radiograph is normal and a transesophageal echocardiography exam can be performed
B) The chest radiograph is abnormal but a transesophageal echocardiography exam can be performed
C) The chest radiograph is abnormal and a transesophageal echocardiography exam cannot be performed
D) The chest radiograph is not useful in determining if a transesophageal echocardiography exam can be performed

Answer: B.

The hyperlucent area (dotted line) corresponds to an hiatal hernia. There are many relative contraindications (Table 8.5). These include various esophageal pathologies, hiatal hernia, previous gastroesophageal surgeries, bleeding diathesis, cervical abnormalities, or anatomic distortion from arthritis or radiation therapy. Relative contraindications may not preclude TEE examination but warrant careful evaluation of the risk-benefit ratio of the procedure. A chest radiograph can identify patients with hiatal hernia.



Chapter 9: Segmental Ventricular Function and Ischemia

Q1: Which of the following has the least effect on the interpretation of interventricular septal wall motion:

A) Right bundle branch block (RBBB)
B) Constrictive pericarditis
C) Left bundle branch block (LBBB)
D) Right ventricular pacing

Answer: A.

RBBB "In addition, the presence of a LBBB, right ventricular (RV) volume overload, constrictive pericarditis, ventricular pacing or the postoperative state after cardiac surgery often complicates the assessment of inter-ventricular septal wall motion."

Q2: A dobutamine stress test results are shown in the table below. Which wall is hibernating?

Dobutamine dose	Anterior wall	Anterolateral wall	Inferolateral wall	Inferior wall	Inferoseptal wall	Anteroseptal wall
0 mcg/kg/min	Normal	Hypokinesia	Akinesia	Mild hypokinesia	Normal	Normal
5 mcg/kg/min	Normal	Hypokinesia	Severe hypokinesia	Moderate hypokinesia	Normal	Normal
15 mcg/kg/min	Normal	Hypokinesia	Mild hypokinesia	Severe hypokinesia	Hypokinesia	Normal
20 mcg/kg/min	Normal	Hypokinesia	Akinesia	Severe hypokinesia	Hypokinesia	Normal

A) Anterior wall
B) Anterolateral wall
C) Inferolateral wall
D) Inferior wall

Answer: C.

Inferolateral wall. Hibernation is a state of persistently impaired myocardial function at rest from reduced coronary blood flow. Therefore, partial or complete restoration of coronary blood flow to normal is required to resolve hibernation, which involves surgery, percutaneous coronary intervention (PCI) and/or afterload reduction. Demonstration of increased contractility in a hypokinetic or akinetic region suggests that the regional systolic function will improve either after revascularization in the case of hibernating myocardium or spontaneously after recovery from stunning. A biphasic response to increasing dobutamine doses characterized by enhanced thickening at low doses (5–10 μg/kg/min) followed by deterioration of thickening at higher doses (>10 μg/kg/min) is the most accurate echocardiographic criterion to detect viable but hypoperfused myocardium.

Q3: Which of the following is true concerning myocardial rupture of the left ventricle?

A) It accounts for less than 1% of all in-hospital deaths in the post infarction period
B) It is more common in older patients
C) Anterior wall rupture is the most common site of occurrence
D) Lateral wall rupture is the most common site of occurrence

Answer: B.

Rupture of the LV free wall is usually a sudden event, which accounts for 8–17% of all in-hospital deaths in the postinfarction period. It occurs in elderly hypertensive patients with Q-wave infarcts. There is an equal distribution of myocardial rupture sites between the anterior, posterior, and lateral walls. Usually, there is an acute clinical deterioration with recurrent chest pain, massive hemopericardium, hemodynamic deterioration, electromechanical dissociation, and sudden death within minutes It is more common in older patients.

Q4 (see video Chap9_Q4): The image shown is best representative of what condition?

A) A large basal/mid anterior left ventricular (LV) aneurysm
B) A large basal/mid anterior pseudoaneurysm
C) A large basal/mid inferior aneurysm
D) A large basal/mid inferior pseudoaneurysm

Answer: C. A large basal/mid inferior aneurysm. The clip shows an aneurysm with the typical features of an akinetic segment, a wide neck that persists in diastole and a well defined subendocardium. In contrast a pseudoaneurysm is characterized by a narrow orifice arising from the ventricular chamber and represents chronic ventricular rupture which is contained by pericardium. Pseudoaneurysms have a high incidence of spontaneous rupture. The 60° image plane in the mid esophagus demonstrates the inferior wall segments on the left and anterior segments on the right.

Q5 (see video Chap9_Q5-6A and video Chap9_Q5-6B): A 70-year-old male presents with an acute MI and dyspnea. Which of the following diagnoses is most likely based on the images shown?

A) Pericardial tamponade
B) Left ventricular (LV) to right atrial fistula
C) LV pseudoaneurysm
D) Ventricular septal defect (VSD)
E) Ruptured sinus of Valsalva aneurysm

Answer: D.

Ventricular septal defect. There is septal drop-out between the LV and right ventricle suggestive of a VSD. Color Doppler also reveals left-to-right shunt through the defect. The associated aneurysm on the clip is a true aneurysm.

Q6 (see video Chap9_Q5-6A and Chap9_Q5-6B): Which coronary artery is most likely to have been occluded to result in the pathology demonstrated?

A) Left anterior descending (LAD) artery
B) Septal perforator artery
C) Circumflex artery
D) Right coronary artery (RCA)

Answer: D.

Right coronary artery. The lesion is in the mid inferoseptal segment, which is supplied by the RCA.

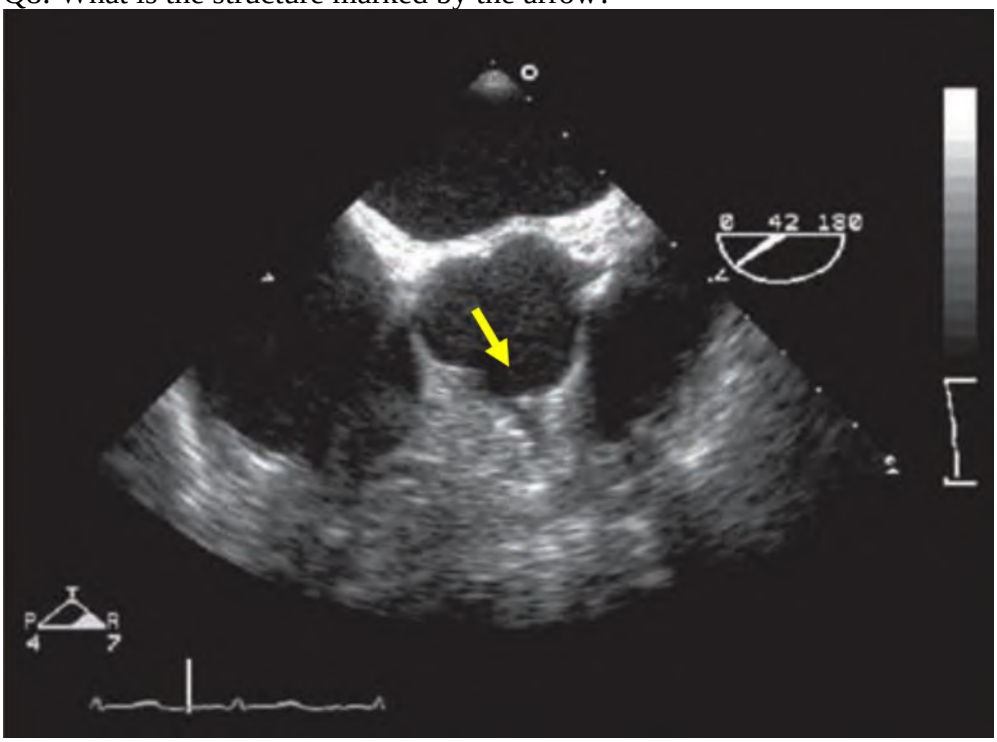
Q7: Which sentence of the followings is correct about coronary circulation?

A) System dominance is defined by the artery providing the posterior descending artery (PDA)
B) System dominance is defined by the artery providing the postero-lateral artery (PLA) branch
C) The posterior descending artery arises from the right coronary artery (RCA) in 20% of patients
D) The posterior descending artery arises from the circumflex in 80% of patients

Answer: A

An artery providing the PDA and the PLA defines coronary arterial system dominance. The commonest pattern is right dominance in about 85% by the RCA

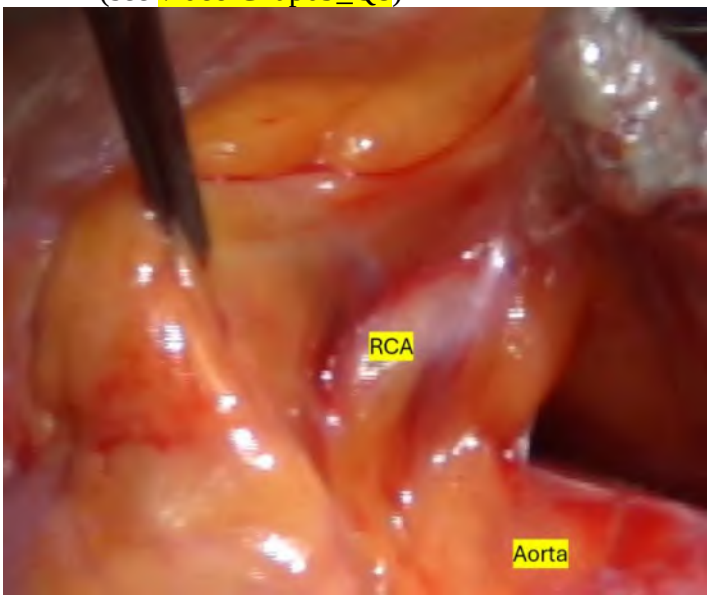
Q8: What is the structure marked by the arrow?



A) Left main coronary artery
B) Left anterior descending artery
C) Left circumflex artery
D) Right coronary artery

Answer: D.

The right coronary artery can be seen in some patients intraoperatively. (see video Chap09_Q8)



Q9: Which sentence of the followings is incorrect?

A) Acute ischemia is usually manifested as a regional wall motion abnormality
B) Global ventricular dysfunction may result from high-grade obstruction of one or more arteries perfusing a large area
C) Global ventricular dysfunction may result from the acute obstruction of one artery in the setting of previous infarction in other areas.
D) Global hypokinesia rule out coronary artery disease as a cause of left ventricular (LV) dysfunction

Answer: D

Although acute ischemia appears echocardiographically as regional wall motion abnormality (RWMA), global ventricular dysfunction may result from high-grade obstruction of one or more arteries perfusing a large area, acute obstruction of one artery with a previous infarction in other areas or an ischemic mechanical complication such as papillary muscle rupture

Q10: Which sentence of the followings is incorrect?

A) Segmental wall motion abnormality is defined as hypokinesis when contraction is normally directed, but reduced in magnitude
B) Segmental wall motion abnormality is defined as akinesis when the contraction is absent
C) Segmental wall motion abnormality is defined as dyskinesis when there is systolic bulging
D) Segmental wall motion abnormality is defined as dyskinesis when there is diastolic bulging

Answer: D

The assessment of regional myocardial function is by observing wall thickening and endocardial motion of the myocardial segment. A regional wall motion abnormality (RWMA) is hypokinetic when contraction is inwards but reduced in magnitude, akinetic when it is absent, or dyskinesis when there is a movement in the opposite direction (systolic bulging)

Q11: According to Wall Motion Score Index, a score of 4 is given for?

A) Aneurysmal segment
B) Dyskinetic segment
C) Hypokinetic segment
D) Akinetic segment
E) Hyperkinetic segment

Answer: B

A score of 1 is a normal contracting or hyperkinetic segment, 2 is a hypokinetic segment, 3 is akinesis, and 4 is a dyskinetic segment or aneurysmal (diastolic deformation) segment.

Chapter 10:
Global Ventricular Function and Hemodynamics

Q1: All of the following variables can be used to assess systolic function with the exception of:

A) Fractional shortening
B) Ejection fraction
C) Stroke volume
D) Pulmonary vein Doppler analysis

Answer: D.

Pulmonary vein Doppler analysis is used to assess left ventricular diastolic function

Q2: The pseudonormalized filling pattern can be distinguished from the normal pattern by all the following except:

A) The Valsalva maneuver unmasks impaired relaxation
B) The E/A ratio decreases to less than 1.0 with the administration of sublingual nitroglycerin
C) A reduction in preload by sitting unmasks impaired relaxation
D) The E/A ration is < 1

Answer: D

The E/A ratio is typically > 1 and of normal aspect. Patients with relaxation abnormalities and increased filling pressure show a moderate or intermediate form of diastolic dysfunction called the pseudo-normal pattern. The expression “pseudo-normal” is a consequence of the normal pulsed-wave Doppler (PWD) mitral inflow signal, while the pulmonary vein velocity (PVV) pattern is clearly abnormal (S/D < 1).

Q3: All of the following are true regarding myocardial performance index (MPI), with the exception of:

A) Doppler interrogation of mitral inflow is required
B) Doppler interrogation of left ventricular outflow tract is required to measure ejection time
C) Not affected by changes in diastolic function
D) Useful in the evaluation of both left ventricular (LV) and right ventricular (RV) systolic functions

Answer: C.

The RV and LV MPI (see Eq. 10.7) incorporate both systolic and diastolic time intervals, measured by Doppler, to assess systolic and diastolic function is affected by changes in diastolic function

Q4 (see video chap10_Q4): Watch the video of the tricuspid annular plane systolic excursion (TAPSE). Which statement is true?

A) TAPSE is useful to assess left ventricular function and it is normal in this patient
B) TAPSE is useful to assess left ventricular function and it is abnormal in this patient
C) TAPSE is useful to assess right ventricular function and it is normal in this patient
D) TAPSE is useful to assess right ventricular function and it is abnormal in this patient

Answer: C.

TAPSE is useful to assess right ventricular function and it is normal in this patient. TAPSE) < 17 mm is abnormal and highly suggests RV systolic dysfunction

Q5 (see video chap10_Q5): In the video, the global left ventricular (LV) systolic function is best characterized as:

A) Normal
B) Mild systolic dysfunction
C) Moderate systolic dysfunction
D) Severe systolic dysfunction

Answer: D.

Severe systolic dysfunction. Low LV ejection fraction (LVEF) inferior to 52% in men and 54% in women suggests abnormal LV systolic function. The subclassification of LVEF dysfunction severity is mild at 51% to 41% (53% for women), moderate between 30 to 40% and severe at < 30%.

Q6: Which one of the followings is incorrect?

A) Normal LV function is associated with radial shortening
B) Normal LV function is associated with longitudinal 15–20 mm displacement of the base toward the apex
C) Longitudinal displacement of the LV base toward the apex can be quantified using M-mode or tissue Doppler imaging
D) Assessment of longitudinal displacement of the LV base toward the apex using M-mode or tissue Doppler imaging is not correlated with the ejection fraction

Answer: D

Other indirect echocardiographic signs useful in identifying reduced LV systolic function include intracavitary spontaneous echo contrast, increased anterior MV leaflet septal distance and reduced mitral annular plane systolic excursion, an abnormal myocardial performance index (MPI) and reduced strain from 2D or 3D speckle tracking imaging

Q7: Which one of the followings is incorrect regarding mitral annular plane systolic excursion (MAPSE)?

A) The motion of the mitral annulus toward the apex can also be used as an indirect measure of LV systolic function
B) It is usually measured in the apical four-chamber view
C) The normal value is > 17mm
D) MAPSE less than 8mm can predict an ejection fraction less than 50%

Answer: D

MAPSE measurement occurs in the mid-esophageal (ME) four-chamber (4C) on TEE or apical 4C on TTE view by M-mode, where the septal and lateral mitral annulus movement is parallel to the ultrasound beam and is normally 12 ± 2 mm. MAPSE reflects the longitudinal LV function. In a 4C view, a motion of < 8 mm has a 98% sensitivity and a 82% specificity in identifying an LVEF < 50%.

Q8: Which one of the followings is incorrect?

A) In the presence of mitral regurgitation (MR), the rate of change of the regurgitant jet velocity in early systole allows calculation of dP/dt,
B) To calculate dP/dt , the time required for the MR velocity to rise from 1 to 3 m/s should be determined.
C) Normal of dP/dt value is >800 mmHg/s.
D) A dP/dt value below 1000Hg/sec is associated with poor LV systolic function

Answer: C

The normal rate of pressure change is >1200 mmHg/s or < 27 ms between 1 to 3 m/s on MR using continuous wave Doppler (CWD) jet assessment. In contrast, it will be < 1000 mmHg/s (or 32 ms) with poor LV systolic function

Q9: Which sentence of the followings is correct?

A) Right ventricular (RV) volume overload is associated with diastolic flattening of the interventricular septum
B) RV volume overload is associated with systolic flattening of the interventricular septum
C) RV volume overload is associated with systolic and diastolic flattening of the interventricular septum
D) All of the above

Answer: A

With RV volume overload, the RV dilates and the ventricular septum, normally convex toward the RV, flattens or is even convex toward the LV in diastole only, creating a diastolic “D” shaped septum, with associated paradoxical motion during systole. With RV pressure overload, ventricular septal flattening occurs during both systole and diastole

Q10: Which sentence of the followings is incorrect about dynamic right ventricular outflow tract obstruction (RVOT) obstruction?

A) It can occur in the settings of preload reduction
B) It can happen with hypertrophic RV
C) It is improved by inotropic agents
D) It is rarely observed in cardiac surgery.

Answer: C

Abnormal gradients more than 6 mmHg can be found in 30-40% of patients undergoing cardiac surgery and are typically associated with the use of inotropic agents.

Chapter 11
Cardiomyopathy

Q1: In patients with severe hypertrophic cardiomyopathy, subaortic obstruction is characterized by which of the following?

A) Mid-systolic closure of the aortic valve
B) Late peaking high velocity in the outflow tract
C) Systolic anterior motion of the mitral leaflet
D) All of the above

Answer: D.

All of the above. As the left ventricular outflow tract (LVOT) obstruction begins in mid- or late systole, the aortic cusps may close prematurely as a result of the reduced flow in the later half of the ejection period. This mid-systolic closure is best appreciated using M-mode of the aortic valve (AoV) at the mid-esophageal long-axis (LAX) view." "The LVOT obstructive dynamic gradient is late peaking and significantly rises in mid- to late systole. The CW Doppler velocity profile takes a characteristic dagger shape in contrast to the more symmetrical shape of a fixed valvular stenosis or a regurgitant jet of MR. Maneuvers to modify the loading condition should unmask latent LVOT or mid-ventricular obstructions. Performing a Valsalva maneuver or inhalation of amyl nitrite is often impractical in sedated patients; instead, intravenous or sublingual nitroglycerin administration can be used to decrease preload and, to a lesser extent, afterload to provoke or enhance the obstruction. The systolic anterior motion (SAM) of the mitral valve (MV) and its contact with the septum is best evaluated in the mid-esophageal five chamber or LAX views. The extent and duration of the mitral-septal contact can also be appreciated using M-mode of the left ventricle (LV) in the same views. Significant LVOT obstruction is present when the septal contact lasts at least 30% of the systole duration, giving the highest SAM severity grade of 4+.

Q2: In addition to two-dimensional imaging, which of the following signs is associated with poor left ventricular systolic function:

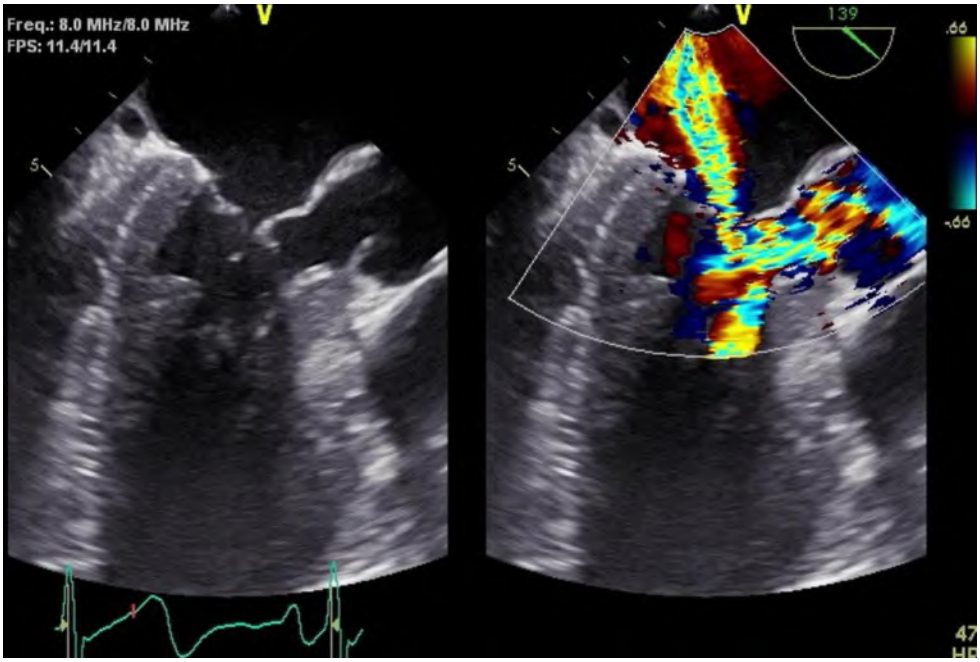
A) Premature mitral valve closure
B) Increased mitral E-point to septal separation
C) Left atrial enlargement
D) Tricuspid regurgitation

Answer: B.

Increased mitral E-point to septal separation "Increased mitral E-point to septal separation is due to a combination of left ventricular dilatation and reduced mitral leaflet motion due to low transmitral flow rates. "

Q3: Which complication is the most frequent after the surgical procedure required to treat the pathology shown in the following echocardiography image?

A) Significant mitral regurgitation
B) Complete heart block
C) Ventricular septal defect
D) Systolic anterior motion of the mitral valve



Answer: B.

Complete heart block “Excessive muscle resection can create complete AV block (7% of cases) or a ventricular septal defect, either acutely or during the healing period.”

Q4 (See video Chap11_Q4). This patient develops hypotension after aortic valve replacement. Treatment of hypotension involves all of the following, with the exception of:

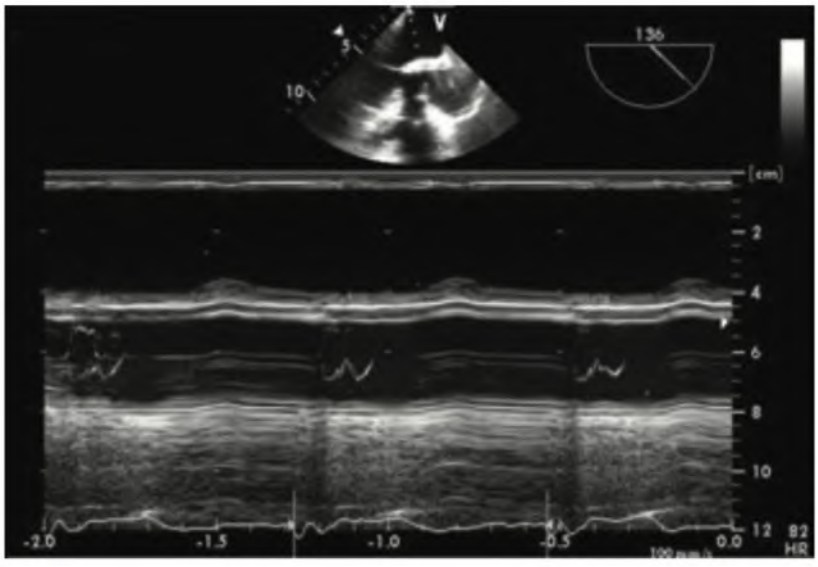
A) Volume replacement
B) Phenylephrine infusion
C) Vasopressin infusion
D) Dobutamine infusion

Answer: D.

Dobutamine infusion. Caring for a hypertrophic obstructive cardiomyopathy (HOCM) patient can be challenging, as inotropes and vasodilators can, paradoxically, decrease cardiac output (CO) by increasing LVOT obstruction. Invasive hemodynamic monitoring with Swan-Ganz catheter demonstrates elevated filling pressures that are difficult to interpret with significant diastolic dysfunction. Transesophageal echocardiography is particularly useful in providing direct evaluation of LVOT obstruction, SAM, and degree of mitral regurgitation (MR). By integrating hemodynamic and echocardiographic monitoring data, it is easier to administer the ideal amount of fluid or to introduce and titrate drugs that reduce the inotropic state (calcium channel blockers, β- blockers) or increase systemic vascular resistance (vasopressors) to minimize LVOT obstruction.

Q5: The M-mode image shown is most consistent with which of the following?

A) Diastolic heart failure
B) Dilated cardiomyopathy (CMP)
C) Hypertrophic obstructive cardiomyopathy (HOCM)
D) Restrictive CMP



Answer: C.

HOCM “This mid-systolic closure is best appreciated using M-mode of the aortic valve (AoV) at the mid-esophageal long-axis (LAX) view. “

Q6: Which sentence of the followings is correct about hypertrophic cardiomyopathy?

A) This disorder has an estimated prevalence of 1/500 individuals in the general population
B) It can be found in 0.5% of the patients referred for an echocardiogram
C) The estimated annual mortality rate is 1% to 2% with sudden death, the first manifestation in as many as 10%.
D) All of the above

Answer: D

HCM is the commonest inherited cardiomyopathy, with an estimated prevalence of 1:500 to 1:200. The estimated annual mortality rate is around 3% whereas sudden death is often the first disease manifestation.

Q7: What is the percentage of apical hypertrophy in patients with hypertrophic cardiomyopathy in western country?

A) 0.5%
B) 1-10%
C) 15%
D) 20%
E) 38%

Answer: B

Apical hypertrophic cardiomyopathy (apHCM) is a phenotypic variant of HCM involving the LV apex. Accounting for 1 to 10% of HCM patients in Western countries, apHCM is more prevalent (38%) in Asia.

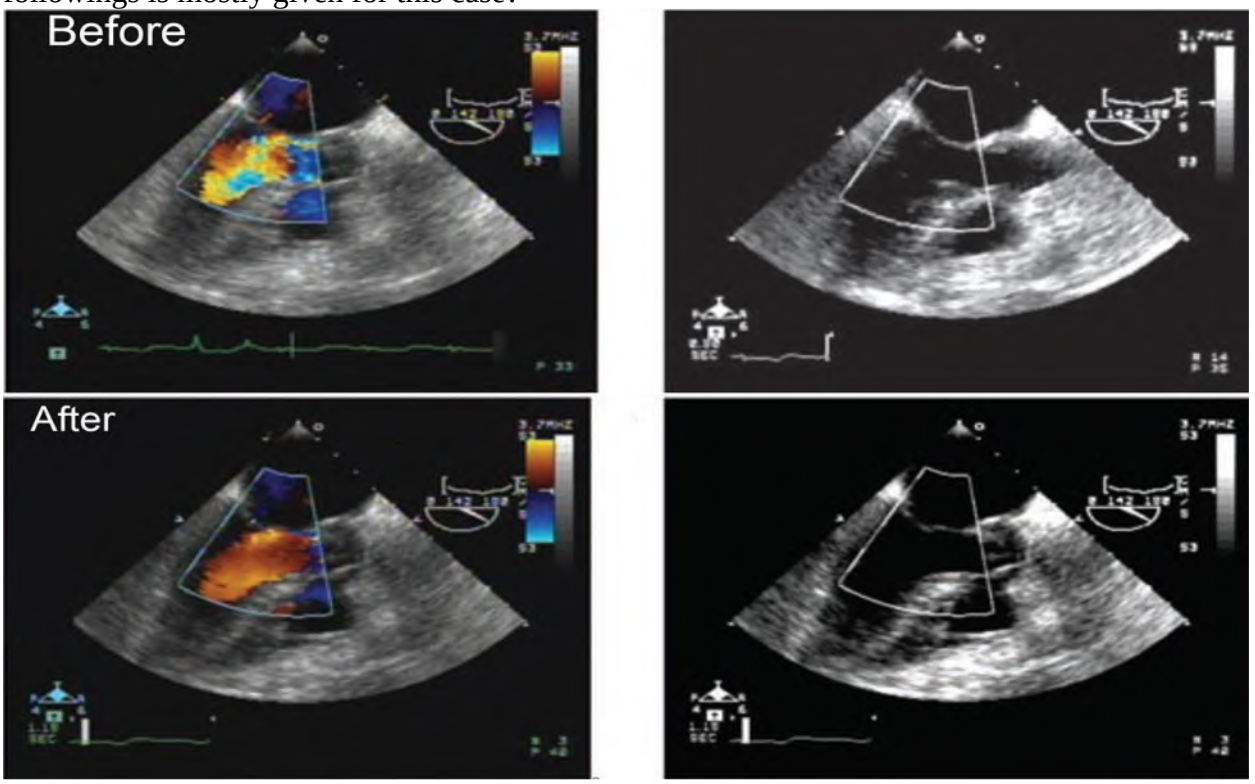
Q8: Which sentence of the followings is incorrect about hypertrophic cardiomyopathy?

A) The mitral valve (MV) may be intrinsically abnormal
B) The papillary muscles can be displaced anteriorly
C) The mitral leaflets can be elongated
D) This end-stage HCM is different from dilated cardiomyopathy (DCM)

Answer: D

However, longstanding HCM might develop, with the replacement of hypertrophic segments by thinner, dysfunctional fibrotic wall dilating the LV systolic and diastolic dimensions. This end-stage HCM is indistinguishable from DCM.

Q9: These images were obtained before and after giving a certain drug. Which medication of the followings is mostly given for this case?



A) IV digoxin
B) IV furosemide
C) IV amiodarone
D) IV metoprolol

Answer: D

The initial management of asymptomatic HCM patients with LVOTO is with negative inotropic drugs such as non-vasodilating beta-blockers or non-dihydropyridine calcium channel blockers.

Q10 Which of the following options would be the best additional therapy for a patient presenting with hypotension and this echo image? (See video Chap11_Q10)

A) Increase with epinephrine infusion dose
B) Sodium nitroprusside infusion
C) Intra-aortic balloon counterpulsation
D) Increase the phenylephrine dose

Answer: D

Systolic anterior motion is best treated medically with additional intravascular volume administration or by the increasing of afterload such as with increasing doses of phenylephrine. Increasing the epinephrine infusion would more than likely increase the dynamic outflow tract obstruction, as would decreasing the afterload with sodium nitroprusside, or IABP insertion.

Chapter 12:
Pericardium

Q1: Regarding the echo findings in cardiac tamponade, from the following choose the best answer:

A) Right atrial systolic collapse
B) Blunted tricuspid inflow peak velocities
C) Right ventricular systolic collapse
D) Evidence of excess pericardial fluid

Answer: A. During cardiac tamponade, the intrapericardial pressure exceeds the right atrial systolic pressure, leading to inversion or systolic collapse of the right atrial free wall. This is recognized as an early sign of tamponade, as the right atrium is the one with the lowest intracavitary pressure. When this collapse lasts for more than one-third of systole, is a sensitive (nearly 100%) and specific indicator of cardiac tamponade diagnosis. The mid-esophageal four-chamber view is probably the best view to visualize this collapse. The presence of early diastolic collapse of the right ventricle, is more specific but less sensitive to diagnose tamponade when compared to right atrium collapse."

Q2: Which would be expected in patients with constrictive pericarditis but not in restrictive cardiomyopathy (RCM)?

A) Lateral mitral valve annular tissue Doppler E_m < 7 cm/s
B) Exaggerated Doppler respiratory variations in transmitral and transtricuspid inflow velocities
C) Biatrial enlargement
D) Moderate to severe pulmonary hypertension

Answer: B.

Exaggerated Doppler respiratory variations in transmitral and transtricuspid inflow velocities are present in constrictive pericarditis. Newer techniques like tissue Doppler imaging (TDI) of the mitral annular motion or color M-mode seems promising in discriminating the two pathologies. In RCM, the mitral annular e velocity is decreased while in constrictive pericarditis the e velocity e is usually >7 cm/s; with color M-mode, mitral flow propagation velocity is <45 cm/s in RCM Some other but less specific findings such as elevated pulmonary pressures, more than moderate MR (or TR) or increased wall thickness may all suggest the presence of RCM. In contrast, finding a thickened or calcified pericardium and annulus reversus where the septal e velocity is higher than the lateral e velocity suggests constrictive pericarditis.

Q3: Which would be expected with a patient with tamponade physiology during spontaneous inspiration?

A) Exaggerated tricuspid peak flow velocity increases by 20%
B) No change in tricuspid or mitral peak flow velocities
C) A decrease in stroke volume through the pulmonic valve
D) An increase in stroke volume through the left ventricular outflow tract (LVOT)

Answer: A.

Exaggerated transtricuspid peak flow velocity increases by 20% “With normal physiology, small increases (<15%) in tricuspid and pulmonic peak flow velocities and right ventricular (RV) stroke volume (SV) and corresponding decreases (<10%) in left-sided parameters are seen during inspiration (Figure 12.17). These respiratory variations are markedly increased in tamponade. Both tricuspid and pulmonic valve peak velocities nearly double with spontaneous inspiration, while both mitral (E velocity) and aortic valve (MV, AoV) velocities are decreased by more than 25%.

Q4 (see video Chap12_Q4): A 68-year-old male develops unexplained hypotension twelve hours after his coronary artery bypass graft procedure. An emergent TEE is performed in the cardiac intensive care unit. Which of the following most accurately reflects the diagnosis?

A) Aortic dissection
B) Cardiac tamponade
C) Pericardial effusion
D) Anterior wall myocardial ischemia

Answer: B.

Cardiac tamponade The image displayed is the transgastric two-chamber view. A large pericardial collection with thrombus is demonstrated in association with reduced left ventricular filling volume.

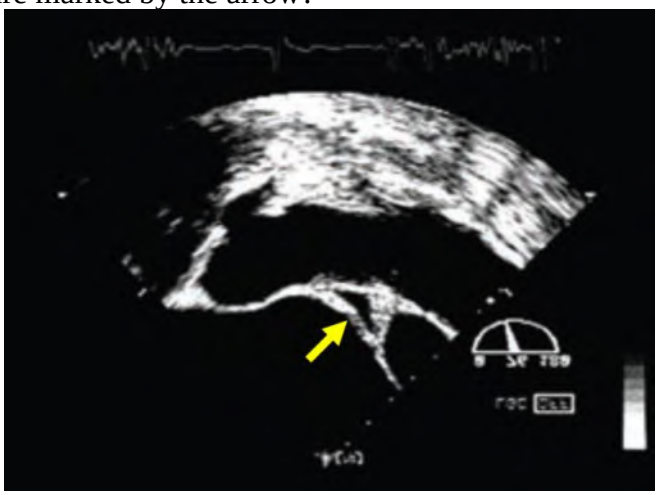
Question 5 (see video Chap12_Q5): In the video shown, what is the diagnosis?

A) Right pleural effusion
B) Left pleural effusion
C) Pericardial effusion
D) Both left pleural effusion and pericardial effusion

Answer: B.

Left pleural effusion. Pericardial and pleural effusions may coexist in the same patient. They can be recognized by locating the position of the descending thoracic aorta and by identifying the pericardium as the membrane separating the two echo-free spaces. Indeed, the presence of a small pericardial effusion often aids in the accurate identification of a pleural effusion. Note also the thickening of the aortic wall consistent with an aortic hematoma.

Q6: What is the structure marked by the arrow?

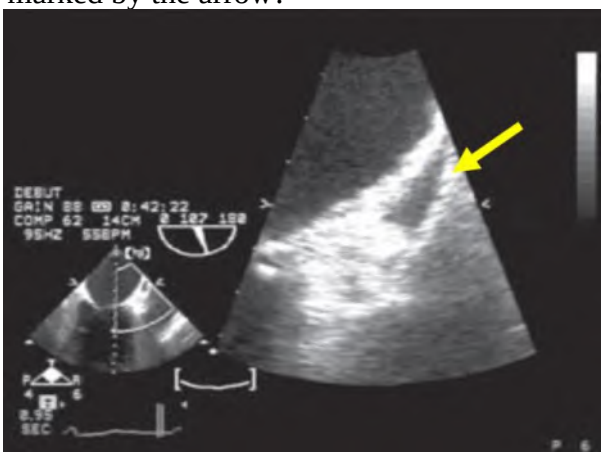


A) Transverse pericardial sinus
B) Oblique pericardial sinus
C) Aortic root abscess
D) Right pulmonary artery

Answer: A

The transverse sinus rests beneath the ascending aorta and pulmonary artery, on the superior surface of the left atrium

Q7: What is the structure marked by the arrow?

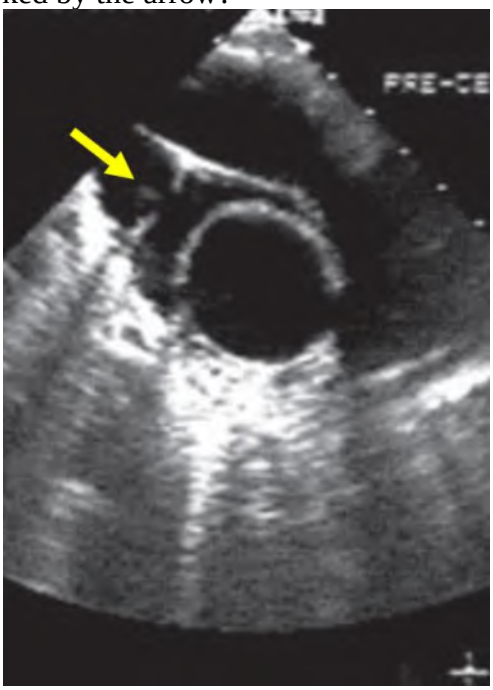


A) Left atrial appendage
B) Aortic root abscess
C) Pericardial effusion
D) Right pulmonary artery

Answer: C

A pericardial effusion appears on echocardiography as an echolucent space between the parietal and visceral pericardial layers.

Q8: What is the structure marked by the arrow?



A) Main pulmonary artery
B) Superior vena cava (SVC)
C) Pericardial effusion
D) Right pulmonary artery

Answer: B

Note also that anechoic region between the SVC and ascending aorta corresponding to fluid in the transverse sinus.

Q9: Which sentence of the followings is incorrect?

A) In the mid-esophageal (ME) four-chamber (4C) view, an isolated echo-free space superior to the right atrium (RA) most likely represents pleural fluid.
B) In the ME 4C view, an isolated echo-free space superior to the right atrium (RA) most likely represents pericardial fluid.
C) The echo-free space is posterior to the descending thoracic aorta in the case of a pleural effusion
D) In the ME 4C, an isolated echo-free behind the left atrium (LA) most likely represents pericardial or pleural fluid.

Answer: A

A left pleural effusion may mimic a pericardial effusion, with the fluid located posterior to the descending aorta in a TTE parasternal long axis view or in a TEE descending aorta short axis view. When the fluid location is between the descending aorta and heart, the fluid is pericardial rather than pleural

Q10: Which sentence of the followings is incorrect?

A) Cardiac tamponade occurs when a pericardial pressure causes the pericardial pressure to exceed the intracardiac pressure, resulting in impaired cardiac filling
B) The amount of fluid is more important than the rapidity of fluid accumulation for the occurrence of tamponade
C) A slowly expanding pericardial effusion (PE) can become quite large (up to 1000 mL) with little increase in pericardial pressure
D) Rapid accumulation of fluid, with a volume as small as 100 mL, may be sufficient to cause cardiac tamponade.

Answer: B

When a moderate to large PE generates enough pressure to exceed the intracardiac pressure, this causes cardiac tamponade, a life-threatening condition that impairs cardiac filling. The amount of pericardial fluid alone is of less importance than the rapidity of fluid accumulation for tamponade to occur.

Chapter 13 :
Echocardiography During Cardiac Surgery

Q1: Which of the following TEE views can help coronary sinus catheter insertion?

A) Lower esophageal view at 0°
B) Bicaval view at 100°
C) Transgastric right ventricular longitudinal view at 90°
D) All of the above

Answer: D.

All of the above.

The lower esophageal level at 0° can image the CS in long-axis. However, a modified bicaval view at 100 ±10° best provides catheter guidance while locating the orifice of the sinus from this plane: as the inferior vena cava (IVC) appears, rotating the probe shaft toward the patient's left; can identify the CS following its course in the left atrioventricular groove, where it appears in cross -section as a circular structure. A transgastric right ventricular (RV) longitudinal view at 90° can also show the CS.

Q2: How often is a left superior vena cava can be observed in adult?

A) 0.5%
B) 1%
C) 2%
D) 5%

Answer: A

Finally, during difficult catheter insertion, TEE may disclose a persistent left SVC known to be present in 0.5% of adults and 1% of children The left SVC usually connects to the RA dilating the coronary sinus (CS) but may sometimes open into the left atrium (LA) (unroof CS), resulting in a right-to-left shunt. Catheter tip placement in the CS via a persistent left SVC may lead to arrhythmias or angina and preclude the insertion of a retrograde cardioplegia catheter.

Q3: What would you tell the surgeon before insertion of the retrograde cardioplegia canula based on this video (see video Chap13_Q3)

A) The coronary sinus is too small
B) There is an Eustachian valve that would impede insertion of the catheter
C) There is a Thebesian valve that would impede insertion of the catheter
D) The coronary sinus is of adequate dimension

Answer C

CS catheter insertion from the RA is often uncomplicated and its position easily confirmed by palpation and pressure tracing measurements. However, difficult insertion may be anticipated when ostial abnormalities, the thebesian valve and a small or stenotic sinus from previous procedures, are present. In these circumstances, TEE can assist cannulation, and confirm and monitor adequate or aberrant catheter placement

Q4 Following the beginning of cardiopulmonary bypass, you observe the following (see video Chap13_Q4). Which statement is incorrect

A) This is a rare complication occurring in less than 0.2%
B) The mortality is higher when present before cardiopulmonary bypass than post-operatively
C) High suspicion and the rapid increase in aortic dimensions and/or a color change visually perceivable in the ascending or transverse aorta constitute keys to an early diagnosis <
D) It can be missed by TEE

Answer: B

Disruption of atherosclerotic plaques or thrombi and dissection may occur during aortic manipulation with cannulation, cross-clamping, side-clamping, and clamp removal. The frequency of intraoperative aortic dissection during cardiac surgery is infrequent at 0.16%. While its mortality rises to 20% when discovered intraoperatively versus 50% for dissections diagnosed postoperatively. High suspicion and the rapid increase in aortic dimensions and/or a color change visually perceivable in the ascending or transverse aorta constitute keys to an early diagnosis. TEE can miss an acute aortic type A dissection limited to the distal ascending aorta and/or proximal aortic arch

Q5 (see video Chap13_Q5): In the video shown, what would you suggest to the surgeon?

A) Allow the air to flow out of the ascending aorta through an aortic root vent or the antegrade cardioplegic with the patient's head down
B) Aspirating air through fine needles located in the LA or the LV apex
C) Expelling air out of the LV by agitation
D) All of the above

Answer: D.

All of the above Intracoronary and intracardiac air. ME AoV LAX view in a 70 year-old man undergoing aortic valve replacement. Air bubbles are directed into the right coronary artery (RCA) and in the ascending aorta

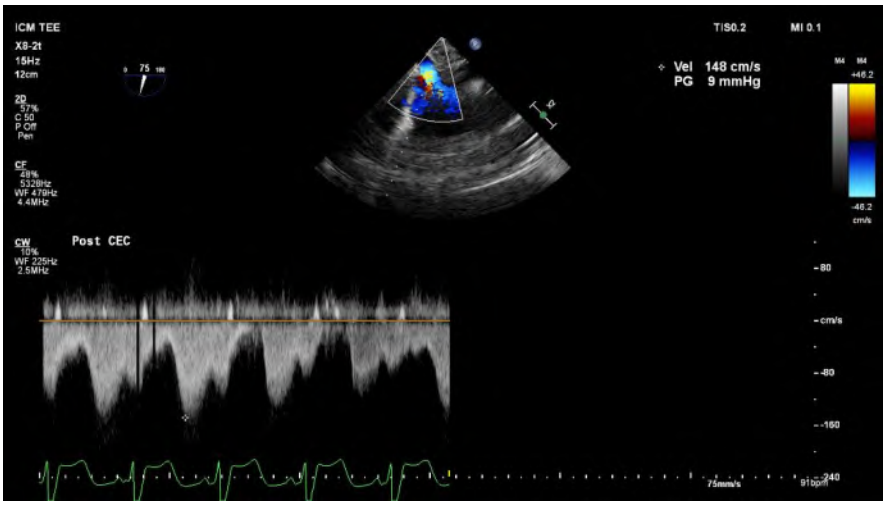
Q6 What is shown in this image (see video Chap13_Q6)?

A) There are 2 inferior vena cava (IVC) canula
B) The IVC canula is not adequately positioned
C) There is a mirror image of the IVC canula
D) The IVC canula is not deep enough

Answer C

This is an example of a mirror image of the IVC canula which is well positioned otherwise. During venous cannulation, IVC cannula malposition in a suprahepatic vein impairs venous return to the CPB reservoir, and, when recognized, repositioning the cannula under TEE guidance can easily correct this.

Q7 What is the most likely cause of hemodynamic instability after cardiopulmonary bypass in this patient after heart transplantation (see video Chap13_Q7)?



A) Iatrogenic tricuspid stenosis
B) Iatrogenic inferior vena cava stenosis
C) Right upper pulmonary vein stenosis
D) Persistent mitral stenosis

Answer B

Exclusion of obstruction to IVC flow from iatrogenic stenosis following cannula removal should involve identifying a dilated IVC and reduced or absent hepatic venous flow

Q8 Why this patient became hemodynamic unstable upon sternal closure following coronary revascularisation? (see video Chap13_Q8)

A) Cardiac tamponade
B) Myocardial ischemia
C) Hypovolemia
D) Diastolic dysfunction

Answer B

During sternal closure, mammary artery flow can be compromised resulting in regional wall motion abnormality which are reversible upon reopening the sternum

Q9 Unstable after cardiac surgery for coronary revascularisation. What is the structure identified by the arrow (see video Chap 13_Q09)?

A) Cardiac hematoma
B) Thickened pericardium
C) Pericardial fat
D) Pericarditis.

Answer C

This is typical of a pericardial fat commonly observed in patients with obesity or dyslipidemia. Note the homogenous and non intense signal which is similan on the anterior portion of the heart. Echocardiographic differentiation of epicardial fat and pericardial effusion can be subtle. Epicardial fat is usually more echogenic or granular, less mobile, and located more anterior than the posterior pericardial effusion.

Q10. Why is this 49 year-old man unstable after a Ross procedure? (see video Chap13_Q10)

A) Myocardial ischemia
B) Air embolisation
C) Hypovolemia
D) Right ventricular dysfunction

Answer: B.

The most frequent location of intracardiac air in patients undergoing left cardiotomy is the RUPV, followed by the LV, LA, and right sinus of Valsalva. Air will typically go in the right coronary artery and end up into the inferior wall of the left ventricle as in this patient.

Chapter 14:
Native aortic valve

Q1: TEE exam demonstrates a left ventricular outflow track (LVOT) diameter of 2 cm, a velocity-time integral (VTI) at the LVOT of 15 cm, a VTI at the aortic valve of 45 cm. What is the aortic valve area?

A) 0.5 cm^2
B) 1.0 cm^2
C) 1.5 cm^2
D) 2.0 cm^2

Answer: B.

The aortic valve area (AVA) may be calculated using the continuity equation.
$AVA = (Area_{LVOT} \times VTI_{LVOT})/VTI_{AoV} = (0.785d^2 \times VTI_{LVOT})/VTI_{AoV}$
$AVA = (0.785(2)^2 \times 15)/45 = 1.0\ cm^2$

Q2: What are the signs of significant aortic valve (AoV) insufficiency?

A) Increased aortic systolic expansion (Corrigan pulse)
B) Restrictive mitral valve inflow pattern
C) Reverse diastolic doming of mitral valve
D) All of the above

Answer: D.

All of the above. "Other clues suggesting significant AoV regurgitation include increased aortic systolic expansion (Corrigan pulse), a restrictive mitral inflow pattern, a left ventricular end-systolic diameter >55 mm, and reverse diastolic doming of the mitral valve, MV. In patients with severely elevated left ventricular end-diastolic pressure (LVEDP), diastolic mitral regurgitation, premature closure of the mitral valve (MV), and early AoV opening may be observed."

Q3: Which of the following conditions will lead to overestimation of the regurgitant pressure half time (PHT)?

A) Non-compliant left ventricle
B) Severe mitral regurgitation
C) Restrictive cardiomyopathy
D) All of the above

Answer: D.

All of the above. "Patients with chronic AoV regurgitation tend to have a more dilated and compliant left ventricle (LV) which can accommodate a greater volume of regurgitant blood. Therefore, for the same regurgitant volume, acute AoV regurgitation will have a steeper regurgitant slope and a shorter regurgitant PHT compared with chronic AR. Other conditions leading to rapidly rising LV pressure during diastole will also shorten the regurgitant PHT, as in restrictive cardiomyopathy or severe mitral regurgitation."

Q4 (see video Chap14_Q4-6): The 2D images in this example were obtained from which of the following echocardiographic views?

A) Mid-esophageal long axis view (120 degrees)
B) Deep transgastric view (0 degrees)
C) Descending aortic long axis view (90 degrees)
D) Transgastric long axis view (90 degrees)

Answer: D.

Transgastric long axis view (90 degrees). The material in this example was derived from the transgastric long-axis view. From this view, a Doppler ultrasound beam can be aligned with the left ventricular outflow tract (LVOT), AoV, and the ascending aorta. The combined use of 2D and Doppler echocardiography from this view permits calculation of the aortic valve area and estimation of the severity of aortic stenosis and regurgitation. When this view is unsatisfactory, the deep transgastric view will often provide similar information. Normally, a Doppler beam cannot be aligned with the above-mentioned structures from mid-esophageal views.

Q5 (see video Chap14_Q4-6): The patient's stroke volume as measured by thermodilution is 80 ml. What is the aortic valve area?

A) 1.75 cm^2
B) 1.25 cm^2
C) 0.725 cm^2
D) 0.19 cm^2

Answer: C.

0.725 cm^2 Aortic valve area (AVA) can be calculated in a patient with a pulmonary artery catheter by measuring stroke volume (SV) using the thermodilution method or from left ventricular 3D SV measurements. The SV from thermodilution can be substituted, in the continuity equation, for the SV in the left ventricular outflow tract. Thus, AVA = SV/VTI, where VTI is the velocity time integral in the supravalvular aorta. In this case, the SV is 80 cm^3 and VTI in the supravalvular aorta is 110 cm. Thus, AVA = 80 cm^3/110 cm = 0.725 cm^2

Q6 (see video Chap14_Q4-6): The patient's stroke volume as measured by thermodilution is 80 ml. What is the aortic valve area?

A) Severe aortic stenosis with mild aortic regurgitation
B) Severe aortic stenosis with moderate aortic regurgitation
C) Moderate aortic stenosis with mild aortic regurgitation
D) Moderate aortic stenosis with moderate aortic regurgitation

Answer: A.

Severe aortic stenosis with mild aortic regurgitation. In severe aortic stenosis, the aortic valve area is <1.0 cm^2. In moderate aortic stenosis, the aortic valve area is >1.0 and <1.5 cm^2. Based on the aortic valve area of 0.725 cm^2 derived in the preceding question, the aortic stenosis is severe. The pressure half-time of the continuous wave Doppler tracing of aortic regurgitation is >500 for mild aortic regurgitation, 200 – 500 ms for moderate aortic regurgitation and <200 ms for severe aortic regurgitation. The pressure half-time of 1000 ms in this patient indicates mild aortic regurgitation. In addition, the width of the color jet of aortic regurgitation is clearly less than one-third the width of the left ventricular outflow tract. This is also indicative of mild aortic regurgitation. Therefore, the diagnosis is severe aortic stenosis with mild aortic regurgitation.

Q7- What is the mechanism of aortic regurgitation (see video Chap14-Q7)

A) Type 1
B) Type 2
C) Type 3
D) Type 4

Answer A

Type 1 with dilated aortic root.

Q8 When using TEE to determine the aortic valve area using the continuity equation, which of the following statements are correct?

A) Diameter (d) of the left ventricular outflow tract (LVOT) is best measured using the deep transgastric long-axis view
B) The velocity time integral of the LVOT should be measured using a pulse wave Doppler on mid-esophageal aortic valve long-axis view
C) The velocity time integral of the aortic valve should be measured using a pulse wave Doppler on a deep transgastric long-axis view
D) The velocity time integral of the LVOT should be measured using a PW Doppler on a deep transgastric long-axis view

Answer: D.

The diameter of the LVOT is best measured using the mid-esophageal aortic valve long-axis view and should be measured in mid-systole. The VTI of the LVOT should be measured using a PW Doppler on a deep transgastric long-axis view. The VTI of the aortic valve should be measured using a continuous wave Doppler on the deep transgastric long-axis view.

Q9: Which of the followings measurements of the aortic valve is consistent with severe aortic stenosis?

A) Mean gradient at 40 mmHg
B) Aortic jet velocity at 4.2 m/sec
C) AVA at 1.1 cm^2
D) Indexed AVA at 0.75 cm^2 /m^2

Answer: B.

All the measurements represent moderate aortic stenosis, except the aortic jet velocity at 4.2 m /sec, which represents a severe aortic stenosis.

Q10 A 70 year old patient with a known systolic ejection murmur is undergoing CABG surgery with TEE monitoring. Calculate the aortic valve (AoV) area , cardiac index and and left ventricular end-diastolic pressure. Should he undergo Aov replacement? <u>These measurements are:</u>
HR = 70/min; BSA = 2.0 m^2 ; BP = 100/60; LVOT diameter = 2.0 cm; VTi LVOT = 27 cm; TVI aortic valve = 86 cm; Aortic regurgitation diastolic vel. = 300 cm/s

A) AoV area 0.7 cm^2, CI 2.9 ml/m/m^2 and LVEDP 14 mmHg
B) AoV area 1.0 cm^2, CI 3.9 ml/m/m^2 and LVEDP 14 mmHg
C) AoV area 1.0 cm^2, CI 2.9 ml/m/m^2 and LVEDP 24 mmHg
D) AoV area 0.7 cm^2, CI 2.9 ml/m/m^2 and LVEDP 24 mmHg

Answer: C

In this patient the LVOT area X VTI = 86 cm X AoV area
Aov area = [(2.0 cm/2)^2 X 3.14 X 27]/86 = 1 cm^2
LVEDP = DBP – 4 X(AoV regurgitant diastolic velocity)^2 = 60 – 36 = 24 mmHg
CI = 86 cm X 1 cm^2 = (86ml X HR)/BSA = 2.97 ml/m/m^2
In this case AoV replacement would be recommended.

Chapter 15
Aortic Valve Surgical and Non-Surgical Management

Q1-Which one of the following statements is correct (see videos, Chap15_Q1 A to Chap 15_Q1D)?

A) The aortic valve (AoV) appears normal in structure
B) There is a prolapse of the left coronary cusp
C) There is a prolapse of the right coronary cusp
D) There is mild aortic insufficiency
E) There is a dissection of the aortic wall

Answer C

Cusp prolapse is present whenever the free edge of one or more AoV cusps overrides the aortic annular plane. As in mitral valve (MV) prolapse, the resulting regurgitant jet is eccentric in the opposite direction to the pathologic cusp. A right coronary cusp (RCC) prolapse gives rise to a posterior jet, while left coronary cusp (LCC) or non-coronary cusp (NCC) prolapse will cause an anterior jet. Here, the short-axis (SAX) analysis and multiplane reconstruction (MPR) of the AoV will help distinguish between a prolapse of the LCC or the NCC.

Q2-Which surgical option is the most appropriate?

A) A valve sparing procedure with associated cusp repair
B) A tube graft to the ascending aorta
C) A Bentall procedure
D) Isolated repair of cusp prolapse

Answer A

One or more aortic cusps can have an excess of tissue or mobility, resulting in some cusp prolapse. There are 3 types of cusp prolapse based on the portion of the cusp overriding the plane of the aortic annulus, as described in Chapter 14. Surgical correction of a cusp prolapse usually comprises a triangular resection, or plication, of the middle portion of the prolapsing cusp occasionally with reinforcement of the free edge by an over-and-over suture. This is sometimes associated with a sub-commissural plasty made at the level of the inter-leaflet triangles.

Q3- The patient underwent an AoV sparing reimplantation with a Valsalva prosthesis, Non-coronary cusp (NCC) plication and free margin resuspension of the 3 aortic cusps. Which one of the following statements is correct (see video Chap15_Q3A and Chap15_Q3B)?

A) Risk of recurrent AoV regurgitation and need for reoperation within 8 years is high
B) This is a good result
C) Cusp coaptation length is adequate
D) Aortic regurgitation is mild and acceptable
E) There is no residual cusp prolapse

Answer A

The more predictive criteria of AoV repair failure are the level at which coaptation occurs and the effective height (eH). In fact, the level of cusp coaptation should be above the aortic annulus; if there is residual billowing or prolapse, the risk for recurrent AoV regurgitation is >70%. The eH should be ≥ 9mm and reach the middle of the sinus of Valsalva. The coaptation length should be ≥ 4mm to avoid a 30 to 40% chance of recurrent AR in follow-up.

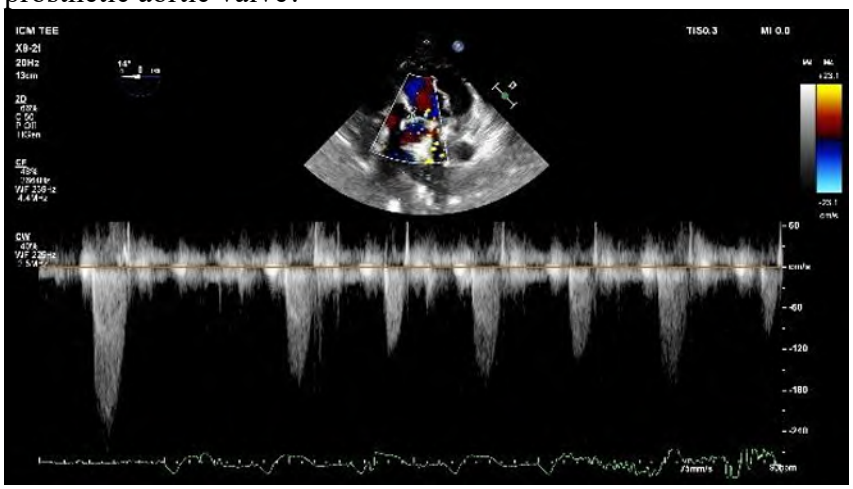
Q4- All those factors would favor transcatheter aortic valve implantation instead of surgical aortic valve replacement except?

A) High surgical risk
B) Mild mitral regurgitation
C) High SYNTAX score
D) Porcelain aorta

Answer: C.

The SYNTAX score derives from the coronary angiogram and describes the complexity of coronary artery disease (CAD). The SYNTAX score is the sum of the points assigned to each lesion in vessels with >50% diameter narrowing in vessels > 1.5 mm diameter. The coronary tree is divided into 16 segments. Many characteristics contribute to the score, including bifurcation and trifurcation lesions, ostial lesions, tortuosity, length of the lesion, calcifications and thrombus. A computer algorithm calculates a sum value for the SYNTAX score: low < 18, intermediate range from 18 to 27, and high score > 27. Surgical aortic valve replacement is recommended in patients with high SYNTAX score > 32. (See Figure 15.3)

Q5 67-year-old man with previous aortic valve replacement. Based on the following figures (mean gradient 13 mmHg) and video Chap15_Q5, what is the severity of the prosthetic aortic valve?



A) Moderate prosthetic aortic valve stenosis
B) Severe prosthetic aortic valve stenosis
C) The prosthetic aortic valve is most likely severe due to significant left ventricular cardiomyopathy
D) Transcatheter aortic valve implantation should be considered

Answer: C

In order to evaluate the severity of aortic valve prosthesis, it is important to obtain Doppler velocities across the aortic valve in order to calculate the DVI or Doppler velocity index which is the ratio of the velocity of the left ventricular outflow tract over the velocity of the prosthetic valve. In patients with severe left ventricular dysfunction, the mean gradient across the prosthetic valve will be reduce and not reflect the severity of the stenosis. Severe AS may occur with a lower transvalvular gradient and velocity in patients with a low cardiac output. This patient was schedule for heart transplantation.

Q6 46-year-old woman with unicuspid aortic valve stenosis. Is she a candidate for a Ross procedure? (see Video Chap15_Q6A, Chap15_Q6B and Chap15_Q6C)

A) The Ross procedure can be performed
B) The left ventricular strain is abnormal and a ross procedure should not be performed
C) The aortic valve is too calcified to consider a Ross procedure.
D) There is more that trace pulmonary valve regurgitation and am epicardial echocardiography of the pulmonic valve should be performed.

Answer D.

In a Ross procedure, TEE should carefully evaluate both the aortic and the pulmonic valve prior to cardiopulmonary bypass (**Error! Reference source not found.**, see Figure 6.22). Multiple studies have shown that the main predictors of late pulmonary autograft failure are pre-operative aortic regurgitation, an aortic annulus ≥27 mm and a size mismatch between the aortic and pulmonary annuli. Pulmonic regurgitation is a relatively common finding, and any PR with a jet length of < 10 mm is normal or physiologic. Dense, broad-based jets as seen in this patient are more likely to reflect severe PR, regardless of jet length or area. In doubt, epicardial echocardiography should be performed. In this case, it revealed a significant PR and the Ross procedure was canceled. Abnormal left ventricular strain is not currently used as a criteria in Ross procedure.

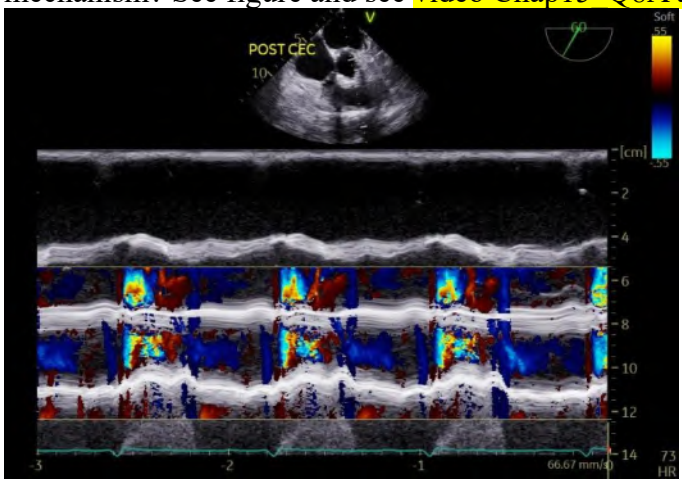
Q7 Following aortic valve replacement, the following was observed (see Video Chap15_Q7A)

A) A right upper pulmonary vein stenosis was present
B) A ventricular septal defect was present
C) There is color Doppler acceleration in the superior vena cava
D) There is a right coronary fistula

Answer: C

This view is a transgastric view where the right atrium is in the middle, tricuspid valve on top and superior vena cava (SVC) on the bottom. Acceleration in the SVC can result in a SVC syndrome (see Figure 13.11). In this case, the SVC compression was a result of external compression by sponges. Removal of those result in normalisation in the color Doppler signal (see video Chap 15_Q7B)

Q8 55-year-old man hemodynamically unstable after a Ross procedure. Identify the mechanism? See figure and see video Chap15_Q8A and Chap15_Q8B



A) Right ventricular outflow tract obstruction
B) Hypovolemia
C) Vasodilatation
D) Diastolic dysfunction

Answer A

Those mid-esophageal and transgastric views illustrate dynamic right ventricular outflow tract obstruction (RVOTO) that can occur in any conditions associate with increased right ventricular (RV) contractility or reduced RV afterload. It is possible to monitor simultaneous the RV and pulmonary artery pressure (PAP) waveform from the RV pacing port of a PAC to confirm the diagnosis. (See Figure 10.30) Color M-mode should show the simultaneous appearance of RVOT collapse and associated flow acceleration. If the continuous wave Doppler tricuspid regurgitation pressure gradient is superior to the systolic PAP, then suspect RVOTO.

Q9 What are the major determinants in order to determine the transcatheter heart aortic valve dimension?

A) Left ventricular outflow tract diameter measures using transthoracic echocardiography
B) Aortic valve perimeter derived from computed tomography for self-expanding valve
C) Aortic valve annular area based on transesophageal echocardiography
D) 3D annular area for self-expanding valve.

Answer: B

The aortic valve annular area helps select transcatheter heart valve size in balloon-expandable valves, while multi-detector computed tomography derived annular circumference or perimeter selects the valve size of self-expanding valves, as per manufacturer-generated algorithms. See eTable 15.13 and eTable 15.14

Q10 All those elements are bioprosthetic valve dysfunction red flags except

A) Acceleration time (AT)/ left ventricular ejection time (LVET) >0.32
B) Increase in mean gradient ≥10-20 mm Hg during follow-up
C) Effective orifice area <1.1 cm^2
D) Doppler velocity index (DVI) >0.35

Answer: D

The DVI < 0.35 may indicate severe aortic valve prosthetic dysfunction. (See Table 15.3)

Chapiter 16

Q1 True statement concerning restricted leaflet motion (Type III):
A) Usually results in a jet directed toward the affected leaflet
B) Is the most frequent mechanism of primary MR
C) The jet is typically contralateral in direction to the pathologic leaflet
D) Is due to annular dilatation

Answer: A

The Carpentier classification categorizes MR mechanisms by leaflet motion during closure as Type I normal, Type II excessive or Type III restricted if a portion of the leaflet moves at, beyond or under the annulus plane (see **Error! Reference source not found.**). Restricted leaflet motion (Type III) usually results in a jet directed toward the affected leaflet (see **Error! Reference source not found.**). In ischemic cardiomyopathy, the restriction is often worse in the postero-medial MV portion (P3 leaflet). If both leaflets are equally affected, as in dilated cardiomyopathy, the jet can be central. Frequent causes of restricted leaflet motion are ischemia and dilated cardiomyopathy (**Error! Reference source not found.**) and less often rheumatic valve disease. A combination of mechanisms can cause MR. For example, MR in dilated ischemic cardiomyopathy is often a mixed of Type I and Type III.

Q2 The normal coaptation length of a competent mitral valve is:
A) 10-12 mm
B) 8-10 mm
C) 5-7 mm
D) > 10 mm

Answer: B

Systematic TEE examination assesses the quality and amount of coaptation, which is the apposition surface of the valve leaflets during systole. A competent valve has a coaptation length of 8-10mm. The mechanism leading to malcoaptation helps predict the origin and severity of regurgitant jets, which color flow imaging (CFI) can confirm by demonstrating consistent jet flow. Specifically, this requires a careful leaflet examination with particular attention to the leaflet motion in relation to the mitral annulus.

Q3 In Carpentier classification, Type I mechanism of MR can be found in found in the following cases except:

A) Annular dilatation
B) Congenital cleft
C) Leaflet perforation
D) Restricted leaflet motion

Answer: D

In Type I, leaflet motion is normal and MR is from annular dilatation as in chronic atrial fibrillation (AF), leaflet perforation, or a congenital cleft or perforation. The jet origin in the latter two conditions is often eccentric to the commissural line but the jet direction can also be central. Pure annular dilatation without leaflet restriction is rare but can occur in chronic AF with LA dilatation. This type of MR is named atrial functional MR and is different than ventricular functional MR.

Q4 The correct statement concerning Carpentier classification, Type II mechanism of MR is:

A) MV prolapse, flail, papillary muscle rupture
B) Occurs when leaflet tissue extends ≥ 1 mm above the high axis of annular mitral plane
C) The ensuing jet is in direction to the pathologic leaflet
D) Is due to restrictive leaflet motion

Answer: A

Excessive leaflet mobility (Type II) is the most frequent mechanism of primary MR. Prolapse is present when leaflet tissue extends ≥ 2 mm above the high axis of the mitral annular plane, as determined from a ME LAX view and not from a bi-commissural view. A flail leaflet has free leaflet motion above the annular plane with the exposition of its ventricular side to the LA (eversion). The ensuing jet is typically contralateral in direction to the pathologic leaflet (**Error! Reference source not found.**). In chronic MR, degenerative disease is the usual culprit. Papillary muscle rupture represents an extreme case of flail, causing severe acute Type II MR

Q5 All the statements concerning Type III mechanism of MR are correct, except:

A) The jet is directed toward the affected leaflet
B) Is due to restricted leaflet motion
C) Causes of Type III mechanism of MR are: ischemia, dilated cardiomyopathy and rheumatic valve disease
D) In ischemic cardiomyopathy, the restriction is often worse in the anterolateral MV portion (P1 leaflet)

Answer: D

Restricted leaflet motion (Type III) usually results in a jet directed toward the affected leaflet (**Error! Reference source not found.**). In ischemic cardiomyopathy, the restriction is often worse in the postero-medial MV portion (P3 leaflet). If both leaflets are equally affected, as in dilated cardiomyopathy, the jet can be central. Frequent causes of restricted leaflet motion are ischemia and dilated cardiomyopathy (**Error! Reference source not found.**) and less often rheumatic valve disease. A combination of mechanisms can cause MR. For example, MR in dilated ischemic cardiomyopathy is often a mixed of Type I and Type III.

Q6 The true statement concerning EROA is:

A) The measured radius of the hemispheric shell of the aliased velocity; v_r the aliased velocity at the radius r, and $V_{MR\ max}$ the maximal MR velocity across the orifice from CWD (in cm/s)
B) The measured radius of the hemispheric shell of the aliased velocity; v_r the aliased velocity at the radius r, and VTI_{MR} is the velocity-time integral (in cm) of the MR signal from CWD
C) EROA calculation does not require an angle correction factor
D) An EROA $\geq 0.30\ cm^2$ (or $40\ mm^2$) is consistent with severe MR

Answer: A

The PISA or Proximal Isovelocity Surface Area (Flow Convergence) method derives from conservation of mass and the hydrodynamic principle describing flow through a narrowed orifice. As red blood cells approach the smaller orifice, their velocity gradually increases and cells with similar velocity form concentric hemispheric shells with decreasing surface or diameter as the isovelocity increases. Equations (Eqs) 16.1-16.3 describe this principle (see Chapter 5).

The EROA is the effective regurgitant orifice area (in cm^2); r the measured radius of the hemispheric shell of the aliased velocity; v_r the aliased velocity at the radius r, identified as the Nyquist limit (in cm/s); and $V_{MR\ max}$ the maximal MR velocity across the orifice from CWD (in cm/s) and VTI_{MR} is the velocity-time integral (in cm) of the MR signal from CWD. The PISA must be multiplied by an "angle-correction factor" or "α" (see Figure 5.31).

Calculation of the ERO and the RVol requires four parameters. The measured radius, r, of the hemispheric shell of the aliased velocity is from high-resolution, zoomed MV views with color flow imaging (see **Error! Reference source not found.**), carefully positioned at the regurgitant jet center and aligned with the jet direction. There should be an uninterrupted visualization of the hemispheric shell with the VC. Failure to attain this position significantly underestimates the true hemispheric shell radius. Next, adjust the v_r of the color scale to create a nice hemispheric shell. This occurs by shifting the baseline toward the direction of the regurgitant flow or, less frequently, by changing the Nyquist limit by lowering the color scale maximal velocity to between 25-40 cm/s. Qualitatively, PISA visible at a Nyquist limit of 50-60 cm/s should alert the existence of severe MR. The r measurement is from the hemispheric shell edge, where the color scale changes (from one edge of the spectrum to the other) to the shell base at the leaflet plane. Intermittently, turning off the color flow overlay on the freeze frame can show the latter. Radius measurement is critical, as any error introduced will magnify to its squared value. To complete the EROA RVol calculation requires measurements of the peak mitral regurgitant velocity (V_{MR}) and the VTI of the regurgitant jet by CWD. A fast PISA can be obtained assuming a V_{MR} of 5m/s and the use of a 40 cm/s aliasing velocity.

Q7 Most reliable technique to quantify MR severity with TEE is:

A) 3D PISA
B) 3D VC
C) 2D PISA
D) CFJ

Answer: B

Conventional PISA will underestimate the EROA if the flow converges is a hemi-ellipse, such as in secondary MR. Computational fluid dynamics studies show that the PISA method underestimates MR depending on the ellipse ratio (8% in 3:1 ellipse, ≤ 35% in 10:1 ellipse). Precise description of the orifice and the flow convergence shape is sometimes difficult. An EROA ≥ 0.40 cm^2 (or 40 mm^2) is consistent with severe MR, while < 0.2 cm^2 is mild MR (Table 16.2). The EROA is a more robust parameter compared with CJA and alters less by changing hemodynamic conditions.

The assumption of hemispheric PISA or 3D Proximal Isovelocity Surface Area for ERO calculation is often not accurate with anisotropic flow convergence, such as in functional MR. Assumption of hemi-ellipsoid PISA from 2D TEE is possible and better correlates with computer-derived measures of true 3D TEE PISA, but still underestimates PISA and calculated EROA in functional MR (see **Error! Reference source not found.**) Although more precise, true measurement of 3D TEE PISA surface is not practical for real-life bedside assessment and decision-making.

Three-Dimensional Vena Contracta Area (3D VCA) planimetry is a reliable technique to quantify MR severity obtained readily with 3D TEE probes. TEE studies show superiority of 3D VCA over 2D PISA method in MR severity grading, especially in functional MR, where 2D PISA derived EROA underestimates MR severity by 27% compared with 3D VCA. There is a strong correlation between 3D VCA and computer-assisted 3D PISA derived EROA calculation (**Error! Reference source not found.**). Despite validation of 3D VCA with gold-standard cardiac MRI for MR quantification, guidelines do not yet include 3D TEE criteria for grading of severity.

Planimetry of the 3D VCA uses MPR of an optimal 3D color flow imaging dataset of the MR jet (See Figure 16.1). The VCA can be traced along the core of the high velocity (brighter color) area, excluding peripheral lower velocities (darker colors). This technique is also valuable for evaluating multiple MR jets where the total VCA represents adding each individual jet's VCA.

Q8 Pressure Half-Time measurement in MS can be affected by:

A) Aortic stenosis
B) Aortic regurgitation
C) Degenerative calcific MS
D) Prosthetic MVA

Answer: B

The PHT or Pressure Half-Time is the time interval in milliseconds (ms) between the maximum diastolic transmitral pressure gradient and the time point where the pressure gradient has decreased to half its maximal initial value (**Error! Reference source not found.**). The measurement involves tracing the deceleration slope of the E-wave (in mid-diastole instead of the early slope when the signal is bimodal) using the same CWD signal used to calculate diastolic pressure gradients. As the MV becomes more stenotic, it takes more time for the diastolic pressure between the LA and LV to equalize.

Several hemodynamic factors affect the PHT (Table 16.1). LV diastolic pressure may increase abnormally with significant AR or LV hypertrophy. This decreases PHT, independent of the MV status, and underestimates mitral stenosis severity. Impaired diastolic function, particularly in the elderly, can make the use of PHT in degenerative calcific MS unreliable, requiring interpretation with caution and even avoidance. A concomitant eccentric AR jet may also complicate mitral stenosis assessment, causing a functional stenosis (the Austin–Flint phenomenon) when it prevents full diastolic excursion of the anterior mitral leaflet and maintains it in a relatively closed position (**Error! Reference source not found.**).

Q9 The following statements concerning the quantitative TEE measurements of MS are true, except:

A) The mean gradient is more relevant than the peak gradient
B) 3D planimetry gives the most accurate method of MVA measurement
C) Assessment of MS severity uses the pulmonary pressures, mean pressure gradient, MVA as determined by planimetry, and the PHT
D) The continuity equation and the proximal flow convergence method are the most useful methods to determinate the MVA

Answer: D

The diastolic maximal and mean pressure gradient across the MV is measured from the velocities of the mitral inflow using CWD according to the modified Bernoulli equation (**Error! Reference source not found.**). The mean gradient is more relevant than the peak gradient and has its own prognostic value, particularly following balloon valvuloplasty. Direct planimetry of the MV orifice by TTE during mid-diastole is well valid for determining the anatomic MVA, but requires technical expertise. Planimetry is the reference measurement of MVA. Although 2D biplane imaging from a TG two-chamber view can improve plane alignment, 3D planimetry using MPR can better locate the smallest valve orifice for more accurate results (**Error! Reference source not found.**).

The continuity equation states that in the absence of valvular regurgitation and atrial or ventricular septal defect, the SV across the MV must equal that of other valves or sub-valvular regions such as LVOT, the AoV, or pulmonic valve at the same time and during hemodynamic stability (**Error! Reference source not found.**). The MVA can be obtained by applying Eq. 16.11, here Q_{mitral} equals Q_{aortic}, provided there is no significant MR or AR. The continuity equation is prone to errors, as it needs multiple measurements. This method is not well validated and cannot calculate MVA with significant AR or MR.

The basis proximal flow convergence method, or PISA, was described earlier for MR lesions. In MS, the surface surrounding the stenotic orifice is funnel-shaped rather than planar, and distorts the PISA, requiring an additional correction factor

Q10 Causes of mitral stenosis (MS) includes all of the following, except:

A) Rheumatic heart disease
B) Degenerative MS
C) Carcinoid syndrome
D) Vegetation

Answer: D

The commonest etiology of mitral stenosis (MS) worldwide remains rheumatic heart disease. In high-income countries, nonrheumatic calcific MS (also named degenerative MS) is frequent. It occurs more often in patients with advanced age, atherosclerosis, hypertension, diabetes mellitus, renal failure, obesity, and smoking. Other causes of nonrheumatic MS include congenital anomalies, systemic diseases (lupus, carcinoid syndrome), drug-induced, non-valvular lesions (mass, tumour, cor triatriatum), prosthetic valve dysfunction, and iatrogenic (prosthesis-patient-mismatch, undersized ring during MV repair).

Chapter 17

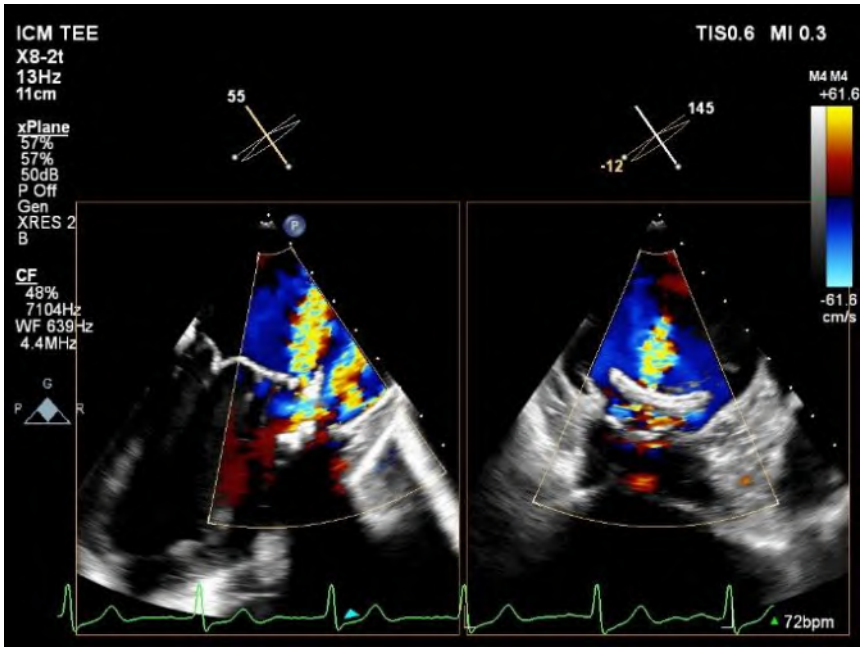
Q1 This TEE is taken pre bypass on a 55-year-old female with exertional dyspnea. Identify the INCORRECT statement. (see video Chap17_Q1)

A) Excessive leaflet motion is demonstrated
B) Myxomatous pathology is demonstrated
C) Likelihood of successful repair exceeds 95%
D) There is bi-leaflet involvement

Answer: C

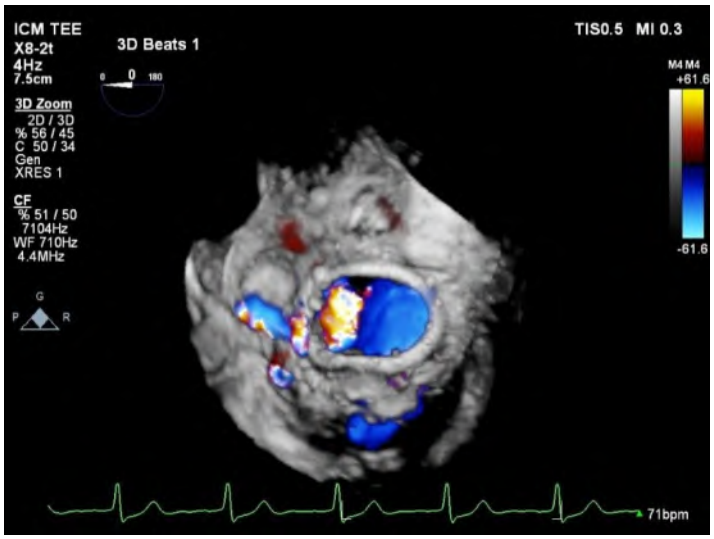
Bileaflet pathology is demonstrated with lower success rate of repair. The success rate for repair is higher for posterior leaflet pathology than for anterior or bileaflet involvement. The probability of successful MV repair for primary and secondary MR depends on several factors summarized in Table 17. 1.

Q2 Where is located the prosthetic paravalvular mitral regurgitation? (see Video Chap17_Q2)



A) 12 o'clock
B) 3 o'clock
C) 6 o'clock
D) 9 o'clock

Answer: D.



On this mid-esophageal biplane view of the left ventricle, the abnormal regurgitant jet is anterior and close to the position of the left atrial appendage. The use of 3D echocardiography confirms the 9 o'clock position of the paravalvular leak.

Q3 Which statement is FALSE in percutaneous mitral balloon commissurotomy (PMBC)

A) PMBC is the preferred first-line intervention for rheumatic mitral stenosis (MS) or select patients with congenital MS
B) PMBC can be considered when the underlying pathology involves primarily calcification of the mitral annulus and not the commissures
C) Anatomic characteristics predicting unsuccessful PMBC outcomes include asymmetric commissural fusion, severe subvalvular apparatus involvement and severe commissural calcification
D) The definition of procedural success is a reduction in MS severity to mild, with less than moderate mitral regurgitation.

Answer B.

Although calcific MS is becoming more prevalent in clinical practice, PMBC is not an option when the underlying pathology involves primarily calcification of the mitral annulus and not the commissures (see Figure 16.37).

Q4 Which statement is INCORRECT regarding mitral annular calcification (MAC)?

A) There is no universally accepted classification of MAC severity using echocardiography
B) The most common region with MAC is P1.
C) MAC that results in a transmitral mean gradient of ≥ 3 mmHg or extensive leaflet calcification makes the MV unsuitable for repair.
D) Extensive MAC bears the risk of postoperative para-valvular or para annuloplasty ring leakage and atrioventricular dissociation

Answer: B

The distribution of MAC varies with the P2 region most involved (see **Error! Reference source not found.**).

Q5 All those are risk factors for systolic anterior motion following mitral valve repair EXCEPT?

A) Anterior mitral valve leaflet (AMVL) length in end-diastole > 20 mm
B) Posterior mitral valve leaflet (PMVL) length in end-diastole > 15 mm
C) AMVL/PMVL ratio ≤1.3
D) Septum to leaflet coaptation length (SLCL) in end-systole > 25 mm

Answer D

The shorter the SLCL (< 25mm), the higher the risk of SAM. (see Figure 17.26)

Q6. Complication of mitral valve repair include all the following EXCEPT?

A) Ligated or distorted circumflex artery in 1.8% of cases
B) Peri-annular leak in up to 2% of cases
C) Residual mitral regurgitation is more likely if the coaptation length is less than 7 mm
D) Iatrogenic mitral stenosis

Answer B.

Significant peri-annular leaks are uncommon after mitral valve (MV) repair. A systematic examination of leaks and evaluation of their severity should occur as with MV replacement (MVR). In the long term, annular dehiscence with peri-annular leak is an infrequent condition and often results from degenerative disease, endocarditis or implantation of an excessively small annuloplasty ring

Q7 What complication occurred after mitraclip insertion in this 72-year-old woman? (see video Chap17_Q7A)

A) Transverse sinus hematoma
B) Oblique sinus hematoma
C) Pulmonary emboli
D) Tamponade

Answer: B.

Perforation of the posterior wall of the left atrium can lead to an hematoma located in the oblique sinus. This form of posterior mediastinal hematoma was confirmed using computed tomography. (see video Chap17_Q7B)

Q8 Identify the correct statement regarding mitraclip position (See video Chap17_Q8)

A) The mitraclip position is at A1PI
B) The mitraclip position is at A2P2 before full closure
C) The mitraclip position is at A2P2 after full closure
D) The mitraclip should be repositioned

Answer B.

The MitraClip™ system comprises two arms with two corresponding grippers to grasp the opposing edge of the AMVL and PMVL for re-approximation during closure. Grippers can be independently lowered or raised; therefore, correct gripper identification (anterior or posterior) must occur with the arms open at 120°-180° by actuating one at a time, a maneuver called the gripper wave or gripper identification, done in the ME LAX view or 3D en face surgical view.

Q9 Complications following mitral valve transcatheter edge-to-edge repair include all the flowing EXCEPT?

A) Residual mitral regurgitation
B) Pericardial tamponade
C) Myocardial infarction
D) Systolic anterior motion (SAM)

Answer. D.

The Alfieri technique which is the surgical equivalent of the mitral valve transcatheter edge-to-edge repair can be used as a form of treatment for SAM. This approach will remove the anterior mitral valve leaflet away from the left ventricular outflow tract. See Table 17.11.

Q10 Which statement is FALSE regarding coronary artery perfusion in mitral valve repair?

A) Abnormal regional wall motion in the lateral region should raise suspicion in left circumflex (LCx) suturing
B) LCx suturing typically happens in the P1 region, where the LCx artery course is closest to the native mitral annulus
C) Regional wall abnormality in the inferior territory should raise suspicion of ligated right coronary artery.
D) A ligated or distorted LCx artery complicates 1.8% of MV surgical procedures

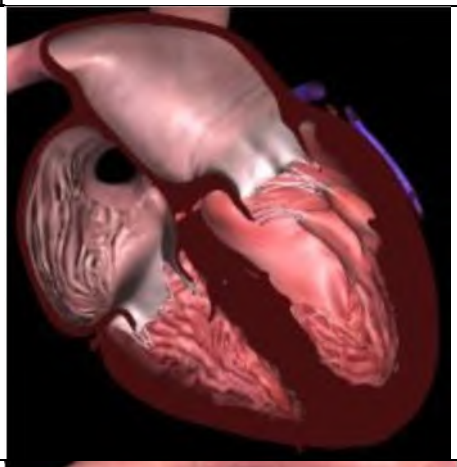
Answer C.

Compromise of the LCx artery can occur during the suturing of an annuloplasty ring or prosthetic valve. Usually, this happens in the P1 region, where the LCx artery course is closest to the native mitral annulus. Regional wall abnormality in the inferior territory is typically a result of air embolism in the right coronary artery.

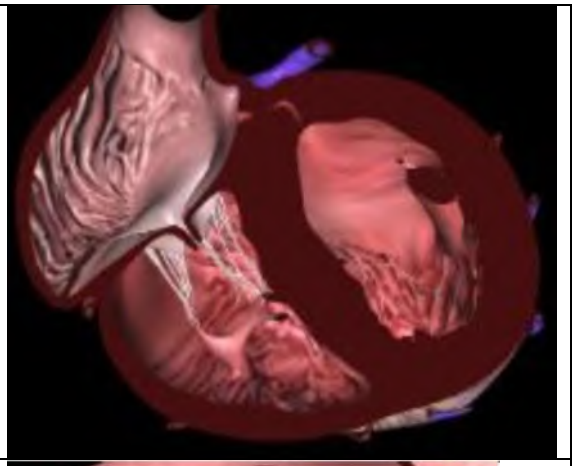
Chapter 18:
Tricuspid valve

Q1: Which of the following pictures of TEE show the perfect time and incidence for the tricuspid valve annular diameter measure?

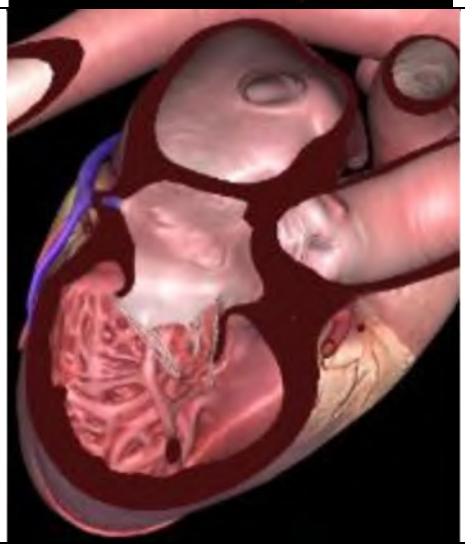
A)



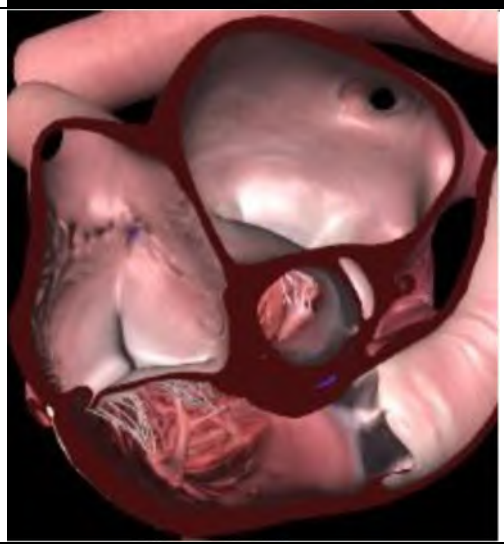
B)



C)



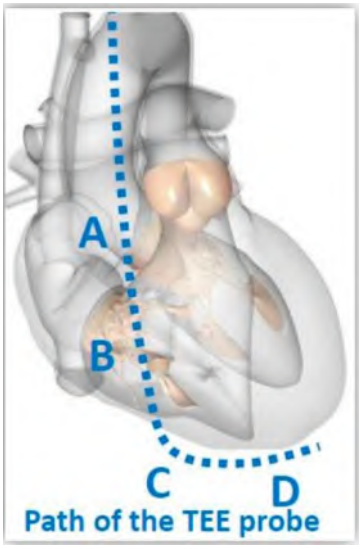
D)

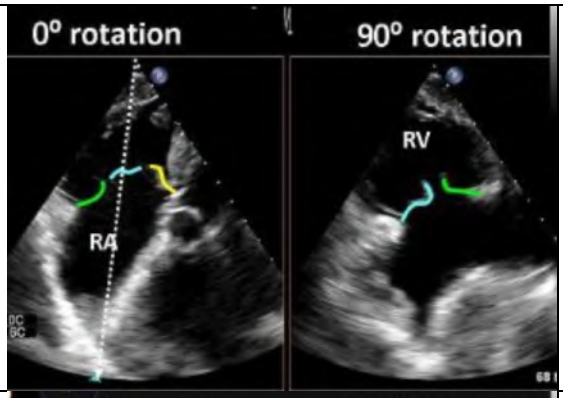
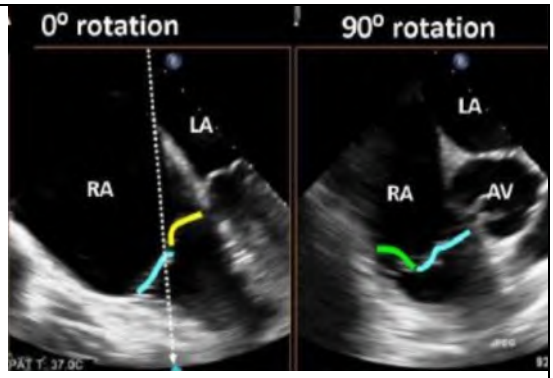
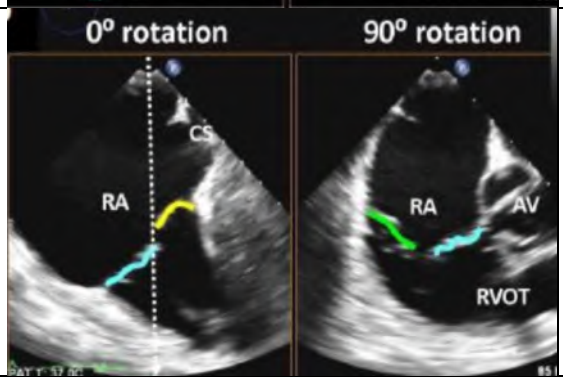
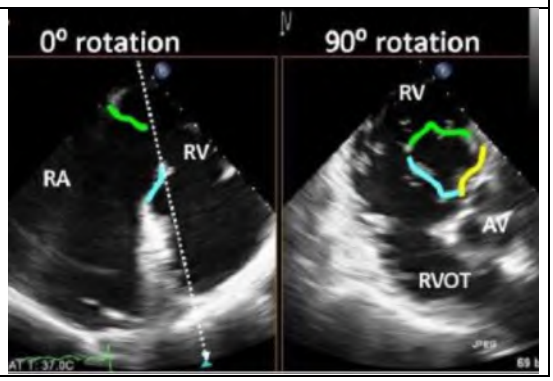


Answer: C.

The TV annular diameter is underestimate in 4C end diastole (see figure 18.1) so the adequate view is the modified bicavale one (angle 90-120). (see figure 18.10).

Q2: Here is your exam plan for the tricuspid valve in 2D TEE. Link the letter A,B,C,D to the correct TEE views. Which color corresponds to which leaflet?

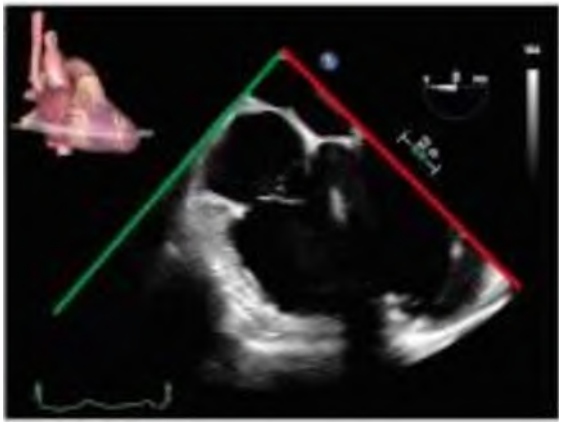


1		2	
3		4	

Answers:
A correspond to 2 = mid esophageal
B correspond to 3 = distal esophageal (we see the coronary sinus)
C correspond to 4 = transgastric (only 2D view with all the three leaflets)
D correspond to 1 = deep transgastric

Yellow	septal leaflet
Green	posterior (inferior) leaflet
Blue	anterior (superior) leaflet

Q3: Concerning the tricuspid valve anatomy, which sentence is CORRECT?



A) The image shows the anterior and septal leaflet
B) The image shows the upper and posterior leaflet
C) The image shows the anterior and septal leaflet
D) The image shows the septal and inferior leaflet

Answer: A.

The anterior leaflet (also called superior) is higher than the posterior one so it can be seen in five chambers view (See Figure 18.6). The posterior (also called inferior) leaflet appears when viewing the coronary sinus (See Figure 18.7) while the anterior leaflet is present when seeing the left ventricular outflow tract or aortic root. The leaflet close to the CS ostium is the septal leaflet. The septal leaflet is always seen in 4 chambers view and is close to the LVOT (See Figure 18.12) Pushing the probe further down the RV inflow outflow view is seen reveals the anterior and posterior leaflets when rotating the probe to the right (See Figure 18.13). At aortic root or valve cusp level, when a single leaflet is present, it usually is the anterior leaflet (See Figure 18.16).

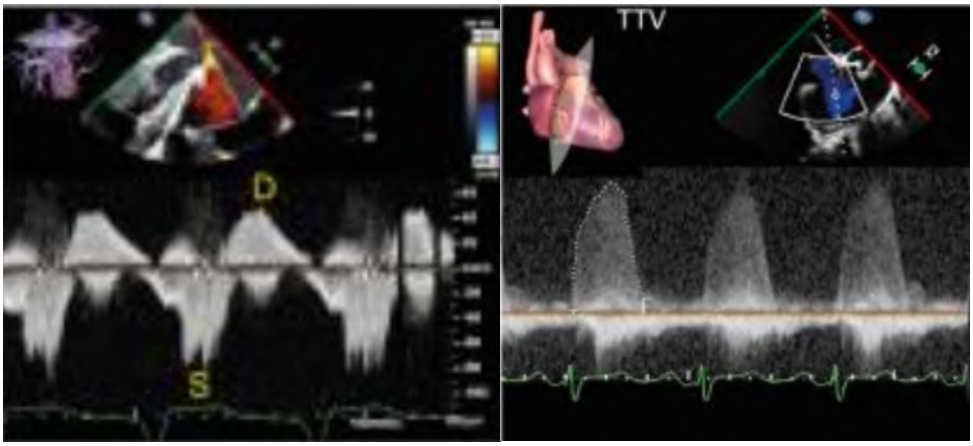
Q4: Concerning the tricuspid valve regurgitation, which sentence of the following is INCORRECT?

A) The most frequent type of tricuspid annular is dilatation of the mural annulus, which supports the anterior and posterior leaflets with little change in the septal annular dimensions

B) The PISA method will overestimate severity, but it remains a reference parameter to quantify tricuspid regurgitation severity

C) Vena contracta (VC) width is a semiquantitative parameter measured in the mid-oesophageal four chambers view. A VC width > 7 mm at a Nyquist limit between 50-60 cm/s is a better predictor of severe TR than regurgitant color flow area

D) These two images show severe tricuspid regurgitation



Answer B:

Quantitative methods for grading TR include EROA and regurgitant volume calculated by the PISA method, but only a few studies have validated this approach. It is important to consider that the actual ROA is noncircular, so the PISA method underestimates severity, but it remains a reference parameter to quantify TR severity

A dense triangular continuous wave Doppler jet correlates to severe tricuspid regurgitation. High velocity turbulent systolic flow reversal assessed by pulsed wave Doppler in the hepatic veins is a specific sign of severe tricuspid regurgitation (See Figure 18.22).

Q5: Concerning tricuspid valve interventions, which sentence is INCORRECT?

A) For surgery, tenting distance and tenting volume predicts residual tricuspid regurgitation post annuloplasty, especially with a tethering distance of > 7.6 mm, a tethering area of > 1.63 cm^2 and a tenting volume > 1.68mL

B) Tricuspid valve prosthetic obstruction must be evoked with a peak velocity > 1.5m/s, a mean pressure gradient > 10mmHg and a PHT < 240ms

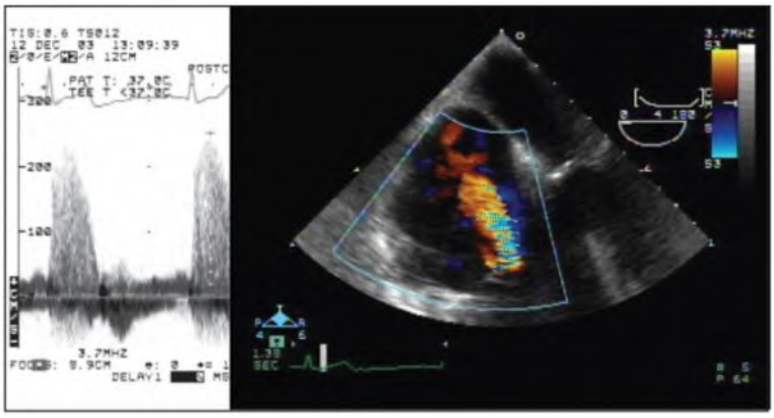
C) For transcatheter tricuspid valve replacement, the superior venous cave approach is favoured because of its easier alignment with the tricuspid annulus

D) For transcatheter tricuspid valve replacement, the first clip should be central between the septal and anterior leaflets to maximize the annuloplasty effect

Answer: B.

In case of obstruction, the flow through the prosthetic valve slows so the PHT longer (> 240ms). The right circulation is a low-pressure circulation so a mean pressure gradient > 5mmHg through the prosthetic valve is already abnormal (see table 18.6)

Q6. Based on the following figure, where V_{TR} is the peak tricuspid regurgitant velocity and RAP is the right atrial pressure (RAP), what is the right ventricular systolic pressure (RVSP) in this patient



A) 10 mmHg

B) 21 mmHg

C) 40 mmHg

D) The RVSP cannot be determined with the above information

Answer: C

The peak tricuspid regurgitant velocity reflects the peak pressure gradient between the RV and the right atrium during systole.

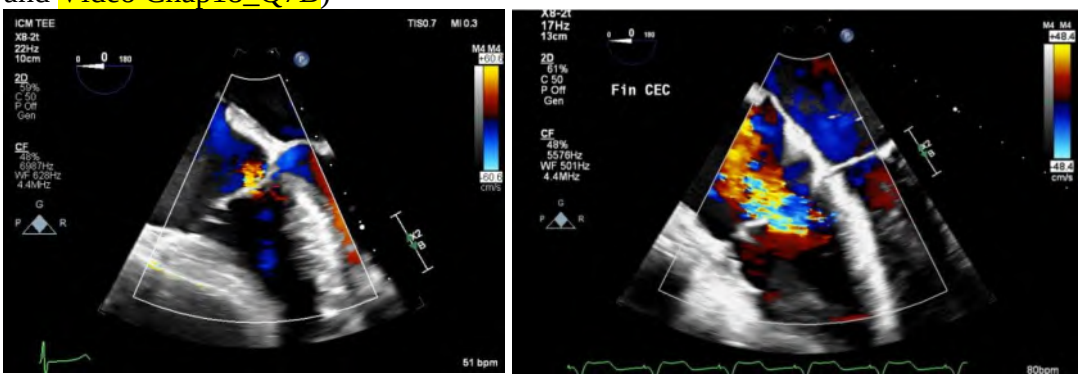
The RVSP is estimated using CW Doppler by the following equations:

$RVSP = 4(Vtr)^2 + RAP$

$RVSP = 4(2.5)^2 + 15 = 40$ mmHg

The RVSP should be the same as the PASP as long as there is no obstruction in the right ventricular outflow tract and at the pulmonic valve.

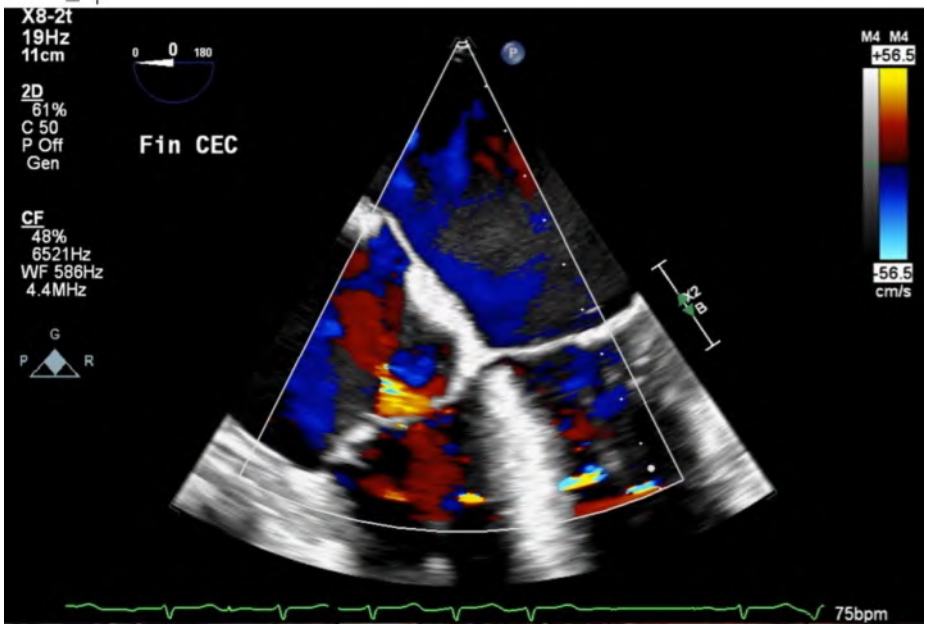
Q7. Which is the most likely cause of new onset tricuspid regurgitation in this 84 year-old man following aortic valve replacement and coronary revascularization? (see Video Chap18_Q7A and Video Chap18_Q7B)



A) Primary tricuspid regurgitation
B) Secondary tricuspid regurgitation
C) Tricuspid regurgitation related to interaction of the pulmonary artery catheter
D) Tricuspid regurgitation related to the pacemaker dysynchrony.

Answer: D

There are two TR types: secondary or functional TR (90% of TV diseases) and primary or organic regurgitation (8-10% of TV diseases) (Table 18.2). Secondary TR is further divided into two phenotypes, atrial and ventricular. Moderate to severe TR involves leaflet pathology or annular dilation. Pacemaker lead interaction with the leaflet (i.e., leaflet entanglement or impingement) is a primary TR cause. In contrast, RA and RV remodeling without lead TV leaflet interference or cardiac remodeling from pacing are causes of secondary TR. Pacemaker can cause dyssynchrony as in this case. Indeed, return to sinus rhythm was associated with resolution of tricuspid regurgitation (see Figure below).

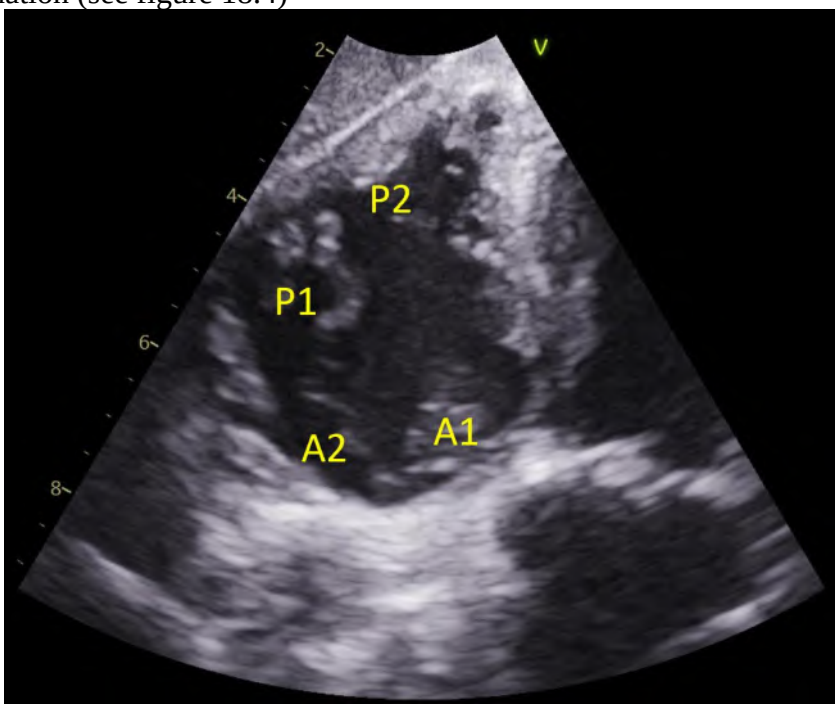


Q8 What is the type of tricuspid valve in this video (see video Chapter 18_Q8)

A) Type 1
B) Type 2
C) Type 2
D) Type 4

Answer. D

This is a type 4 that occurs in 2% of tricuspid valve. A proposal to standardize TV nomenclature includes six subtypes which describe every leaflet and scallop combination (see figure 18.4)



Q9 Which statement is true regarding tricuspid valve transcatheter edge-to-edge repair (TV-TEER) in the following video (see video Chap18_Q9)

A) The TV-TEER grasping is between the septal and posterior leaflet
B) The TV-TEER grasping is between the anterior and posterior leaflet
C) The TV-TEER grasping is between the anterior and septal leaflet
D) TV devices are identical to the mitral devices

Answer C.

The first clip position should be central between the septal and anterior leaflets to maximize the annuloplasty effect. TV devices are identical to the mitral devices but with an adapted delivery system for easier navigation through right heart anatomy.

Q10 What is the major complication of transcatheter tricuspid valve repair system such as the Cardioband?

A) Right ventricular perforation
B) Embolisation
C) Right coronary artery artery occlusion
D) Right ventricular failure

Answer: C

The procedure is challenging because of the complex right heart anatomy requiring precise navigation and alignment, particularly considering the variability between the IVC and TV annulus. RCA proximity poses a significant risk of complications. Performing RCA angiography post procedure can exclude new obstruction. A study by Körber et al. demonstrated a 97% technical success rate and reduced TR grade ≥1 in 88% of patients using the Cardioband direct annuloplasty system. Still, the procedure took over 4 hours, and 15% of patients developed RCA complications.

Chapter 19: Pulmonic valve

Q1: Which of the following is TRUE regarding PV anatomy?
A) The PV and TV are anatomically contiguous.
B) The PV is located inferior and medial to the aortic valve.
C) The 3 PV cusps are named left, right and non.
D) The PV is a semilunar valve without chordae.

Answer: D

Positioned in the crescentic, pyramid-shaped right ventricle (RV) that supports the low-pressure pulmonary circulation, the PV is anterior and superior to the tricuspid valve (TV) in the RV outlet. Unlike the aortic valve (AoV) and mitral valve (MV), the TV and PV are anatomically discontiguous, separated by a body of myocardium called the infundibulum (or conus). The PV is situated anterior, left, and superior to the AoV, as summarized by the mnemonic PALS (pulmonic, anterior, left, superior). The PV is a semilunar valve with two posterior cusps (right and left) and one anterior cusp, in a mirror image to the AoV

Q2: PV dysplasia is associated with which congenital syndrome?
A) Noonan syndrome
B) Shone complex
C) Trisomy 21
D) Williams's syndrome

Answer: A

A dysplastic PV is associated with Noonan syndrome and balloon valvuloplasty may not be as successful as for a dome-shaped PV, in the absence of commissural fusion.

Q3: Which of the following is the most common method of assessing the severity of PV stenosis?
A) PVA by planimetry
B) Continuity equation
C) Doppler analysis of transvalvular flow
D) PISA

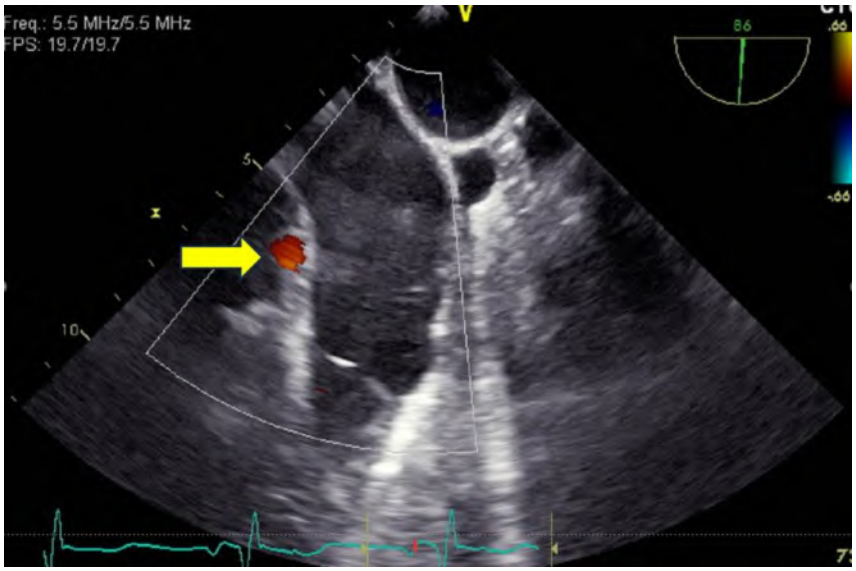
Answer: C

In contrast to other cardiac valves, quantification and grading of PS severity is based almost entirely on transpulmonary velocities. Other methods, such as the calculation of PV area by planimetry, are often inaccurate, as inadequate imaging planes result in measurement errors. Valve area calculation via the continuity equation or proximal isovelocity surface area methods is technically possible, but not validated for PS.

Q4 Which of the following IS NOT an indication of severe pulmonic regurgitation (PR)?
A) A jet width to annulus ratio ≥70%
B) A dense PR jet with a pressure-half time (PHT) < 100msec
C) Early termination of PR flow
D) Diastolic flow reversal in the main pulmonary artery (PA)

Answer: D
The 2017 ASE guidelines specify five criteria for severe PR: a jet width to annulus ratio ≥70%, a dense PR jet with a PHT < 100 msec, early termination of PR flow, diastolic flow reversal in the branch PAs (not the main PA) and RV dilatation with normal function.

Q5 What is the structure indicated by the arrow? (see video Chap19_Q5)



A) Right coronary artery
B) Left main coronary artery
C) Left anterior descending artery
D) Coronary sinus

Answer: C
This is the left anterior descending artery (figure 19.4) close to the pulmonic valve left cusp. The flow can be compromised during any procedure involving the pulmonic valve such as a Ross procedure.

Q6 Which statement is FALSE regarding pulmonic valve stenosis

A) Moderate stenosis is defined as a peak velocity between 3-4 m/s with a mean gradient between 36 and 64 mmHg
B) Pulmonic valve area can be calculated to determine severity of pulmonic valve stenosis
C) The current recommendation is for balloon pulmonary valvuloplasty in asymptomatic patients with domed valve morphology and peak echocardiographic gradient >60 mmHg (mean > 40)
D) Congenital or acquired PS may be subvalvular (infundibular), valvular or supravalvular

Answer B:

In contrast to other cardiac valves, quantification and grading of PS severity is based almost entirely on transpulmonary velocities

Q7 What is the etiology of the increase velocity across the pulmonic valve (see Video Chap19_Q7)

A) Right ventricular outflow tract obstruction
B) Tetralogy of Fallot
C) Pulmonic valve stenosis
D) Supravalvular stenosis

Answer: D

This is a deep transgastric basal view showing a supravalvular pulmonic valve stenosis. Congenital or acquired PS may be subvalvular (infundibular) (**Error! Reference source not found.**), valvular or supravalvular (**Error! Reference source not found.**), so identifying the level of obstruction may help in the differential diagnosis.

Q8 All of the following are causes of right ventricular outflow tract obstruction (RVOTO) EXCEPT:

A) Left mammary harvesting
B) Inotropic agents
C) Left-sided tension pneumothorax
D) Right sinus of Valsalva aneurysm

Answer A

It is typically during right mammary harvesting that RVOTO can be observed. Extrinsic compression, such as the sinus of Valsalva aneurysm (see Figure 10.29), during right mammary artery harvesting (see Figure 13.24), dynamic RVOTO (see Figure 10.30) and left tension pneumothorax (see Figure 32.10) can result in RVOTO.

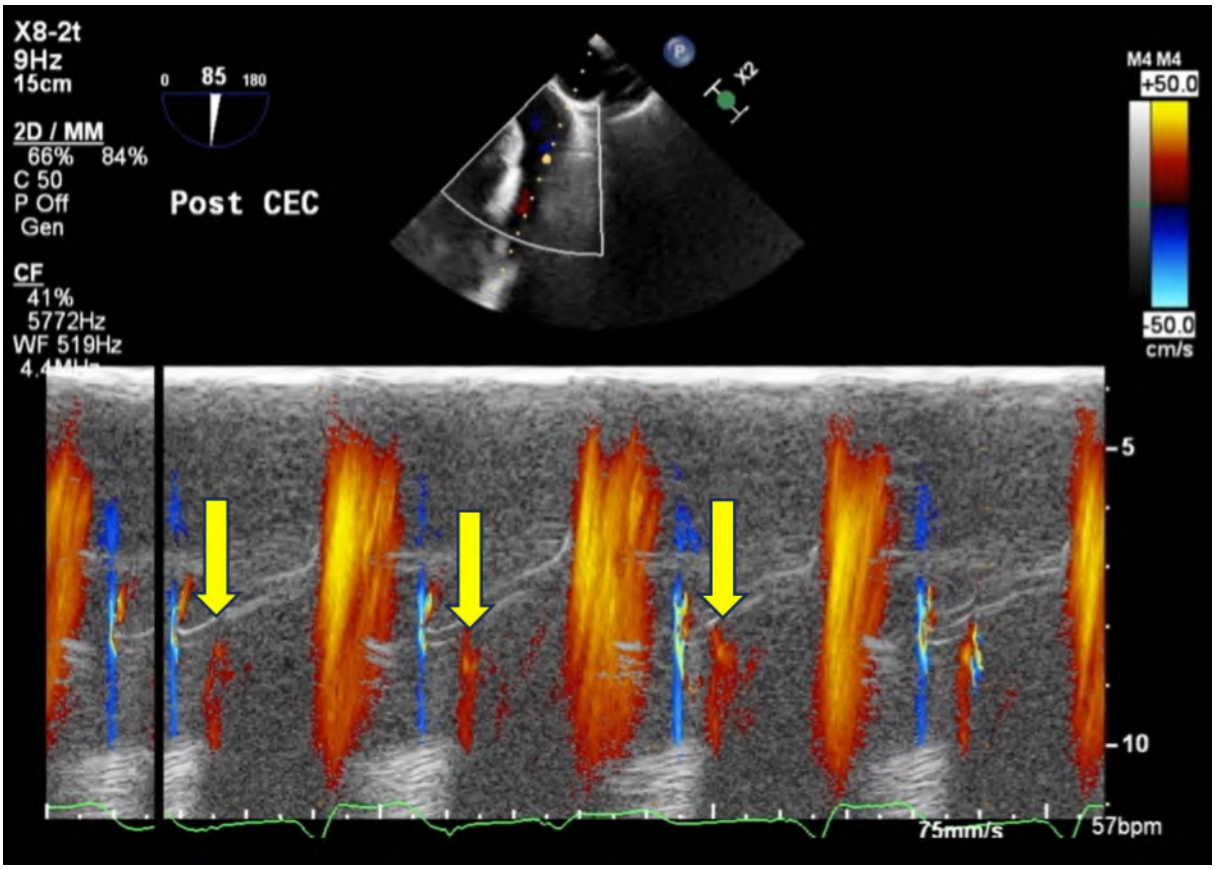
Q9 Which statement is TRUE regarding the pulmonary regurgitation index (PRI)?

A) A PR index > 0.77 define severe pulmonic valve regurgitation
B) The PR index corresponds to the duration of pulmonic regurgitation divided by diastolic time
C) The PR index corresponds to the duration of diastolic time divided by the duration of pulmonic regurgitation
D) The PR index has been validated in large cohort of patients

Answer B

The PRI (Pulmonic regurgitation duration/total diastolic time) < 0.77 (**Error! Reference source not found.**) correlate with severe PR, although it remains unvalidated in a large population.

Q10 What is the significance of the color M mode signal indicated by the arrow in a 77-year-old woman after coronary revascularisation?



A) Pulmonic valve regurgitation
B) Artifact
C) Severe right ventricular failure (RVF)
D) Pulmonic valve stenosis

Answer C

Diastolic opening of the pulmonic valve occurs when the right ventricular diastolic pressure exceeds the diastolic pulmonary pressure. This is typical of RVF (see Figure 10.37) and can be seen by looking at the right ventricular pressure waveform where the pressure changes can be seen. (see video Chap19_Q10)

Chapter 20: minimal invasive cardiac surgery

Q1: Concerning mitral valve procedure, which sentence is INCORRECT?

A) A patent foramen ovale can be found in 10% to 39% of patients and must be closed at the end of the procedure
B) Relative contra-indications include severe aortic regurgitation
C) Relative contra-indicationsinclude severe atherosclerotic aortic disease
D) Recognizing a left pleural effusion early is important if planning for one lung ventilation

Answer: A

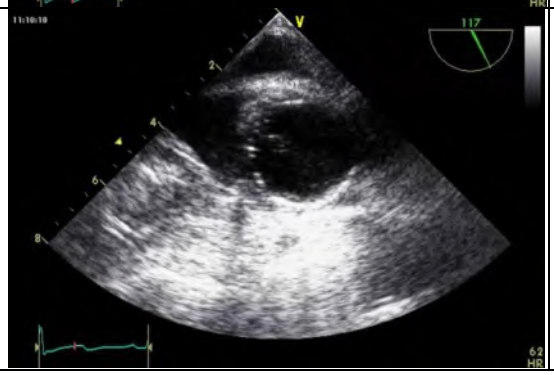
A patent foramen ovale must be closed at the beginning of the procedure to avoid repeated flooding of the operating field and air embolism

Q2: Which of the following pictures show the perfect positioning of anaortic balloon endoclamp?

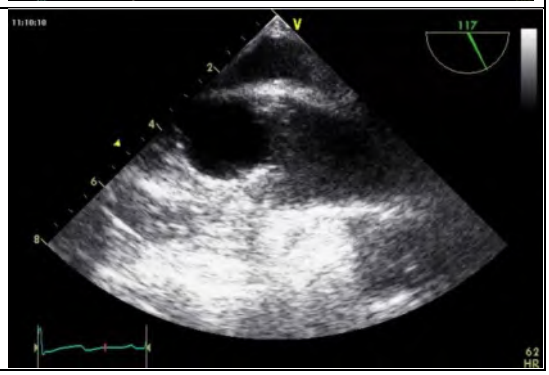
A

B

C



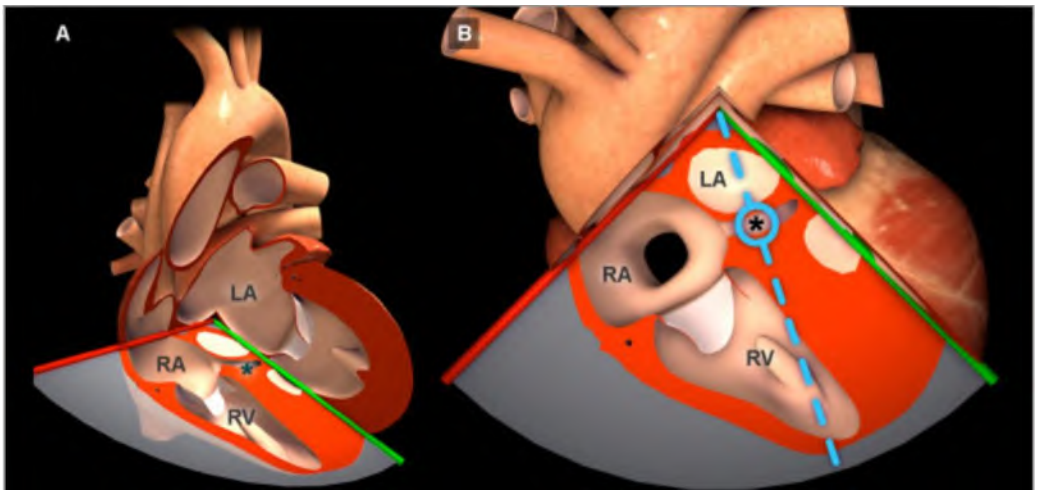
D



Answer: A

(See figure 20.14). The aortic balloon endoclamp zone lies between the STJ and the right brachiocephalic trunk with an ideal position 1-2 cm above the STJ without obstructing the coronary ostia.

Q3: Which anatomical structure is marked with a star in the following pictures?

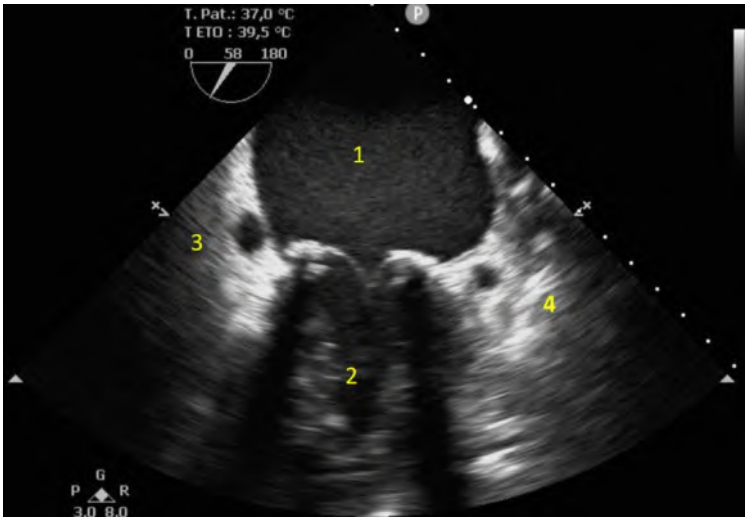


A) Right atrium
B) Superior cave vein
C) Septal tricuspid leaflet
D) Coronary sinus

Answer: D.

This is the coronary sinus (CS), just above the tricuspid valve. This structure is very important to identify for retrograde canulation. (Image from https://pie.med.utoronto.ca/tee/). A low esophageal view at 0° can confirm the catheter in the CS (see Figure 20.20). Catheter advancement should be under fluoroscopic guidance since TEE only shows the CS ostium, and progression within the small median vein increases risks of perforation. Advancing the catheter as distal as possible just before the before the great cardiac vein increases its stability (see Figure 20.18).

Q4: Select the appropriate name for the 4 structures in the following view



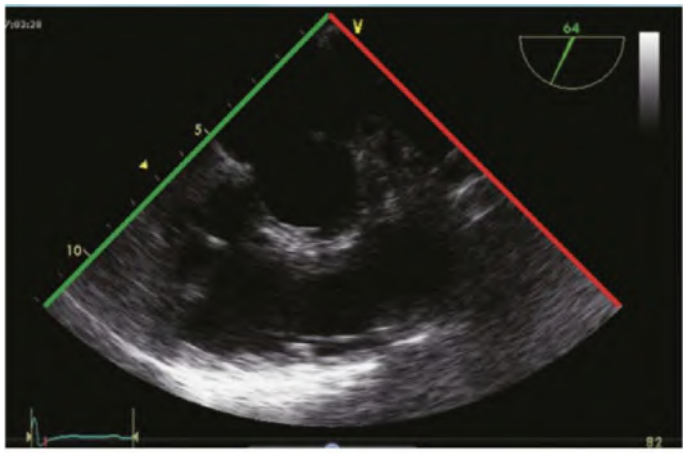
A) 1 = left atrium, 2 = left ventricle; 3 = coronary sinus; 4 = circumflex artery
B) 1= left atrium; 3 = left ventricle; 3=circumflex artery; 4= coronary sinus
C) 1= right atrium; 2 = right ventricle; 3 = coronary sinus; 4 = circumflex artery
D) 1= right atrium; 2 = right ventricle; 3 = circumflex artery; 4 = coronary sinus

Answer A.

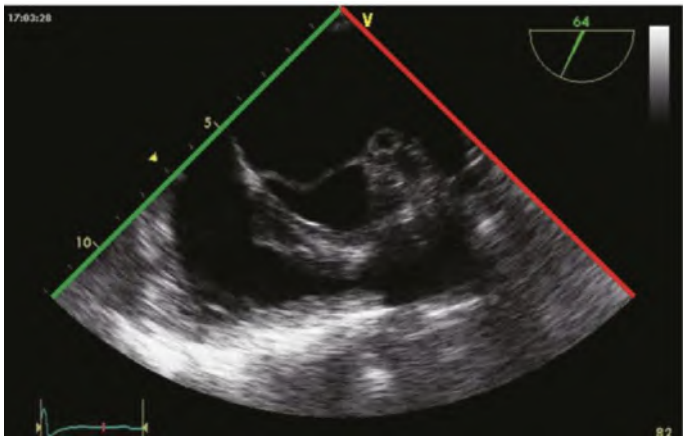
A detailed exam of coronary circulation is important to detect any aberrant anatomy such as a circumflex passing close to the mitral annulus (see Figure 9.15). Knowledge of this condition could prevent trauma or iatrogenic occlusion to the circumflex artery during mitral annuloplasty (see Figure 9.11).

Q5: You are the cardiac anesthesiologist of a patient going under robotic assisted procedure for coronary revascularization with a hybrid approach. The patient has a history right coronary artery stent angioplasty and is going under surgical approach for the left coronary artery. What do you suspect with the following picture?

Before:



After:



A) Right ventricular outflow tract ischemia
B) Mechanical right ventricular outflow tract
C) Dynamic right ventricular outflow tract
D) Left mammary artery spasm

Answer B

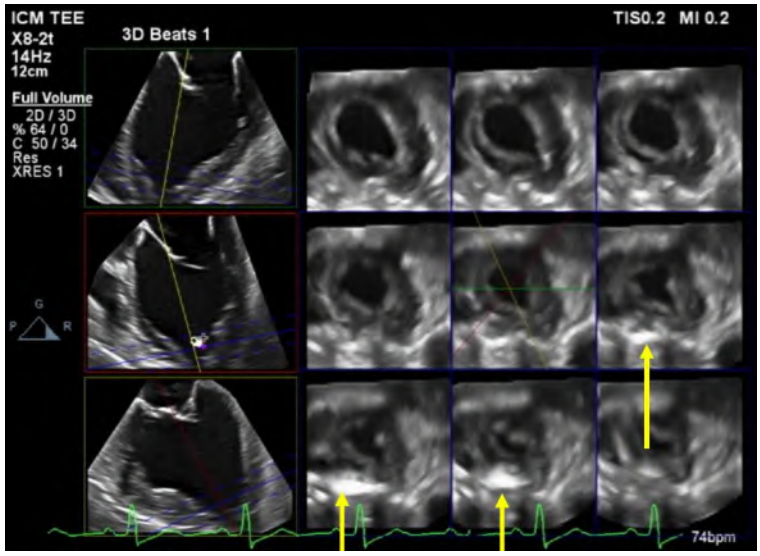
This is typical aspect of mechanical RVOT obstruction owing to the trocar insufflation pressure being over 10cmH2O (see Figure 20.33, 20.34) similar to a left tension pneumothorax (see Figure 32.10). Reducing the insufflation pressuremay also help by reducing the pulmonary artery pressure. Right sided dysfunction is a frequent cause of conversion to conventional cardiopulmonary bypass, especially in patients with associated right coronary artery disease.

Q6 How do you evaluate regional wall motion (RWM) in this 63 year-old man undergoing robotic revascularization? (see Video Chap20_Q6)

A) There is abnormal RWM in the anterior portion of the heart
B) There is no RWM abnormalities
C) The RWM abnormalities are most likely secondary to the pressure of the retractor on the heart
D) This is most likely secondary to abnormal right coronary artery perfusion abnormality

Answer C.

The arrows in this multislice left ventricular view (see figure below) in this patient indicate the retractor used in robotic surgery which are causing the regional wall motion abnormality. In robotic revascularisaiton, it is mostly the left anterior coronary artery that is revascularized.



Q7 Identify this complication following minimally invasive cardiac surgery. (see video Chap21_Q7A)

A) Left ventricular regional wall motion abnormality
B) Pericardial tamponade
C) Right ventricular failure
D) Right ventricular regional wall motion abnormality

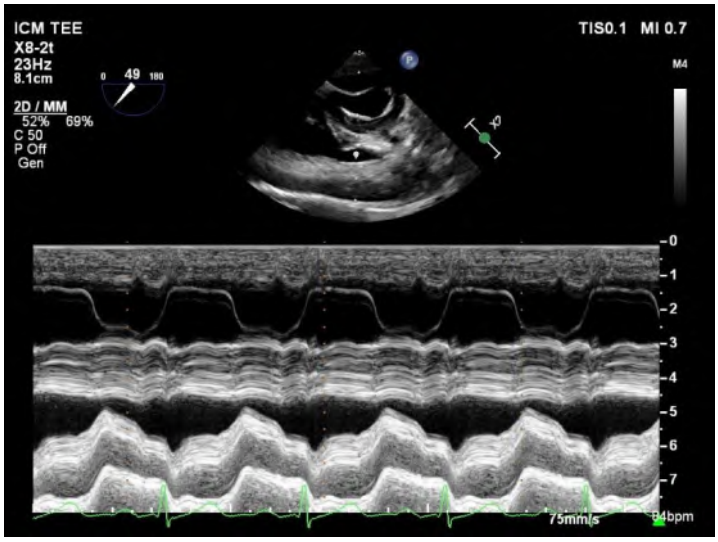
Answer: B

Pericardial tamponade is secondary to right ventricular perforation (see video Chap21_Q7B). In such a case, the minimally approach should be converted to a sternotomy.

Q8 What is the mechanism of hemodynamic instability during robotic surgery (see Video Chap20_Q8A)?

A) Dynamic right ventricular outflow tract (RVOT) obstruction
B) Mechanical RVOT obstruction
C) Myocardial ischemia
D) Pericardial tamponade

Answer B
In this patient the left sided pneumothorax (as a result of thoracic carbon dioxide insufflation) was compressing the RVOT in diastole. Mechanical RVOT obstruction was present in diastole. Dynamic RVOT obstruction typically occurs in systole. Pericardial fat was present anteriorly to the RVOT. M-mode can be used to confirm the diastolic obstruction (see Video Chap20_Q8B)



Q9 Radial (pink) and femoral (red) pressure before and during insertion of the aortic canula. What is the appropriate diagnosis?

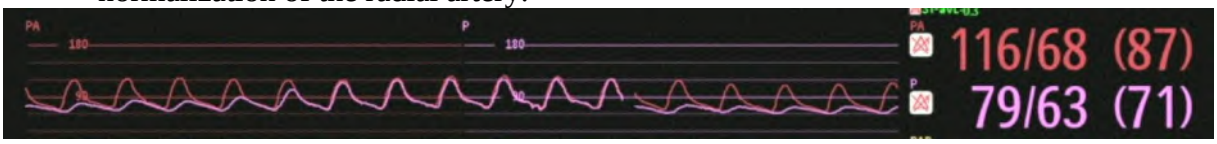
Before (13:55)

After (13:56)

A) The is inappropriate damping on the radial artery
B) The patient has received vasoactive agents
C) There is local compression of the radial artery
D) The aortic canula is positioned in the left subclavian artery

Answer: D

In this patient the aortic canula was seen in the aortic arch but the distal portion was in the left subclavian artery. (see Video Chap_Q9) Pulling back the canula resulted in normalization of the radial artery.



Q10 All of the following are important considerations in minimally invasive cardiac surgery in patients undergoing reoperation EXCEPT the following:

A) Mediastinal adhesions might require endovascular pacing prior to the procedure
B) Pericardial adhesions will make the LA opening more difficult, increasing the risk of perforation and hemorrhage
C) Minimally invasive procedure is contra-indicated in previous valvular surgery
D) Cardioplegia might be challenging in a patient with previous coronary revascularization with mammary graft permeability

Answer: B.

There might be a restriction to surgical access by a thoracoscopic approach, including but not limited to difficulties with trans-thoracic aortic clamping, epicardial temporary pacing wire insertion, and isolation of both venae cavae for snaring. The procedure is technically more challenging or in some cases impossible. These situations mandate discussion with the surgical team to ensure safe procedural planning.

Chapter 21

Mechanical Circulatory Devices

Q1. All the following elements should be excluded on transesophageal echocardiography (TEE) before insertion of a mechanical circulatory device EXCEPT:

A) Aortic dissection
B) Tamponade
C) Aortic insufficiency
D) Acute myocardial infarction

Answer D

Echocardiography plays a key role in the early management of patients presenting with coronary syndrome. Although acute myocardial infarction is the cause in most cases, one must exclude other causes such as aortic dissection, endocarditis, tamponade, valvular heart disease, myocarditis, pulmonary embolism and non-ischemic cardiomyopathy, that may change the treatment pathway.

Q2. In which part of the cardiac cycle does an intra-aortic balloon pump (IABP) inflates?

A) Start of isovolumic relaxation
B) Start of the systole
C) End of isovolumic relaxation
D) End of diastole

Answer A

The IABP inflates at the start of isovolumic relaxation to augment diastolic coronary perfusion pressure and deflates at the onset of systole to reduce left ventricular afterload, which increases cardiac output and improves the myocardial oxygen supply/demand balance.

Q3. What is the ideal position of the inlet port of the Impella 2.5 device in the left ventricle?

A) 4-5 cm from the aortic valve
B) 3-4 cm from the aortic valve
C) 2-3 cm from the aortic valve
D) 5-6 cm from the aortic valve

Answer B

The distance from the middle of the inlet portion to the aortic valve annulus varies with the device at 3-4 cm for the 2.5 and CP models and 5cm for the 5.5 model.

Q4. Which valvular pathology is a contraindication to the use the an Impella® system?

A) Moderate mitral regurgitation
B) Mild aortic regurgitation
C) Severe aortic valve stenosis
D) Moderate aortic valve stenosis

Answer C

Contraindications to the use of the Impella® system include significant aortic pathology such as dissection, severe aortic valve stenosis, more than moderate aortic regurgitation, mechanical aortic valve replacement and left ventricular thrombus. Conditions where decompressing the left-heart causes a significant left-to-right intracardiac shunt, such as atrial septal defect and ventricular septal defect may also be problematic.

Q5. In a Tandem Heart, where should the tip of the drainage canula be ideally positioned?

A) At the entrance of the superior vena cava
B) In the left atrium pointing towards the pulmonary veins
C) The correct positioning is always achieved using only echocardiographic guidance.
D) Through the femoral artery to get into the left atrium

Answer B

Ideally, the tip of the cannula should lie in the left atrium pointing towards the pulmonary veins, without contacting the wall of the left atrium as this may impede drainage. The side holes in the drainage cannula should all lie within the left atrium, which can be determined by color flow imaging interrogation of the cannula. Cannula malposition, where some of the drainage holes lie within the right atrium, can lead to deoxygenated blood being pumped systemically. This is readily detected by transesophageal echocardiography using color flow imaging.

Q6. Which of the following statements on peripheral veno-arterial ECMO is CORRECT:

A) It unloads the left ventricle.
B) It significantly reduces afterload.
C) It can potentially cause left ventricle distension.
D) It will cause the oxygenated blood flow in the aorta to be anterograde.

Answer C

In peripheral veno-arterial ECMO, circulatory support occurs by draining blood from the central venous system and delivering it back into a major artery, most commonly the femoral see Figure 21.1A. This configuration does not unload the left ventricle. Quite the opposite, it imposes a significant afterload, potentially causing left ventricle distension, worsening left-sided valvular insufficiencies, as well as increasing left atrial pressure. This often mandates decompression of the left heart chambers. Additionally, the retrograde flow of oxygenated blood in the aorta may lead to differential oxygenation and carbon dioxide clearance.

Q7. Which is a potential complication of peripheral veno-arterial ECMO?:

A) Recirculation
B) Harlequin syndrome
C) Acute aortic regurgitation
D) Pulmonary embolism

Answer B

Deoxygenated blood ejected from the LV in the setting of impaired native lung gas exchange can lead to a Harlequin syndrome where the face and upper extremity are blue and the legs are red. (see Figure 21.17B)

Q8. In order to avoid recirculation in veno-venous ECMO, the ideal distance between the reinjection and drainage canula should be:

A) 3-5 cm
B) $\geq$ 5 cm
C) $\geq$ 10 cm
D) Recirculation does not occur in veno-venous ECMO

Answer B

TEE is particularly helpful for dual-lumen cannula to appropriately position the reinfusion. In the femoro-femoral VV-ECMO, the distance between the reinjection canula and the drainage canula should be $\geq$ 5 cm in order to avoid recirculation. The adequate lumen position can be verified using chest radiograph see Figure 21.19

Q9. The following should be evaluated and corrected before and after left ventricular assist device (LVAD) insertion EXCEPT:

A) Aortic regurgitation
B) Atrial septal defect
C) Intra-cavitary thrombus
D) Mild secondary mitral regurgitation

Answer D

Intraoperatively, TEE assessment should inform about valve function (regurgitation, stenosis), patent foramen ovale (PFO) or interatrial communication, right ventricular function, and presence of left ventricular or right ventricular thrombus. Secondary mitral regurgitation might indeed improve following left ventricular assist device (LVAD). The 2023 guidelines for mechanical support mention that concomitant mitral valve interventions may be considered during LVAD implantation for severe mitral valve regurgitation. Mitral valve repair or mitral valve replacement using a bioprosthetic valve can be performed on the beating decompressed heart. (Level of evidence C).

Q10. All of the following are true for total artificial heart (TAH) EXCEPT:

A) Atrial thrombi and shunts, stenotic pulmonary veins and dilatation of pulmonary artery and of the aorta should be excluded before TAH insertion
B) TAH is made of two implanted artificial ventricles, mechanical heart valves and a four-layer membrane separating air from blood
C) TAH can deliver a cardiac output >9 L/min
D) Ejection pressures are preset to be about above 60 mmHg

Answer D

The two implanted artificial ventricles are made of polyurethane solution and contain two mechanical heart valves (Synhall™) directly connected to the ventricular cuff and a flexible membrane of four layers separating air from blood. The pre-implantation baseline TEE study should exclude pathology that could affect device function or patient outcome, such as atrial thrombi or shunts, stenotic or abnormal pulmonary veins or cava, and dilatation or dissection of the PA and aorta. Post-implantation, the native atria provide adequate windows for upper and ME TEE views. However, the prosthetic TAH precludes visualization of structures below the ventricular anastomotic ring, and air artifact from the pneumatic ventricles impede transgastric imaging. The TAH-t provides immediate and effective circulatory support due to the possibility of assuring a high cardiac output (>9 L/min) and reducing venous congestion due to the low resistance of the inflows. The cardiac output in most adult patients runs at 7 L/min at a preload of 5-10 mmHg. Ejection pressures are preset to be about above 30 mmHg anticipated PA pressure and 60 mmHg above the anticipated systolic pressure.

Chapter 22:
Heart transplantation

Q1. Which of the following statements on post heart transplantation (HT) right ventricle (RV) function is CORRECT?

A) Tricuspid annular plane systolic excursion (TAPSE) is expected to remain lower than normal one-year post transplantation.
B) Post transplant RV hypertrophy is expected up to a year after transplantation.
C) Diastolic flattening of the interventricular septum always resolves within the first-year post transplantation.
D) With improved therapies and cardiac protection strategies, early RV dysfunction is rare.

Answer A

The donor RV remodels in response to recipient perioperative pulmonary hypertension. Initially enlarged, it dilates further during the first month and subsequently returns to its immediate perioperative dimensions one year after surgery. The RV wall thickness does not increase significantly, probably because the pulmonary vascular resistance (PVR) declines close to normal levels. Right ventricular systolic dysfunction is present in all patients in the early weeks post heart transplant. RV systolic function assessed by 3D ejection fraction and longitudinal strain gradually improved in heart transplantation patients but remained reduced compared with healthy controls at 1-year follow-up. Two thirds of the patients yield partial recovery of RV longitudinal function during the first year, however tricuspid annular plane systolic excursion (TAPSE) remained lower than normal values. Tricuspid regurgitation is the most frequent valve disease after HT, commonly due to the afterload mismatch and RV dilatation. Finally, abnormal diastolic flattening of the ventricular septum was present in all patients immediately postoperatively. This proportion decreased to 75% at one month and 42% at one year post transplantation. This decline parallels the decrease in tricuspid regurgitation (TR) and RV dimensions.

Q2. Identify the best echocardiographic indicator to rule out early graft rejection (GR):

A) Decrease of more than 15% of mitral deceleration time, 6-month post-transplantation.
B) Normal left ventricular systolic ejection fraction immediately post-transplantation.
C) 8% decrease in isovolemic relaxation time immediately and 6-month post-transplantation.
D) Normal left ventricular mass immediately post-transplantation.

Answer C

Morphological features suggestive of GR include an increase in myocardial mass due to inflammatory cell infiltration and myocardial edema. However, with the addition of cyclosporine to the immunosuppressive medical regimen, cellular rejection is associated with less myocardial edema: the evaluation of LVEF and myocardial mass has thus become less sensitive as a means of detecting early rejection. Doppler parameters of diastolic function have been used to detect acute rejection. Moderate to severe rejection has been associated with a fall of at least 15% in the mitral deceleration time or the isovolemic relaxation time. However, wide interpatient variability in Doppler variables renders isolated measurement cut-offs less predictive. Each patient acting as her/his own control, from baseline study at 6 months after heart transplant, provides the basis for Doppler-based surveillance of graft rejection. An echocardiographic assessment with no changes in systolic and diastolic parameters from baseline has a negative predictive value for GR. In addition, constant Doppler tissue imaging (DTI) velocities (<10% reduction in diastolic mitral annular motion velocities) and high DTI velocities, such as e′ >16 cm/s appear to have a considerable accuracy in excluding (more than detecting) acute GR. Strain / strain rate are parameters of myocardial deformation suitable to diagnose subclinical allograft dysfunction, even with preserved ejection fraction. Global longitudinal peak systolic strain has been shown to detect early and subtle alterations of LV systolic function that could be used to monitor and characterize an acute GR in association with endomyocardial biopsies.

Q3. Echocardiographic evaluation of a potential heart donor should include:

A) Left ventricular diastolic function
B) Absence of left ventricular hypertrophy
C) Absence of congenital defects
D) All of the above

Answer: D

Echocardiographic evaluation of a donor should include evaluation of the donor's heart's systolic and diastolic function and to rule out anomalies including congenital defects, LV hypertrophy, and valvular diseases. If the LVEF is estimated to be < 45%, serial echocardiography may be useful to identify donors with reversible LV dysfunction. Pharmacologic stress echo may also assist in distinguishing between coronary artery disease, subclinical cardiomyopathy and reversible LV dysfunction.

Q4. Hemodynamic instability after heart transplant can be caused by:

A) Hyperacute graft rejection
B) Tamponade
C) Right ventricular outflow tract obstruction
D) All of the above

Answer D

Hemodynamic instability after heart transplant may arise from a single or multiple causes such as primary graft failure, hyperacute rejection, RV dysfunction, hypovolemia, vasodilatation, tamponade, right ventricular outflow tract obstruction or left ventricular outflow tract obstruction. Nonspecific graft failure, which occurs in up to 30% of patients, is still the most common cause of death in the early postoperative period.

Q5. Which is the most frequent valve disease after a heart transplant?

A) Pulmonary regurgitation
B) Mitral stenosis
C) Tricuspid regurgitation
D) Aortic stenosis

Answer C

Tricuspid regurgitation is the most frequent valve disease after HT, commonly due to the afterload mismatch and RV dilatation. Other causes of TR include endomyocardial biopsies causing chordal damage, alteration of right atrial morphology resulting from biatrial technique, papillary muscle edema and dysfunction due to acute rejection and endocarditis. TR has decreased after the adoption of the bicaval anastomosis technique. The current incidence of significant TR (moderate–severe) changes from 21% after weaning from CPB to 6% at 1-year follow-up and only 1% required surgical intervention during follow-up.

Q6. A normal echocardiographic profile after heart transplant includes:

A) Dilated left ventricular cavities
B) Increase left ventricular wall thickness and mass
C) Normal right ventricular function as assessed by TAPSE and DTI
D) Left atrial thrombus

Answer B

One year after OHT, echocardiograms of recipients doing clinically well are characterized by increased LV wall thickness and mass. Left ventricular dimensions, volumes, and ejection fraction are within normal limits. Right ventricular wall thickness and cavity size are increased with preserved RV systolic function. However, RV contractile pattern may change after HT. Longitudinal contraction of the RV, estimated by TAPSE and DTI may be reduced, in the context a normal overall RV function as radial shortening provides compensation.

Q7. After cardiac transplantation, initial treatment for right ventricular failure should include which of the following:

A) Intra-aortic balloon counterpulsation
B) Inhaled nitric oxide
C) Permissive hypercapnia
D) Right ventricular assist device

Answer: B

Whereas a more comprehensive treatment for right ventricular failure might very well be the placement of a right ventricular assist device, the best, and least invasive, initial treatment option would be the addition of inhaled nitric oxide (NO). Permissive hypercapnia may adversely impact the function of the failing right ventricle by artificially elevating the pulmonary artery pressures. Intra-aortic balloon counterpulsation is more useful for the treatment of left ventricular failure. Reviews have been published on the management of RV failure after heart transplantation and the role for inhaled NO treatment

Q8 What is the most likely cause of hemodynamic instability after heart transplantation in this patient? (see video Chap22_Q8)

A) Right ventricular failure
B) Hypovolemia
C) Graft rejection
D) Inferior vena cava (IVC) stenosis

Answer: D

This is a transgastric abdominal ultrasound longitudinal view of the IVC The increase in color flow imaging (CFI) indicate turbulence at the level of the IVC. IVC stenosis will be associated with abnormal CFI with aliasing at the IVC and RA junction. Unstable patients will typically have a dilated IVC (**Error! Reference source not found.**), abnormal hepatic venous PWD velocity signal and reduced RV and LV dimensions (see Figure 28.37).

Q9 Which statement is TRUE regarding the inferior vena cava canula prior to heart transplantation in this patient? (see video Chap22_Q9)

A) There are 2 IVC cannulas corresponding to a double stage canula
B) The IVC canula is in the hepatic vein
C) The IVC canula is too deep in the IVC
D) A mirror artefact of the IVC canula is present.

Answer D

A mirror artifact is seen in an additional IVC canula is present. The position in front of the hepatic vein is adequate.

Q10 What is the abnormality in this patient following cardiac transplantation? (see video Chap22_Q10)

A) Left atrial thrombus
B) Left atrial mass
C) Edematous anastomotic left atrial site
D) Left atrial myxoma

Answer: C

Echocardiography can assess the atrial anastomoses in the bi-atrial approach. The mid-esophageal (ME) long-axis or two-chamber views show an elongated LA, which is now composed of both donor and recipient atrial tissue. The suture line within the LA and RA appears predominantly as an echo dense ridge (**Error! Reference source not found.**). Acquired cor triatriatum may develop from infolding of redundant donor atrial tissue (**Error! Reference source not found.**).

Chapter 23:
Aorta

Q1. In transesophageal echocardiography (TEE) evaluation for atheroma in the ascending or descending aorta, which of the following statements is TRUE?

A) If significant atheroma is detected in the descending aorta, the positive predictive value for ascending aortic atheroma is in the range of 35–40%
B) If significant atheroma is detected in the descending aorta, the positive predictive value for ascending aortic atheroma is in the range of 15–20%
C) If only mild disease is evident in the descending aorta, moderate to severe disease in the ascending aorta is in the range of 25%
D) If only mild disease is evident in the descending aorta, moderate to severe disease in the ascending aorta is in the range of 45–50%

Answer: A

This is true, plus evidence suggesting that if only mild disease is evident in the descending aorta, moderate to severe disease in the ascending is unlikely. Conditions associated with atherosclerosis of the aorta include advanced age, presence of peripheral vascular disease, carotid stenosis, hypertension, a higher EuroSCORE, and disease of the descending thoracic aorta.

Q2. Regarding detection of atherosclerosis in the aortic arch, which of the following statements is FALSE?

A) Presence of atherosclerosis in the aortic arch can be predicted in <50% of patients preoperatively by age and chest X-ray
B) Epiaortic ultrasound is the gold standard to evaluate ascending aortic atherosclerotic plaque
C) Atherosclerosis is most prevalent in the anterior segment of the distal ascending aorta.
D) Direct manual palpation of the aorta has a sensitivity of more than 65% when compared with intraoperative epiaortic scanning

Answer: D

Direct manual palpation of the aorta has a sensitivity of <50% when compared with intraoperative epiaortic scanning for the detection of atheroma. Studies have examined the efficacy of different modalities of aortic evaluation to detect and quantify atherosclerotic disease. Digital palpation is unreliable in detecting aortic atherosclerosis, with a sensitivity of only 14–55%.

Q3. Which portion of the aorta is often difficult to assess with TEE?

A) The proximal ascending aorta
B) The distal segment of the arch
C) The most cephalad portion of the ascending aorta
D) The distal descending thoracic aorta

Answer C

The most cephalad portion of the ascending aorta and the proximal segment of the arch may not always be satisfactorily visualized due to interposition of the right mainstem bronchus and/or the trachea. The entire descending thoracic aorta can usually be scanned with comparable quality to CT scan imaging.

Q4. Which of the following statements is TRUE?

A) Aortic atherosclerosis is present in more than 65% of patients undergoing cardiac procedures.
B) Patients with severe atherosclerotic disease have a fivefold increase rate of risk of perioperative stroke compared with patients with mild disease.
C) Patients with ulcerated lesions or mobile atheromas have a 23.5% risk of perioperative stroke.
D) The presence of atherosclerotic plaque is unrelated to the risk of intimal flap formation after aortic cannulation and clamping.

Answer C

Aortic atherosclerosis is present in 19-58% of patients undergoing cardiac procedures.

Q5. Aortic aneurysm involves the ascending aorta in approximately:

A) 20% of cases
B) 30% of cases
C) 40% of cases
D) 50% of cases

Answer D

Aortic aneurysms involve the ascending aorta in approximately 50% of cases, the descending portion in 40%, and the arch in 10%.

Q6. In diagnosing aortic dissections, TEE has been shown to be:

A) Significantly less sensitive than the MRI for the diagnosis of aortic dissections
B) Only 80% sensitive and specific for the diagnosis of aortic dissections
C) A reliable alternative to CT scan based on the patient's history and presentation
D) The gold standard to diagnose aortic dissections
E) A last resort if the CT scan is not available

Answer C

Many studies have examined the accuracy of different diagnostic modalities for aortic dissection. The TEE has been shown to be able to diagnose aortic dissection with sensitivity as high as 99% and 98% specificity. Other sources even reported 100% sensitivity for both TEE and MRI, while the specificity of TEE was lower (68%) than that of MRI (100%). TEE is also a useful tool to assess many complications of an aortic dissection.

Q7 The corresponding color compare video of the ascending aorta shows evidence of an aortic dissection. The lumen at the bottom of the screen most likely represents the false lumen because? (see video Chap23_Q7)

A) The false lumen is larger than the true lumen
B) The false lumen is less pulsatile
C) The systolic higher velocity signal originates from the lumen at the top or the true lumen
D) Ther is more aliasing in the false lumen

Answer: C

The diagnosis of aortic dissection relies on identifying an intimal flap dividing the aorta into two separate channels, the true and false lumens (see **Error! Reference source not found.**, e**Error! Reference source not found.**, e**Error! Reference source not found.**, **Error! Reference source not found.**, see Figure 13.6 and eFigure 13.12). See Table 23.1 summarizes the key features differentiating a flap versus an artifact. Distinguishing the true and the false lumen may sometimes be difficult (see Table 23.2). Intuitively, blood should not flow freely through the false lumen if it is a blind pouch. On 2D imaging, the pulsatile lumen (showing a bigger diameter in systole) should represent the true lumen, while smoke-like or swirling SEC suggests sluggish or absent flow in the false lumen. Color flow imaging and pulsed-wave Doppler (PWD) may also confirm decreased flow in the blind, false lumen (see **Error! Reference source not found.**)

Q8. What is the mechanism of aortic regurgitation in this patient with type A aortic dissection? (see video Chap23_Q8)

A) Type IA
B) Type IB
C) Type II
D) Type III

Answer: C

This is a type II with a right coronary cusp prolapse leading to a posterior-oriented jet. The mechanism of AR may result from both aortic root dilation and direct geometric disruption of the support by the false lumen. An evaluation of the extent and mechanism of AR helps determine the potential for valve repair or the need for valve replacement (see **Error! Reference source not found.**, e**Error! Reference source not found.**, **Error! Reference source not found.** and eFigure 30.10) as described in Chapter 15

Q9. What is the best way to visualize the stenotic segment of the aorta in a patient with aortic coarctation?

A) Magnetic resonance imaging
B) Direct visualization with transesophageal echocardiography
C) Colour-flow Doppler of the descending aorta
D) Pulsed wave Doppler of the descending aorta

Answer A:

The best echocardiographic window to visualize a coarctation is the transthoracic suprasternal notch view (see **Error! Reference source not found.**). However, Doppler determination of pressure gradient is difficult because of inadequate Doppler alignment with blood flow. Hence, preoperative MRI, angio-CT or biplane aortography may be required to complete the evaluation in adults. CT and MRI can best determine the exact site, degree of obstruction, and extent of collaterals.

Q10. This is a patient who presents with an aortic dissection and hemodynamic instability. The patient is currently on norepinephrine to maintain a mean arterial pressure of 55 mmHg. What is the most likely cause of the patient's shock demonstrated by the TEE? (see video Chap23_Q10)

A) Severe hypovolemia
B) Global left ventricular systolic dysfunction
C) Segmental left ventricular systolic dysfunction
D) Pericardial tamponade

Answer D.

The TEE demonstrates a large pericardial effusion with tamponade. Although limited views are available, the left ventricular function appears normal. Aortic dissection is the greatest actor: it can present as a coronary syndrome (coronary artery dissection), pulmonary edema (acute aortic insufficiency) right ventricular failure (from compression of the right pulmonary artery), pericardial tamponade, hemothorax, stroke (from carotid dissection), abdominal pain and back pain.

Chapter 24:
Endograft placement in aortic disease

Q1. All of these are advantages of endovascular aortic surgery in older patients EXCEPT:
A) Decrease physiological stress response.
B) Shorter hospital stays.
C) Minimal long-term post procedure follow-up.
D) Quicker return to normal activities.

Answer C

One of the main disadvantages of endovascular aneurysmal repair is the requirement for a yearly computed tomography (CT) scan. With the progressive aging of the population and the associated increase in comorbidity, advantages of endovascular surgery include decreased stress response, less perioperative complications, shorter hospital stay, and quicker return to normal activities.

Q2. Which of these is not a role of TEE during endovascular aortic surgery?
A) Rapidly identify intraoperative cardiac ischemia during stent deployment.
B) Confirm the nature and extension of the aortic pathology.
C) Confirm the correct guide placement in the true lumen.
D) Determine the endograft size and landing zones in elective procedures.

Answer D

In all elective and most urgent endovascular procedures, the indication for endovascular repair as well as the endograft size and proximal landing zone are selected preoperatively based on the CT scan and/or magnetic resonance imaging studies. However, both TEE and fluoroscopy can be used to confirm these during the procedure.

Q3. Which statement about type III endoleaks is correct?

A) They donot require further intervention since they will self-resolve with time.
B) They result from inadequate apposition of overlapping endograft joint.
C) They are caused by the porosity of the endograft material.
D) They can further be classified into IIIa and IIIb depending on the localization of the leak.
E) They can be corrected by coiling the culprit collateral vessel in a future intervention.

Answer B

Type III endoleak, or graft defect, is a result of inadequate apposition of overlapping endograft joints or a tear of the graft fabric. Type I and III endoleaks are clearly associated with future aneurysm expansion and should, therefore, be corrected by balloon dilation or additional endograft insertion. Type I endoleak occurs at the attachment sites and can involve the proximal (type IA) and/or distal ends of the endograft (type IB). They are usually large and result from incomplete adhesion of the endograft to the aortic wall. To decrease their occurrence, balloon inflation after endograft deployment is normally performed at the proximal and distal ends to mold the endograft to the aortic wall. Type II endoleak, or branch leak, is due to retrograde blood flow into the aneurysm sac from one or more aortic collateral vessels. Type IV endoleak is due to blood flow into the aneurysm sac due to the porosity of the graft fabric. Type IV endoleak generally does not require any further intervention.

Q4. Concerning endoleaks following endovascular aortic repair, which of the following statement is FALSE?

A) Pulse wave Doppler velocity can help differentiate the type of endoleak.
B) TEE is useful to detect type I endoleak especially in curved section of the aorta.
C) Type I endoleak should be treated before leaving the operating room.
D) Fluoroscopy is more sensitive than TEE to detect small endoleaks.

Answer D

TEE is the most sensitive tool for detecting endoleaks immediately after endograft deployment. Small endoleaks may be missed by angiography because the amount of dye within the leak is not detectable by fluoroscopy or because the imaging view is inadequate. The use of TEE is often superior to angiography in the detection and characterization of type I endoleaks, due to incomplete endograft apposition to the aortic wall. This is particularly useful in sections of the aorta that are highly curved such as the aortic arch. Endoleaks may also be better defined by TEE than by angiography because it is sometimes difficult to differentiate a transient type IV endoleak from the more significant type I or III endoleaks immediately after endograft graft insertion. A pulsed wave Doppler velocity cutoff value of 50cm/s has been advocated to enable differentiation of type IV endoleaks (slow blood flow) from type I, II or III endoleaks (high-velocity flows). Endoleaks that appear several weeks, months, or even years after the insertion of an endograft are called secondary endoleak. They are probably related to dislodgment of the endograft, to structural changes of the aortic wall, or to endoleaks that were simply not diagnosed at the time of insertion. Secondary endoleaks are the main cause of late treatment failure in the endovascular approach. Aneurysm expansion in the absence of visible endoleak has been reported with the hypothesis that endoleaks are not always visualized by current imaging methods, such as angiography or CT.

Q5. In blunt traumatic thoracic aortic injury, the incidence of the aortic tear being at the aortic isthmus is approximately:

A) 40-50%
B) 60-70%
C) 80-90%
D) 90-100%

Answer C

Blunt chest trauma is the most common cause of traumatic thoracic aortic injury. The majority of aortic tears (80–90%) occur in the descending thoracic aorta at the aortic isthmus, just distal to the left subclavian artery and proximal to the third intercostal artery. With sudden deceleration, the more mobile aortic arch swings forward, producing a combination of torsion, shearing, and bending stresses on the aorta at the isthmus, leading to disruption.

Q6. Which if these statement on endograft placement in aortic disease is TRUE:

A) For aneurysms less than 12 cm in length, a single graft can be used.
B) Minimal overlap of endograft is usually sufficient to avoid secondary type III endoleaks.
C) The longest graft possible should be used in treating thoracic aneurysm to avoid Ib endoleaks.
D) The TEE is not a valuable tool to rule out the presence of thrombus or small ulcer at the proposed graft landing sites.

Answer A

With shorter aneurysm lengths of coverage required, 12cm or less, a single graft can be used. For an aneurysmal segment greater than 12 cm, two or more endografts may be required to achieve complete coverage of the aneurysm. In case multiple endografts are required, TEE should be focused on ensuring that sufficient overlap exists between endografts. Balloon dilation may be required at the landing zones and at the sites of endograft overlap. Thoracic aorta repairs require the use of the shortest possible endograft to avoid the risk of occluding thepatent aortic branches and limit the likelihood of spinal cord ischemia. In cases where the aortic lesion is difficult to define or to localize, such as with the presence of small ulcers causing an intramural hematoma, or for the localization of the entry site of an aortic dissection, TEE imaging can be superior to fluoroscopy. For example, TEE can demonstrate that the normal aorta adjacent to the aneurysm is dilated and partially filled with mural thrombus making it a poor site for the endograft landing zone. Both intraoperative fluoroscopy and TEE can provide guidance for precise positioning of the device across an aortic lesion. However, when an aneurysm is located at the junction of the arch and descending aorta, intraoperative angiography may not be able to visualize it properly.

Q7 All are high-risk features for acute intervention in uncomplicated acute type B aortic dissection EXCEPT?

A) Entry tear > 10 mm
B) False lumen diameter >20 mm
C) Pleural effusion
D) Maximal aortic diameter > 50 mm

Answer: C

High risk imaging and clinical finding are listed in Table 24.4.

Q8 During stent insertion for an aortic arch aneurysm, the following is observed on an upper esophageal biplane view (see video Chap24_Q8). Which is the correct statement?

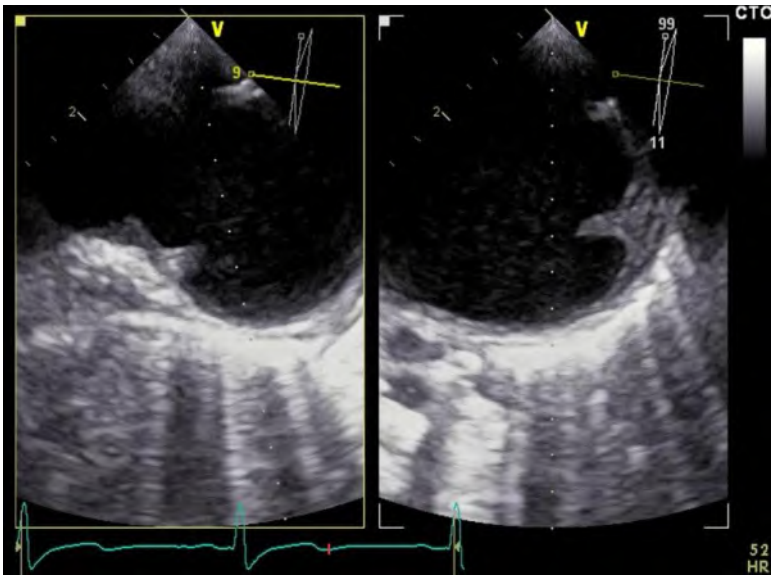
A) There is an aneurysmal rupture
B) This is the tip of the atrial appendage in the transverse sinus
C) This is a left superior vena cava with a thrombus
D) This is a dissection the innominate artery

Answer B:

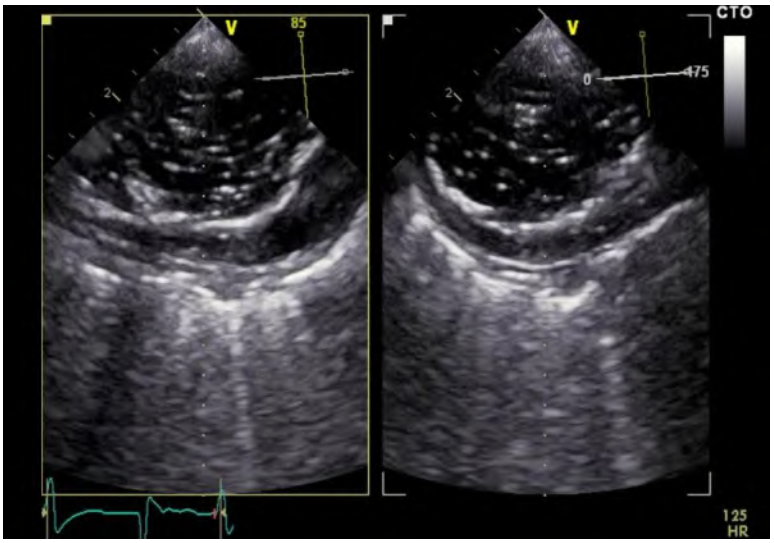
The circumflex artery and coronary sinus can be seen on the right which correspond to the left atrial appendage region.

Q9 These images are from before and after the deployment of an aortic endograft in a 69-year-old man. Which statement is CORRECT? (see Video Chap24_Q9A and Video Chap24_Q9B)

Before



After



A) The is a type 1A leak
B) Air is present within and outside the endograft
C) There are no consequences of air embolization in such cases
D) The stent is unstable

Answer: B

Leaks are typically diagnosed using color Doppler imaging. Air bubbles appear as highly mobile, strongly echogenic dots, often accompanied by side lobe and reverberation artifacts with acoustic shadowing. There is an association between the total number of air emboli quantified using transcranial Doppler in cardiac surgery and adverse outcome (see chapter 13)

Q10 Which of the following statements is FALSE regarding endoleaks?

A) Type I is an attachment site leak
B) Type II is a branch leak
C) Type IIII is a graft defect
D) Type IV is detected using a 20 cm/s pulsed-wave velocity threshold

Answer: D.

(see Table 24.5) TEE is the most sensitive tool for detecting endoleaks immediately after stent graft deployment. Angiography may miss small endoleaks because the amount of dye within the leak is undetectable by fluoroscopy or the imaging view is inadequate. TEE is often superior to angiography in detecting and characterizing type I endoleaks, from incomplete stent graft apposition to the aortic wall. This is most useful in the highly curved aortic sections, such as the aortic arch. TEE may better define endoleaks than by angiography because it is sometimes difficult to differentiate a transient type IV endoleak from the more significant type I or III endoleaks immediately after stent graft insertion. A PWD velocity cutoff value of 50 cm/s enables the differentiation of type IV endoleaks (slow blood flow) from type I, II or III endoleaks (high-velocity flows).

Chapter 25:
Intracavitary content

Q1. A 74-year-old patient with a 70 pack/year smoking history is scheduled for elective coronary artery bypass graft surgery. His only clinical symptom is stable Class III angina. A transesophageal echocardiography (TEE) performed immediately before surgery reveals the presence of a mass on the anterior mitral valve leaflet. Which is the most probable diagnosis?

A) Papillary fibroelastoma
B) Vegetation
C) Lambl's Excrescence
D) Mobile calcification

Answer A

Papillary fibroelastomas represent 11.5% of all primary cardiac tumors. They are more commonly found on the downstream side of valves. They are mostly found on the valvular endocardium of the aortic and mitral valves and less frequently the tricuspid valve or any endocardial surface, such as the left atrial appendage (LAA). They are not generally associated with valvular dysfunction. It is mostly diagnosed in middle-aged patients who present with embolic complications, such as a stroke. They are typically small, with a short and narrow pedicle. They are described as club-shaped, well-defined with a smooth surface and most are independently mobile.

Q2. Which of these structures found on TEE in the right atrium is most likely pathological?

A) A long, thin, and mobile structure at the junction of the right atrium and inferior vena cava.
B) A weblike filamentous structure attached to the interatrial septum.
C) A mobile pediculated mass attached to the septal leaflet of the tricuspid valve.
D) A ridge-like structure extending along the posterior/lateral aspect of the right atrium wall.

Answer C

Could be vegetation especially if the clinical presentation suggested endocarditis. All other structures are variant of normal. A) Eustachian valve B) Chiari Network D) Right atrium appendage

Q3. Which is the most frequent intracardiac mass found on echocardiography?

A) Myxoma
B) Rhabdomyoma
C) Thrombus
D) Sarcoma

Answer C

Intracardiac thrombus are quite common findings and are probably one of the most frequent masses found on routine echocardiography. Myxomas account for 50-80% of primary cardiac tumors. Rhabdomyomas are the most common benign tumor in the pediatric population. Sarcomas are the most frequent malignant tumor of the heart (64.8%)

Q4. Which of the following statements on native valve endocarditis is FALSE?

A) Vegetations are often associated with regurgitant jets.
B) Vegetations are usually pediculated but can be sessile in marantic endocarditis.
C) Lupus is associated with sterile vegetations.
D) Vegetations are most often found on the ventricular side of the atrio-ventricular valves.

Answer D

In native valve endocarditis, the diagnostic accuracy depends on the vegetation size and the underlying valvular disease. The atrial side of the atrio-ventricular valve and the ventricular side of the semilunar valve are the typical locations for vegetations.

Q5. What is the most classic site of attachment of a left atrial myxoma?

A) Posterior wall
B) Left atrial appendage
C) Fossa ovalis
D) Mitral valve apparatus

Answer: C

On echocardiography, myxomas are typically pedunculated but up to 10% can be sessile. Classically, they appear mobile within the left atrium body attached to the endocardial surface by a stalk that arises from the fossa ovalis

Q6. Which condition is most likely to be associated with a left atrial thrombus?

A) Aortic regurgitation
B) Aortic stenosis
C) Mitral stenosis
D) Mitral regurgitation

Answer: C

Intracardiac thrombi can develop in a variety of locations. LA and left atrial appendage (LAA) thrombi are common in the presence of atrial fibrillation (AF). Thrombi are also prevalent in patients with valvular heart disease, specifically mitral stenosis.

Q7. Which of the following mass is the least likely to be found in the right atrium?

A) Thrombus in transit
B) Myxoma
C) Lipoma
D) Fibroma

Answer: D

RA and right ventricular (RV) thrombi are less common than left-sided thrombi. RA thrombi may appear in transit in cases of pulmonary embolism, cancer and other hypercoagulable states that predispose patients to right-sided thrombi. The most common intra-cardiac location if myxomas is the left atrium (in up to 60-80% of cases), followed by the right atrium and ventricles

According to case reports, common locations for intracardiac lipomas include the RA (42% of cases), followed by the LV (33%), RV (13%), and LA (3%). Fibromas are the second most common PCT in the pediatric population, occurring at any age. They often involve the ventricular myocardium, with a predilection for the LV free wall and interventricular septum.

Q8. Which of the following statements is FALSE?

A) Metastatic tumors to the heart are less common than primary cardiac tumors
B) Lymphoma involving the heart may mimick a hypertrophic cardiomyopathy
C) Bronchogenic carcinoma may invade the heart via the pulmonary veins
D) Renal cell carcinoma may invade the heart via the inferior vena cava

Answer: A

Approximately 10% of metastatic extra-cardiac tumors will metastasize to the heart. These resulting cardiac lesions make up the category of secondary cardiac tumor and are up to 40 times more common than primary cardiac tumor. Although lymphoma can involve any cardiac chamber, they have a predilection for the right-sided cavities, especially the right atrium. They can also present as multiple nodular masses, which, if within the LV apex, can be mistaken for thrombi. When infiltrating the interventricular septum, cardiac lymphomas can also mimic hypertrophic cardiomyopathy and lead to a restrictive physiology. Metastases can spread to the heart via the hematogenic or lymphatic routes, as well as from direct/adjacent invasion sur as IVC invasion in renal cell carcinoma.

Q9. Color Doppler flow within a left atrial mass excludes which pathology?

A) Myxoma
B) Sarcoma
C) Left atrial thrombus
D) Hemangioma

Answer:C

All those tumors have some degree of vascularization except thrombus.

Q10.Which of the following conditions favor the diagnosis of a left atrial thrombus rather than a myxoma?

A) The mass is very mobile
B) The mass is attached to the interatrial septum
C) The absence of spontaneous echocontrast
D) The homogenous aspect of the mass

Answer: D

Thrombi usually appear as echo-dense material acoustically distinct from the endocardium. An echocardiographic definition of organized thrombus is a well-circumscribed highly reflective mass with a uniform consistency that differs from the atrial wall. Some thrombi may not appear completely well circumscribed and composed of an organized portion surrounded by spontaneous echocardiographic contrast. Spontaneous echocardiographic contrast does not have uniform consistency and has a "smoke-like" appearance.

Chapter 26
Congenital Heart Disease

Q1 Which of these is NOT one of the main 4 steps of a systematic echocardiographic evaluation for complex congenital heart disease patient?

A) Determining the cardiac position, orientation and visceral sidedness (situs).
B) Identifying the atrial, ventricular and arterial segments.
C) Determining the atrial, ventricular and arterial connections.
D) Determining the level of complexity of the congenital heart disease.

Answer D

The four steps are determining the cardiac and visceral sidedness (situs), determining the cardiac position and orientation, identifying the atrial, ventricular and arterial segments, determining the atrial, ventricular and arterial connections.

Q2 Which of the following statements on atrial septal defect (ASD) is FALSE?

A) Hemodynamically significant ASD often measure less than 10mm.
B) An atrial left-to-right shunt causes right ventricular (RV) and right atrial (RA) dilation in diastole.
C) Previously asymptomatic ASD may become hemodynamically significant in the presence of worsening diastolic dysfunction.
D) Most secundum ASD are closed percutaneously, while other usually require surgical correction.

Answer A

Hemodynamically significant ASDs rarely measure less than 10mm. Atrial left-to-right shunt causes right-sided volume overload with RV and RA dilatation in diastole and increased RV ejection volume in systole into a dilated PA bed. Diastolic dysfunction increases LA pressure and causes the left-to-right shunting to increase.

Q3 Which of the following statements on ventricular septal defect (VSD) is FALSE?

A) VSD with significant left-to-right shunt often present early in life with failure to thrive and high output heart failure.
B) The four types of VSD are perimuscular, inlet, outlet and membranous VSD.
C) Muscular VSD may persist in adulthood but are often small and without significant shunt.
D) VSD closure is necessary in the presence of LV volume overload and a Qp:Qs > 1.5.

Answer B

The classification of VSD is by their location in the IVS. The 4 types are perimembranous, inlet, muscular and outlet VSD.

Q4 Which of the following statements on the coarctation of the aorta is FALSE?

A) Cardiovascular anomalies associated with the coarctation of the aorta include anomalous origin of the right subclavian artery, bicuspid aortic valve and berry aneurysm of the circle of Willis.
B) "Simple" coarctation are rarely associated with intracardiac abnormalities.
C) The narrowing of the aorta is usually at the level of the ligamentum arteriosus.
D) A gradient of > 20mm Hg across the coarctation is mandatory to establish the diagnosis of hemodynamically significant coarctation of the aorta.

Answer D

Minimal or no-pressure gradient my occur in hemodynamically significant coarctation of the aorta with the development of significant collateral circulation.

Q5 Which of the following statements on mitral valve (MV) anomalies is FALSE?

A) Shone's complex is associated with a parachute mitral valve.
B) A single papillary muscle is the hallmark a parachute mitral valve.
C) Parachute mitral valve represents half of the mitral insufficiency diagnosed in pediatric patients.
D) Parachute mitral valve is commonly associated with a supravalvular mitral ring.
E) Transgastric views are extremely helpful for evaluating the number of papillary muscle when suspecting a parachute mitral valve.

Answer C

Parachute MV represents about half of the mitral stenosis (MS) diagnosed in pediatric patients but can also present in adulthood. Here, all the chordae tendineae insert into a single papillary muscle group. Anatomy of the papillary muscles is highly variable, but in a true parachute MV, it originates from the anterolateral LV wall. The MV leaflets also appear dense with restricted motion, short, thickened chordae.

Q6 Which of the following statements on Ebstein anomaly isFALSE?

A) By definition, it corresponds to an apical displacement of the septal leaflet of the tricuspid valve >8mm/m² in adults.
B) Is frequently associated to an ASD or PFO.
C) Is best evaluated in the ME four-chamber view.
D) Surgical repair is rarely associated postoperative right ventricular failure

Answer D

RV failure is a major postoperative complication of Ebstein anomalies repair (cone procedure). Many strategies have been used to minimize this, including valved closure of the ASD to allow right-to-left shunt, or performing a bidirectional cavopulmonary shunt (modified Glenn procedure) to decrease RV preload.

Q7 What anomaly is shown on video Chap26_Q7?

A) Cor triatriatum
B) Left atrial pouch
C) Sinus venosus
D) Persistent left superior vena cava

Answer : D

Persistent left superior vena cava (SVC) occurs as an isolated finding in 0.3% of otherwise normal subjects, with a higher prevalence of 3% to 10% in congenital heart disease patients. It commonly drains into the coronary sinus which becomes markedly dilated. Persistent left SVC presents as an echo-free space between the left atrial appendage and left upper pulmonary vein. Spontaneous contrast is seen in the coronary sinus as a result of the left superior vena cava communication with the left subclavian vein. Left atrial septal pouch can be present in up to 39% in autopsy findings. The pouch may represent an incomplete closure of the foramen ovale with limited fusion between the septum primum and secundum at the caudal portion of the zone of overlap (see Chapter 7, Figure 7.33).

Cor triatriatum sinister is a rare congenital cardiac malformation of the LA, an embryologic result from failure of the common pulmonary vein to incorporate into the LA. Incomplete resorption leaves a fibromuscular membrane dividing the LA chamber into a proximal compartment (atrial accessory chamber) receiving the pulmonary veins and a distal compartment or true LA chamber, which most often contains the fossa ovalis and the left atrial appendage (LAA). Sinus venosus is a type of atrial septal defect.

Q8 What is the congenital anomaly shown in video Chap26_Q8A and video Chap26_Q8B?

A) Secundum atrial septal defect (ASD)
B) Sinus venosus ASD
C) Primum ASD
D) Coronary sinus defect

Answer B

Sinus venosus defect exists as two types. The commonest is the superior sinus venosus, where the defect is in the superior and posterior aspect near the superior vena cava (SVC). In this case, the 3D bical view show te defect and the abnormal color flow imaging in the SVC. Sinus venosus defect is often associated with partial anomalous pulmonary venous return (PAPVR). In the superior sinus venosus defect, the right upper pulmonary vein unroofs into the SVC.

Q9. Which statement is INCORRECT regarding video Chap26_Q9?

A) The aorta overrides the interventricular septum.
B) The primary defect is a posterior displacement of the infundibular septum.
C) This is the most common complex congenital cardiac malformation.
D) This condition can lead to right ventricular outflow tract obstruction.

Answer B

TOF is one of the most common complex congenital cardiac malformations found in adults. The primary defect is antero-cephalad displacement of the infundibular septum leading to RVOT obstruction, which is usually infundibular but can also be valvular or supravalvular. Quantification of RVOT obstruction is mild (peak gradient < 36 mmHg), moderate (peak gradient 36-64 mmHg) or severe (peak gradient > 64 mmHg). The aorta overrides the IVS and doubly commits to both ventricles. If the aorta is >50% committed to the RV, then the more appropriate defect description is a double outlet RV. There is RV hypertrophy from systemic pressure in the RV caused by the unrestrictive VSD and RVOT obstruction.

Q10. Which statement is TRUE regarding video Chap26_Q10?

A) It is rarely associated with other congenital defect.
B) The mitral valve leaflet are typically normal.
C) This condition is a rare cause of mitral valve stenosis in children.
D) The single papillary muscle is the hallmark of this lesion.

Answer D

Parachute MV represents about half of the MS diagnosed in pediatric patients but can also present in adulthood. Here, all the chordae tendineae insert into a single papillary muscle group. Anatomy of the papillary muscles is highly variable, but in a true parachute MV, it originates from the anterolateral LV wall. The MV leaflets also appear dense with restricted motion, short, thickened chordae. A parachute MV is often associated with other left-sided obstructive lesions comprising the Shone's complex, which includes a supravalvular mitral ring, subaortic stenosis, AoV stenosis and aortic coarctation.

Chapter 27:
Lung transplantation

Q1. Following double-lung transplantation, the mean flow velocity in the left upper pulmonary vein is 2.5 m/s. This is most indicative of which of the following conditions?

A) Pulmonary hypertension
B) Intracardiac thrombus
C) Pulmonary venous anastomotic stricture
D) Severe tricuspid regurgitation

Answer C

Left pulmonary venous anastomotic stricture can be demonstrated by significantly elevated flow velocities in the pulmonary veins. The value of 2m/s is a significantly elevated flow velocity and should initiate further investigation and other transesophageal echocardiography views to look for anastomotic stricture or thrombus. The pulmonary venous flows are of little help in the assessment of pulmonary hypertension or severe tricuspid regurgitation. The presence of an arterial or pulmonary vein stenosis should be excluded by observing abnormal turbulence and measuring the corresponding pressure gradient.

Q2. All the following transesophageal echocardiography (TEE) findings are consistent with the need for urgent conversion to cardiopulmonary bypass (CPB) because of hypotension during lung transplantation EXCEPT for:

A) Systolic anterior motion of the mitral valve
B) Acute global left ventricular hypokinesis
C) Dilated right ventricle
D) New onset severe tricuspid regurgitation

Answer A

The development of systolic anterior motion can usually be treated with pharmacologic support (phenylephrine) or judicious fluid administration. Whereas severe left heart failure (indicated by global hypokinesis) or severe right heart failure (often seen with tricuspid regurgitation and dilation of the right ventricle) may need urgent transition to bypass. Intraoperatively, the hemodynamic effects of pulmonary artery clamping, as evaluated by TEE, are useful in establishing the need for CPB: echocardiographic signs of low cardiac output (CO) or severe RV dysfunction such as right atrial (RA) and RV dilatation with paradoxical septal motion and reduced systolic excursion of the tricuspid annulus help to determine the need for circulatory support.

Q3. The roles of TEE during a lung transplantation include:

A) Aiding in the decision to use extra-corporeal life support for the procedure
B) Measuring the pulmonary artery pressure in absence of a pulmonary artery catheter
C) Assessing the quality of the pulmonary vein anastomosis
D) All of the above

Answer: D

Biventricular function should be evaluated before the transplantation, especially if considerable time has elapsed since the patient's last transthoracic echocardiography. Dysfunction in either or both ventricles is often an indication for the use of extra-corporeal life support in centers where it is use on a "as needed" basis. Since severe pulmonary hypertension may alter perioperative management, TEE can be used in the presence of tricuspid regurgitation to estimate pulmonary artery (PA) pressures in absence of a pulmonary artery catheter. Pulse wave Doppler of the pulmonary vein after the transplantation can help identify stenotic anastomosis. Velocities of 2m/s or more should be investigated.

Q4. During lung transplantation, acute right atrial dilatation and paradoxical interventricular septal motion after pulmonary artery clamping is often an indication of:

A) Hypervolemia
B) Malposition of the surgical clamp
C) Patient-graft mismatch
D) Need for extra-corporeal life support

Answer D

Acute right atrial and RV dilatation with paradoxical septal motion are indicators of poorly tolerated pulmonary artery clamping, causing severe RV dysfunction and low cardiac output, and usually lead to extra-corporeal life support initiation.

Q5. Risk factors for post lung transplantation dynamic RVoutflow tract (RVOT) obstruction (aka suicide RV) include:

A) Hypervolemia
B) Significant right ventricular hypertrophy
C) Right ventricular dysfunction
D) Mildly elevated pre transplantation PA pressures

Answer B

In patients with severe pulmonary hypertension and significant RV hypertrophy, TEE is useful to identify and monitor an otherwise very difficult to diagnose cause of hemodynamic instability during and after lung transplantation: dynamic RVOT obstruction, also known as suicide RV. RVOT obstruction can occur in hypertrophic and hyperdynamic RV after the sudden PAP reduction caused by the transplantation. It can be identified by the presence of turbulent high velocity flow in the RVOT on color Doppler and increased pressure gradient between the RV and the main pulmonary artery. On rare occasions, extrinsic compression of the RVOT by surgical instruments such as the sternal retractor or surgical manipulation can occur in patients with a small chest cavity or unusual anatomy. This should always be ruled out quickly in the presence of any significant RVOT obstruction.

Q6. In the ICU after a lung transplant, TEE can be used to quickly diagnose all these complications EXCEPT:

A) Cardiogenic pulmonary edema
B) Vascular anastomotic stenosis
C) Thoracic tamponade
D) Acute bleeding from an intercostal artery

Answer D

In the ICU, TEE can be very useful to help diagnose post transplantation complications, including cardiac or thoracic tamponade, RV and or LV dysfunction, LVOT and RVOT obstruction, pulmonary vein stenosis and post extra-corporeal life support complications. Intercostal artery are difficult to see using TEE.However, TEE could eventually diagnose a hemothorax as a result of this complication.

Q7 Which statement is TRUE regarding video Chap28_Q7?

A) This condition should lead to surgical intervention during lung transplantation
B) It can be useful for patients with elevated left atrial pressure
C) This condition can lead to right ventricular pressure overload.
D) Inhaled vasodilators are not recommended in this condition

Answer: B.

It is important to identify patients with a patent foramen ovale (PFO), as they are at risk of significant right-to-left shunt during one-lung perfusion and postoperatively, especially with pre-existing PAH or abnormal RV function (see **Error! Reference source not found.**). The decision to close a PFO at the time of a lung transplant is controversial and may potentially be harmful in the immediate postoperative period. The PFO can act as a relief valve for the right heart during acute right heart failure or for the lung grafts in the presence of elevated left atrial (LA) pressure. In selected patients, give consideration to percutaneous PFO closure after postoperative stabilization of PAP, LV and RV function. Right to left shunt are treated by reducing right ventricular afterload and increasing left atrial pressure using vasopressors.

Q8 Which statement is TRUE regarding pulmonary artery (PA) anastomotic obstruction?

A) This condition can occur in more than 5% of lung transplant.
B) Thrombus is a common complication of this condition.
C) Peak velocity above 1 m/s is associated with PA obstruction.
D) The most common cause is the narrowing of the PA lumen.

Answer D:

In a recent meta-analysis including 1696 transplants, the incidence of post-transplant PA anastomosis obstruction was 3.66%. Among affected patients, 76% required reintervention, and there was a 23% mortality rate during hospitalization. The most common etiology was a narrowing of the PA lumen (63.93%), followed by PA distortion or kinking from donor-recipient size mismatch (24.59%). Thrombus occlusion accounted for 4.92%, and external compression by surrounding tissues was rare (3.23%). A PA diameter of 0.78 ± 0.40 cm and a peak PA anastomotic velocity of 2.60 ± 0.58 m/s were associated with PA obstruction.

Q9 Risk factors for pre-emptive extracorporal life support (ECLS) include all the following EXCEPT:

A) Pulmonary fibrosis
B) Pulmonary emphysema
C) High pulmonary artery pressure
D) Lobar lung transplantation

Answer B:

The indication for pre-emptive intraoperative ECLS is influenced by patient comorbidities and varies among lung transplant centers. In a recent study, high preoperative mean PAP and a high lung allocation score were the strongest risk factors for unplanned intraoperative ECMO requirements. In a high-volume center in China, independent preoperative risk factors associated with the likelihood of requiring intraoperative ECMO include advanced age, high PAP before surgery, prolonged mechanical ventilation duration before surgery, high APACHE II score, re-transplantation, and a primary diagnosis of pulmonary fibrosis. For lobar lung transplant, perioperative ECLS is usually necessary in all cases. This precaution helps prevent excessive stress on the newly implanted lobe, particularly when the entire systemic cardiac output (CO) would otherwise flow through it during one-lung perfusion.

Q10. Which statement is INCORRECT regarding right ventricular (RV) function before lung transplantation?

A) A tricuspid annular plane systolic excursion < 10 mm predicts RV failure after lung transplantation
B) Severe pulmonary artery (PA) hypertension requires ECLS before PA clamping
C) A PFO can act as a relief valve for the right heart during acute right heart failure or for the lung grafts in the presence of elevated left atrial pressure.
D) A transient decrease in RV systolic function of up to 25% can occur with one-lung ventilation

Answer A:

It is important to evaluate RV function and dimensions prior to lung transplantation (see Chapters 4,5 & 10). No specific pre-transplant RV parameter or threshold clearly predicts perioperative RV failure or all-cause mortality after lung transplantation. A transient decrease in RV systolic function of up to 25% can occur with one-lung ventilation. The superimposed rise of RV afterload associated with unilateral PA clamping may precipitate RV failure in a patient with an already abnormal RV function or high PAP. Therefore, severe PAH or significant RV dysfunction requires ECLS before PA clamping to avoid hemodynamic collapse. A PFO can act as a relief valve for the right heart during acute right heart failure or for the lung grafts in the presence of elevated left atrial (LA) pressure.

Chap 28:
Liver transplantation

Q1. Which of these pathologies when found on a pre-transplant echocardiography evaluation is NOT an absolute or relative contraindication to liver transplantation?

A) Moderate hypertrophic cardiomyopathy.
B) Coronary artery disease.
C) Severe aortic stenosis.
D) Significant right ventricular dysfunction.
E) Dilated alcoholic cardiomyopathy.

Answer B

Although resting TTE is not a sensitive tool to diagnose coronary artery disease, it may reveal other absolute or relative contra-indications to LT such as hypertrophic or dilated cardiomyopathies, severe valvular diseases, right ventricular dysfunction, or pericardial effusion. Cardiopulmonary diseases are increasingly prevalent in LT recipients. Some of them share a common etiology with liver disease, while others are caused by end-stage liver disease (ESLD) or portal hypertension. Up to 30% of patients undergoing a liver transplantation have coronary artery disease.

Q2. What is the one-year survival rate of liver transplantation?

A) 80%
B) 70%
C) 65%
D) 90%
E) 45%

Answer D

One-year survival post liver transplantation is more than 90%.

Q3. Which statement about the safety of TEE in liver transplant recipients is TRUE?

A) Esophageal varices and portal hypertension are absolute contraindications to intraoperative TEE.

B) Recent series have demonstrated the overall incidence of TEE-related esophageal or gastric bleeding in liver transplant recipients is approximately 5%.

C) Routine use of TEE for liver transplantation is recommended in the ASA/AHA 2010 best practice guidelines on the intraoperative use of TEE.

D) A study has found that 11% of TEE during liver transplantation demonstrated unanticipated findings that had a major impact on patient management.

Answer D

The presence of esophageal varices has traditionally been considered a relative contraindication to TEE. Recent series examining TEE-related complications in LT recipients report an overall incidence of any esophageal or gastric bleeding around 0.8%, and around 0.2% for major events, an incidence that is in the higher range of those reported in other populations (0.02% to1%). If pre-emptive TEE insertion and a full examination are felt to carry too much risk, the anesthesiologist may choose to have the TEE on standby for insertion in the event of hemodynamic instability.

The ASA/AHA 2010 best practice guidelines on the intraoperative use of TEE made some recommendations for the use of TEE in non-cardiac surgery: «TEE may be used when the nature of the planned surgery or the patient's known or suspected cardiovascular pathology might result in severe hemodynamic, pulmonary, or neurologic compromise. » «TEE should be used when unexplained life-threatening circulatory instability persists despite corrective therapy. » Because of a lack of supporting evidence, the authors of these guidelines could not agree on a formal recommendation for TEE during liver transplantation. More recent guidelines for the use of transesophageal echocardiography to assist with surgical decision-making in the operating room, released in 2020, focused on cardiac procedures and did not include any recommendation for liver transplantation.

Q4. Post reperfusion syndrome in liver transplantation is defined by:

A) A reduction of more than 30% of the mean arterial blood pressure for more than 1 min within 5 minutes after unclamping.
B) A reduction of more than 50% of the mean arterial blood pressure for more than 1 min within 5 minutes after unclamping.
C) A reduction of more than 50% of the mean arterial blood pressure for more than 5 min within 30 minutes after unclamping.
D) A reduction of more than 30% of the mean arterial blood pressure for more than 1 min within 30 minutes after unclamping.

Answer A

Graft reperfusion comes with the release of cold, acidotic, hyperkalemic, and inflammatory fluid containing vasoactive substances and metabolically active byproducts that can create hemodynamic perturbations through systemic vasodilatation, pulmonary vasoconstriction, cardiac dysfunction, and arrhythmia. This hemodynamic instability is called the 'post-reperfusion syndrome', defined as a mean arterial blood pressure drop of > 30% from baseline for > 1 minute within 5 minutes after unclamping. Even though the predominant cause is severe vasoplegia, it has been associated with decreased contractility, potentially reflecting a lack of inotropic reserve in cirrhotic cardiomyopathy. The post-reperfusion syndrome is often mild and short-lived but may persist for > 30 minutes; it is associated with worse postoperative outcomes, including primary graft non-function.

Q5. During the dissection phase of a liver transplantation, which of these hemodynamic processes is least likely to be the cause of intraoperative hypotension?

A) Low systemic vascular resistance.
B) Major vessel compression.
C) Low left ventricular ejection fraction.
D) Fluid shift following ascites drainage.

Answer C

Hyperdynamic circulatory state with increased left ventricular ejection fraction is common in patients with ESLD. Reduced LVEF can be found in late-stage cirrhotic cardiomyopathy.

Q6. Which of these cardiovascular complications is unlikely to occur during the reperfusion phase of a liver transplantation?

A) Inferior vena cava stenosis
B) Aortic dissection
C) Dynamic left ventricular outflow tract obstruction
D) Right ventricular dysfunction from intracardiac emboli and pulmonary artery obstruction

Answer B

After graft reperfusion, TEE can evaluate the IVC (see figure 32.32) for signs of iatrogenic stenosis (see Figure 32.35), hepatic veins (see Figure 32.31), portal vessels (see Figure 32.33), the aorta and arch vessels such as the celiac trunk (see Figure 32.22), extra HA, intra-HAs, lungs and pleura (see Chapter 32) and the abdominal cavity for free fluid (see Figure 32.29F) as well as assessing the heart. Surface echography with PWD and CFI can best assess HA and PV patency (see **Error! Reference source not found.**). A restrictive IVC anastomosis (see **Error! Reference source not found.**), IVC torsion by the graft or extrinsic IVC compression from increased intrathoracic (see **Error! Reference source not found.**) or abdominal pressure (see **Error! Reference source not found.**) can cause abnormal venous return and consequent severe hemodynamic instability. Aortic dissection is extremely rare.

Q7 All of those elements are present in video Chap28_Q7 EXCEPT:

A) Pericardial effusion
B) Ascites
C) Dilated right ventricle
D) Right ventricular pressure-overload

Answer: B.

In this patient the close proximity of the fluid behind the left ventricle supports a diagnosis of pericardial effusion. With right ventricular (RV) volume overload, the RV dilates and the interventricular septum (IVS), normally convex toward the RV, flattens or is even convex toward the LV in diastole only, creating a diastolic “D” shaped septum, with associated paradoxical motion during systole (see **Error! Reference source not found.**CD, Figure 12.15 and eFigure 27.10). With RV pressure overload, RV dilatation occurs and ventricular septal flattening occurs during both systole and diastole (see **Error! Reference source not found.**EF).

Q8 Which abnormality is not present on video Chap28_Q8?

A) Cirrhosis
B) Ascites
C) Inferior vena cava stenosis
D) Reduced hepatic vein velocities

Answer C

This is a transgastric long-axis view of the inferior vena cava (IVC) in which an abnormal liver contour typical of cirrhosis is present. Note the presence of ascites anteriorly. This view does not allow the diagnosis of IVC stenosis which rarely occurs

before liver transplantation. The reduced color Doppler imaging at 30cm/s of the hepatic vein suggests reduced velocity, which can be associated with reduced cardiac output.

Q9. Which statement is INCORRECT regarding cirrhotic cardiomyopathy?

A) Reduced left ventricular systolic function and reduced global longitudinal strain present in a later stage.
B) This cardiomyopathy, chronically masked by low afterload, might be unmasked with higher systolic demand or vascular resistance.
C) Diastolic dysfunction and decreased systolic contractile reserve with preserved systolic function characterize the first stage
D) Less than 10% of cirrhotic patients have prolonged ventricular repolarization and prolonged QT interval, which may cause ventricular arrhythmias and sudden death.

Answer D :

Cirrhotic cardiomyopathy is a subclinical condition at rest. Diastolic dysfunction and decreased systolic contractile reserve with preserved systolic function characterize the first stage, while the later stages may have reduced systolic function and reduced global longitudinal strain (see e**Error! Reference source not found.**). Additionally, > 50% of cirrhotic patients have prolonged ventricular repolarization and prolonged QT interval, which may cause ventricular arrhythmias and sudden death. End-stage liver disease (ESLD) has chronotropic incompetence, the sinus node being unable to increase the heart rate during exercise or pharmacological stimulation, which could be from direct inhibition of beta-receptor mediated stimulation. This cardiomyopathy, chronically masked by low afterload, might be unmasked with higher systolic demand or vascular resistance, such as during a dobutamine-stress echocardiogram or with vascular tone changes induced by calcineurin-inhibitor based immunosuppressive regimens. This may manifest as postoperative congestive heart failure or low cardiac output (CO) state associated with tissue hypoperfusion. Diastolic dysfunction has also been associated with more hemodynamic instability after graft reperfusion.

Q10. Which complications is unlikely after graft reperfusion?

A) Left ventricular failure
B) Hypovolemia
C) Right ventricular failure
D) Dynamic left and right ventricular outflow tract

Answer A:

Many hemodynamic events may occur at graft reperfusion. Reduction of preload, from ongoing blood loss or vasodilation, is again an important driver of hemodynamic instability. Thrombo-embolic material from the graft or clamped vessels may appear in the right heart and cause hemodynamic instability in an already precarious hemodynamic state (see e**Error! Reference source not found.**). Only TEE can rapidly diagnose an intracardiac emboli and direct subsequent treatment. Such events, combined with the acute PVR increase described at graft reperfusion, may cause acute RV systolic dysfunction. The ME RV inflow-outflow view can monitor these situations. Profound hypovolemia and inotropic drugs may induce dynamic LVOT or RVOT obstruction.

Global LV systolic function remains intact, but cases of acute stress cardiomyopathy may happen at graft reperfusion, perhaps because of high levels of catecholamines or coronary vasospasm.

Chap 29

Q1 Which of the following statements is FALSE regarding the use of transesophageal echocardiography (TEE) in non-cardiac surgery?

A) Intraoperative rescue TEE is indicated in patients with unexplained hemodynamic instability regardless of the surgical procedure.
B) Intraoperative rescue TEE is indicated in patients with unexplained hemodynamic instability regardless of the patient's pre-operative medical conditions.
C) TEE is the preferred imaging modality for hemodynamic assessment intraoperatively, in awake patients prior to the induction of anesthesia and, once extubated, during the anesthesia recovery phase.
D) TEE provides high-resolution images of the posterior cardiac structures whereas TTE offers very good visualization of the anterior and apical cardiac structures.

Answer: C

Although TEE is the preferred imaging modality for hemodynamic assessment intraoperatively, transthoracic echocardiography (TTE) is a more suitable modality for cardiovascular evaluation in awake patients prior to the induction of anesthesia or, once extubated, during the anesthesia recovery phase.

Q2. Which of the following statements is FALSE regarding the hemodynamic assessment using TEE?

A) The easiest way to measure the left-sided CO is by measuring the LVOT diameter from the mid-esophageal LAX view and the VTI of the LVOT from the deep TG view.
B) In an unstable patient, qualitative assessment of the motion of the RV lateral wall and the septum are often adequate to provide a quick assessment of the RV systolic function.
C) Acute RV systolic dysfunction should raise the suspicion of pulmonary embolism.
D) Atrial septal defect and patent foramen ovale are infrequent causes of hypoxemia during non-cardiac surgery.

Answer: D.

Atrial septal defect and patent foramen ovale are common causes of right to left shunt and hypoxemia particularly during laparoscopic procedures, orthopedic, neurosurgical and trauma.

Q3.In which of the following non-cardiac surgery is TEE seldom used?

A) Elective lung resection surgery
B) Vascular surgery
C) Hepatobiliary surgery
D) Neurosurgery

Answer: A.

TEE is seldom used during elective lung resection surgery, as there is a lack of clinical utility. However, its use can be helpful during surgery for mediastinal masses to evaluate the extent and invasion of surrounding structures, such as the atria, pulmonary veins, pulmonary artery, or SVC. It would mainly be used as a rescue if a patient becomes hemodynamically unstable.

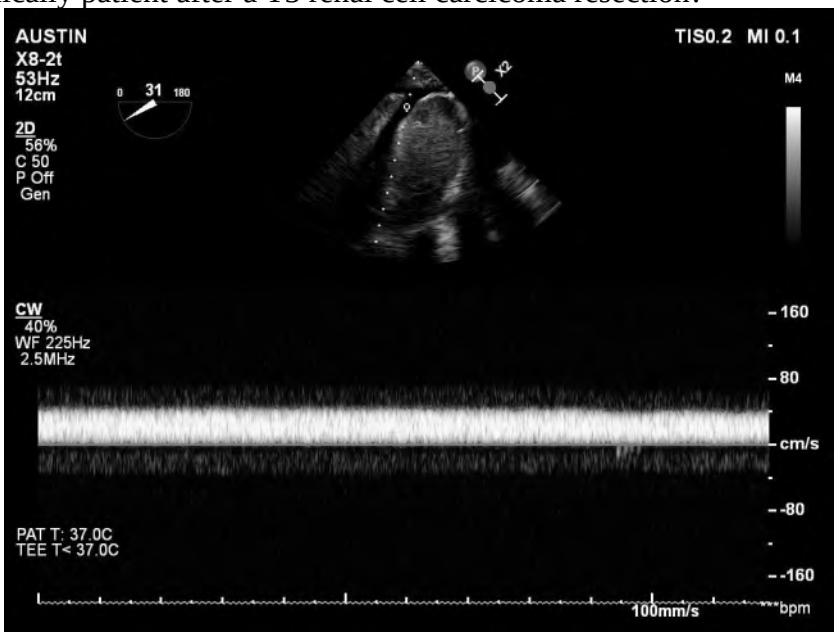
Q4. In patients undergoing non-cardiac surgery, which of the following is the least frequent cause of hemodynamic instability?

A) LV dysfunction
B) RV dysfunction
C) Hypovolemia
D) Pericardial effusion and tamponade

Answer: D.

An early study involving rescue TEE showed the most common causes of hemodynamic instability were LV dysfunction (45%), RV dysfunction (30%) and hypovolemia 16%. The etiology will also vary if rescue TEE is used intra or post-operatively. For instance, in a series of 364 rescue TEEs, hypovolemia was the most common cause intraoperatively (32.2%) but RV dysfunction, the most common post-operatively (24.1%), with confirmation of these findings by a recent study.

Q5. What is the most likely cause of the hepatic venous Doppler signal in this hemodynamically patient after a T3 renal cell carcicoma resection?



A. Hypovolemia
B. Right ventricular dysfunction
C. Hepatic vein stenosis
D. Inferior vena cava stenosis

Answer D:

T3 renal cell carcinoma can be associated with IVC thrombus that need to be removed intraoperatively at the time of the nephrectomy.
See eTable 10.1 summarizes the criteria for inferior vena cava (IVC) stenosis. In IVC stenosis. IVC diameter will be more than 17 mm, spontaneous echo contrast will appear in IVC. The IVC and hepatic vein flow interrogation: area of no flow (color-coded black) in regions that are not perpendicular to the Doppler beam. Finally hepatic vein flow velocity will show loss of quadriphasic pattern, appearance of monophasic flow, blunting of peak velocity (< 40 cm/s) and in some case flow reversal.

Q6. Which statement is FALSE regarding diastolic function in non-cardiac surgery?
A) In elderly patients, abnormal E/e` ratio does not increase the need for vasoactive agents.
B) Acute diastolic dysfunction with hemodynamic instability may occur in patients undergoing aortic surgery as a sign of coronary artery disease.
C) Relaxation abnormalities often appear in hemodynamically unstable patients and is typically associated with a prominent v wave on the pulmonary artery catheter.
D) Patients with LV diastolic dysfunction undergoing non-cardiac surgery incur a higher risk of major adverse cardiac events.

Answer C.

Surgical patients with significant diastolic dysfunction are susceptible to hemodynamic instability. Patients with LV diastolic dysfunction undergoing non-cardiac surgery incur a higher risk of major adverse cardiac events. However, in elderly patients, abnormal E/e` ratio does not increase the need for vasoactive agents in non-cardiac surgery. Intraoperative TEE can help with goal-directed hemodynamic management in patients with significant diastolic dysfunction. A change in diastolic function and the development of acute diastolic dysfunction with hemodynamic instability may occur in patients undergoing aortic surgery as a sign of coronary artery disease. Early recognition and treatment of acute diastolic dysfunction may be crucial in preventing postoperative adverse outcomes. Restrictive diastolic function often appears in hemodynamically unstable patients before or after cardiac surgery, and is typically associated with a prominent v wave on the pulmonary artery catheter

Q7. Which statement is TRUE regarding venous air embolism (VAE)?

A) Transcranial Doppler (TCD) is the most sensitive method to detect
B) Lethal dose of air in human is in the range of 3–5 mL/kg.
C) TEE is recommended for VAE monitoring.
D) Algorithms for automatic detection of VAE using TEE are highly specific.

Answer B.

TEE is unquestionably the most sensitive device to detect VAE with a detection threshold for air as low as 0.02 mL/kg. TCD is sensitive to detect arterial air embolism. The most frequent alternate device is precordial Doppler ultrasound. This device has a detection threshold for air as low as 0.05 mL/kg, is cheap, non-invasive and requires little specialist training to use. In contrast, TEE is more expensive, requires specialized expertise and training to interpret, and requires constant observation by the anesthesiologist at the expense of other clinical tasks. Algorithms for automatic detection of VAE using TEE lack specificity. These shortcomings may explain the limited uptake of the technique in practice. However, TEE offers the additional ability to detect a PFO or atrial septal defect. Such structural lesions may heighten the risk of a disabling or lethal complication at a lower volume of air entrained (<3 to 5 mL/kg) necessary to cause an air lock in the RVOT (see **Error! Reference source not found.**).

Q8. Which statement is INCORRECT regarding orthopedic surgery and the risk of hemodynamic instability in bone cement implantation syndrome (BCIS)?

A) Severe cardiorespiratory complications occur in 2% with an intraoperative mortality of 0.5%.
B) Risk factors include the emergent need for surgery, nature of the surgical procedure and multiple patient co-morbidities, particularly for fractured femoral neck.
C) Embolization of bone cement and other debris into the pulmonary circulation presumably causes acute RV dysfunction through chemical and mechanical effects.
D) Perioperative cardiorespiratory complications occur in 5% of patients who receive a cemented prosthesis.

Answer D.

A cause of intraoperative instability common during, but not exclusive to, hip arthroplasty is bone cement implantation syndrome (BCIS). Perioperative cardiorespiratory complications occur in 20% of patients who receive a cemented prosthesis; these are severe in 2% with an intraoperative mortality of 0.5%. Embolization of bone cement and other debris into the pulmonary circulation presumably causes acute RV dysfunction through chemical and mechanical effects.

Q9 The role of TEE in pulmonary thromboendarterectomy include all the following EXCEPT:

A) Monitor pulmonary artery (PA) pressure
B) Detect residual thrombus in the PA
C) Excluding interatrial septal defect
D) Evaluate left and right ventricular function

Answer: A

Pulmonary thromboendarterectomy is the treatment of choice for patients suffering chronic thromboembolic pulmonary hypertension (see **Error! Reference source not found.**). TEE is essential to exclude interatrial septal defects with intracardiac shunt, evaluate biventricular function and detect any residual thrombus left within the pulmonary artery post-procedure (see **Error! Reference source not found.** & **Error! Reference source not found.**). Although TEE can be used to estimate PA pressure, it remains limited in terms of continuous monitoring. In such case, hemodynamic measurements using a PA catheter with continuous RV pressure waveform is more appropriate in order to detect RV dysfunction and failure.

Q10 Intraoperative TEE is indicated in non-cardiac surgery in all those conditions EXCEPT:

A) Low cardiac output
B) Intraoperative cardiac arrest
C) Persistent unexplained hypoxemia
D) Left bundle branch block (LBBB)

Answer:D
See Table 29.4: Intraoperative indications of TEE include: unexplained persistent hypotension (not responding to traditional therapy), persistent unexplained hypoxemia, low cardiac output or heart failure and intraoperative cardiac arrest. LBBB is more commonly associated with left ventricular dysfunction but is not an indication for intraoperative TEE.

Chap 30

Q1 A 65-year-old male patient becomes hemodynamically unstable a few hours after coronary artery bypass graft surgery. What is the most probable cause of the hemodynamic instability based on the following images (see video Chap30_Q1) obtained by transesophageal echocardiogram (TEE)?

A) Pulmonary embolism
B) Right heart infarction
C) Regional cardiac tamponade
D) Hypovolemia

Answer: C

This transesophageal echocardiogram shows evidence of a localized cardiac tamponade. There is fluid accumulation behind the left atrium resulting in hemodynamic instability. The patient need to be sent back to the operating room.

Q2 Which of the following statements is CORRECT for this unstable patient in the intensive care unit (see video Chap30_Q2)?

A) The aortic annulus is not dilated
B) The aortic valve appears normal in structure and function
C) The sinotubular junction and ascending aorta appear normal
D) There is a dissection visible in the sinus of Valsalva

Answer: A

The aortic valve is abnormal in structure and function. The sinotubular junction is effaced and the ascending aorta is enlarged. The right coronary artery (RCA) orifice is visible. There is no evidence of a definite dissection or systolic anterior motion (SAM) but a linear artifact is present. The aortic annulus is 2.4 cm (within normal limits).

Q3 A 58-year-old male had a prior history of myocardial infarction a few months ago. Which of the following mechanical complications is seen in this transesophageal echocardiogram (see video Chap30_Q3)?

A) Ventricular septal defect
B) Myocardial rupture with large pericardial effusion
C) Pseudoaneurysm of the left ventricle
D) Large aneurysm of the left ventricle

Answer: D

This patient has a large aneurysm of the left ventricle. Aneurysmal segments on TEE imaging are dyskinetic or akinetic with a wide neck, larger than the internal pouch diameter, that persists in diastole.

Pseudoaneurysms usually present with an entry point diameter smaller than the pouch diameter and expand during systole, while the LV cavity becomes smaller.

Q4-With respect to left ventricular (LV) dysfunction in septic shock, which of the following statements is FALSE?

A) LV dysfunction may not be apparent in the initial phase of septic shock when significant vasoplegia is present.
B) The LV is usually globally hypokinetic.
C) LV filling pressures are always elevated.
D) Very low LV ejection fraction (LVEF) (< 25%) and hyperkinetic LV function (LVEF ≥ 70%) have both been associated with increased mortality.

Answer: C

LV filling pressures may not be elevated in patients with septic cardiomyopathy unlike in cardiogenic shock.

Q5 All the following statements are TRUE with respect to pulmonary embolism (PE) EXCEPT:

A) A normal TEE cannot exclude pulmonary embolism
B) The 60/60 sign (pulmonary flow acceleration lower than 60 ms and right ventricular pressure (RV) systolic pressure below 60 mmHg) is specific but insensitive for PE
C) Right-to-left ventricular end-diastolic area ratio > 1 is specific but less sensitive for PE
D) McConnel sign is pathognomonic for PE

Answer: D

Originally thought to be pathognomonic of PE, the McConnell sign, a pattern of preserved contraction of the RV apical segment with concomitant severe hypokinesis of the mid-free wall, is also seen in RV infarct.

Q6 What is the main limitation of echocardiography in diagnosing pulmonary embolism (PE)?

A) High cost of the procedure
B) Lack of availability
C) Low sensitivity and specificity, unless a thrombus is visualized
D) Inability to visualize the pulmonary arteries

Answer: C

TEE can provide signs that point towards RV overload and/or failure, but the definitive echo diagnosis of a PE rests visualizing the thrombus within the RV or the pulmonary artery, which is a rare occurrence. As such, the gold standard remains CT angiography.

Q7 What is a typical echocardiographic finding of dynamic left ventricular outflow tract obstruction (LVOTO)?

A) Increased late peak systolic velocity with a characteristic ‘dagger-shaped’ CWD waveform
B) Decreased late peak systolic velocity with a characteristic ‘dagger-shaped’ CWD waveform
C) Increased early peak systolic velocity with a rounded CWD waveform
D) Decreased early peak systolic velocity with a rounded CWD waveform

Answer: A

Dynamic LVOTO can present with a small LV cavity size from profound hypovolemia, LV hypertrophy (basal septal or diffuse) or with elongated mitral leaflets causing systolic anterior motion (SAM) of the anterior mitral leaflet, which creates a high systolic velocity across the left ventricular outflow tract (LVOT). As such, the typical echocardiographic finding is an increased late peak systolic velocity with a characteristic ‘dagger-shaped’ CWD waveform.

Q8- In the context of unexplained hypoxemia, what is TEE particularly useful for detecting?

A) Pneumothorax
B) Cardiogenic causes of hypoxemia, such as severe mitral or aortic regurgitation
C) Bronchitis
D) Esophageal perforation

Answer: B

TEE can be useful to help distinguish multiple lung pathologies, especially parenchymal disease and pleural effusions. Of the answer options, the one most likely to manifest in parenchymal findings is cardiogenic pulmonary edema leading to B-lines and potentially pleural effusions.

Q9- What specific benefit does TEE offer in the context of acute lung injury and ARDS?

A) It is not useful for assessing recruitable lung parenchyma
B) It can only assess global lung consolidation
C) It can identify and quantify atelectatic and potentially recruitable lung parenchyma, especially peri-mediastinal areas of consolidation.
D) It only assesses the most peripheral lung fields.

Answer: C

TEE can be a useful tool to assess atelectasis. Serial images after recruitment maneuvers can be used to quantify the changes associated with the maneuvers. The probe’s location in the middle of the chest also allows for early detection of parenchymal disease in contrast to surface ultrasound that requires the disease process to extend to the peripheral lung fields.

Q10- What is a key role of echocardiography in managing patients on veno-arterial (VA) VA ECMO?

A) It is not useful in managing patients on VA ECMO.
B) It is only used to guide cannulation.
C) To assess ventricular function, cannula position, and aortic valve opening.
D) It is only used during the weaning process.

Answer: C

TEE can be a valuable tool throughout the entire ECMO process, from cannulation, to cannula positioning and assessment of cardiac function during the weaning process. It can be used in early detection of spontaneous contrast or thrombi on the left heart as well as the opening of the aortic valve as a prompt for more aggressive venting strategies.

Chapter 31
Cardiac arrest

Q1: What is the value of bedside transesophageal echocardiography (TEE) in patients with cardiac arrest?

A) Diagnosis of pseudo-electromechanical dissociation (EMD)
B) Confirm the presence of asystole if the rhythm is difficult to assess
C) Confirm the presence of VF If rhythm is difficult to assess
D) All of the above

Answer: D

The four goals of TEE during cardiac arrest management are: (1) Chest compression quality feedback; (2) Rhythm characterization; (3) Diagnosis of potentially reversible pathology; and (4) Procedural guidance.

Q2 Regarding the role of TEE during cardiac resuscitation, which of the following statement is FALSE?

A) TEE must be done during compression pauses for pulse check to avoid cardiopulmonary resuscitation (CPR) interruptions or delays.
B) The midesophageal long axis view is recommended to provide real-time feedback on chest compression quality.
C) Obstruction of the LVOT during compression can be identified during TEE.
D) The application for TEE in cardiac arrest may extend beyond the heart and assessment of pleural spaces, lungs and abdomen.

Answer: A

TEE can be performed during chest compression thus minimizing CPR interruptions as opposed to transthoracic echocardiography.

Q3 Regarding ultrasound identification of reversible causes of cardiac arrest, which statement is FALSE?

A) Absence of lung sliding is sensitive but not specific for pneumothorax.
B) Echocardiography regional wall motion abnormality evaluation is not reliable intra-arrest.
C) A dilated right ventricle is a reliable sign of pulmonary embolism during cardiac arrest.
D) Pleural effusion and ascites may be mistaken for pericardial effusion.

Answer: C

Right ventricle dilation may be seen regardless of the cause of cardiac arrest. Clear identification of thrombus in the right-sided cavities or PA strongly supports a pulmonary embolism diagnosis. In the US diagnosis of PE, RV dilation is often a key feature. However, interpret the presence of RV dilation with caution, as it is not a reliable sign of PE, considering that it commonly occurs regardless of the cause of cardiac arrest. RV dilation could be a marker of poor prognosis in the post cardiac arrest period.

Q4 Which statement is FALSE?

A) Cardiac ultrasound can detect fine ventricular fibrillation even when no shockable rhythm is noted on the cardiac monitor.

B) Cardiac ultrasound should always be used during cardiac arrest.

C) A localized pericardial effusion with tamponade physiology may be missed with a transthoracic approach.

D) TEE offers superior guidance for endovascular life-saving procedures.

Answer: B

Cardiac ultrasound should not be used if no experienced ultrasonographer is present or if its use interferes with standard ACLS protocol.

Q5 Which statement is TRUE?

A) Cardiac massage rarely causes LVOT obstruction.

B) TTE doesn't allow for identification of area of maximal compression during cardiac massage.

C) TEE use during cardiac arrest is less risky than during cardiac surgery.

D) Simulation can help achieve competency for TEE use during cardiac arrest.

Answer: D

Simulation-based learning is key to developing skills in TEE image acquisition, which requires probe manipulations during stressful and rare events, like cardiac arrest cases. In the ED setting, physicians with no prior TEE ability successfully conducted a focused 4-view TEE protocol after a 2-hour simulation session, with skill retention confirmation at 6-week follow-up.

Q6 Which statement is FALSE?

A) Extra-cardiac TEE views may be useful to identify regions of fluid accumulation that may indicate a bleeding source.

B) The use of TTE may cause prolongation of pulse check pauses.

C) TEE use during cardiac arrest reduces mortality.

D) TEE provides better visualization of the descending thoracic aorta compared to TTE.

Answer: C

Although during non-traumatic unshockable cardiac arrests, a meta-analysis showed an association between detecting cardiac motion on ultrasound and positive clinical outcomes (i.e., ROSC, survival at hospital admission and survival at discharge) there is no evidence so far that the use of TEE in cardiac arrest reduces mortality. TEE can identify the most reversible causes of cardiac arrest, allowing prompt treatment and an extended evaluation of possible hemodynamic instability and hypoxemia causes after ROSC.

Q7 Which statement is TRUE?

A) The ME four-chamber view allows identification of LVOT obstruction during chest compressions.
B) Many TEE views can assist in rhythm characterization during pulse check pauses.
C) TTE should not be used if TEE is available.
D) A lung point is a sensitive sign for pneumothorax.

Answer: B

Extended TEE views are useful after ROSC or to a specific diagnosis when the basic TEE views did not provide enough information. The cardiac extended TEE views are based on the 2013 ASE Guidelines and the lung and abdominal extended TEE views are based on TELUS and TGAUS views respectively. A lung point is specific but not sensitive for the detection of pneumothorax. It can only be used with surface ultrasound.

Q8 What is the underlying cause of cardiac arrest on this mid-esophageal four-chamber biplane view (see video Chap31_Q8)?

A) Ventricular fibrillation
B) Asystole
C) Electromechanical dissociation
D) Cardiac tamponade

Answer: B

This is an example of asystole.

Q9 What is the underlying cause of cardiac arrest on this mid-esophageal four-chamber view (see video Chap31_Q9A)?

A) Ventricular fibrillation
B) Asystole
C) Electromechanical dissociation
D) Cardiac tamponade

Answer: B

This is an example of ventricular fibrillation. The effect of defibrillation is shown on video Chap31_Q9B on the electrocardiogram, hemodynamic data and on the intraoperative aspect of the heart.

Q10 Based on video Chap31_Q10, what are the chances of survival in this patient during cardiac arrest?

A) No chance of survival
B) 5%
C) 20%
D) 50%

Answer: A

This is an example of compression of the outflow tract and the aortic valve. This cannot lead to any significant cardiac output with 100% mortality. Several radiology studies show that the left ventricular outflow tract (LVOT), aortic root and ascending aorta were located underneath the recommended chest compression location in 46-80% of patients, predominantly those with cardiovascular comorbidities and structural heart diseases.

Chap 32 MCQ Extra-Cardiac Transesophageal Ultrasonography

Q1. Which of the following statement is FALSE regarding this extra-cardiac transesophageal ultrasonography (see video Chap32_Q1)?

A) This complication may be found after extracorporeal membrane oxygenation (ECMO) weaning.
B) Pulmonary embolism and RV failure are potential complications.
C) Anticoagulation is the treatment of choice.
D) This is a benign finding.

Answer: D

This is a thrombus in the inferior vena cava (IVC) and can lead to significant complications if not treated accordingly. IVC thrombus commonly occurs after ECMO weaning.

Q2. This TEE was performed in a 43-year-old female with staphylococcus bacteremia. (See video Chap32_Q2) Which of the following is the most likely diagnosis?

A) Aortic dissection
B) Intramural hematoma
C) Aortitis with periaortic abscess
D) Aortic pseudoaneurysm

Answer: C

This is a view of the upper part of the descending thoracic aorta that shows significant heterogeneous thickening around the aorta compatible with a periaortic abscess and aortitis. CT and TEP scan confirmed the diagnosis.

Q3. A 53-year-old female has been put on mechanical ventilation because of severe hypoxemia. According to this lung ultrasonography, which of the following is not part of the differential diagnosis (see video Chap32_Q3A and Chap32_Q3B)?

A) Left heart failure
B) Pneumonia
C) Pneumothorax
D) Acute respiratory distress syndrome

Answer: C

This lung TEE shows B-lines (ie shiny vertical lines arising from the pleural interface and moving along with the parenchymal pleura throughout the respiratory cycle) and an area of consolidation. The presence of B-lines excludes the diagnosis of pneumothorax. However TEE probe is positioned posteriorly and could miss an anterior stable pneumothorax.

Q4. The liver and its vessels (hepatic veins, portal vein and hepatic artery) are easily examined by TGAUS. Which of the following statements is FALSE?

A) The hepatic veins and the portal vein have a normal triphasic flow (systolic, diastolic and atrial reversal).
B) The absence of portal velocity signal in a patient in shock can be a sign of abdominal compartment syndrome.
C) Air resulting from intestinal ischemia may be present in the portal vein of hemodynamically instable patients.
D) A portal vein pulsatility index (PVPI) > 0.5 may be a sign of high right atrial pressure, moderate or greater tricuspid regurgitation and RV dysfunction.
E) Reversal of the systolic forward flow velocities in the hepatic veins may be a marker of severe tricuspid regurgitation.

Answer: A

The hepatic veins have a normal triphasic flow. However, the portal vein has a normal laminar or monophasic flow.

Q5. The main indication of TELUS is the evaluation for acute hypoxemia. Which of the following statements is FALSE?

A) TELUS has a high sensitivity to detect non-tension pneumothorax and right pleural effusion.
B) Vertical “B-lines” can be present in patients with cardiogenic edema or in patients with ARDS.
C) Pneumonia, atelectasis, pulmonary contusion, neoplasm and pulmonary infarction all result in a similar pattern of consolidation.
D) The number of “B-lines” is proportional to the amount of extravascular lung water.
E) “A-lines” are artifactual horizontal lines and the distance between them is constant and equal to the distance between the probe and the first pleural line.

Answer: A

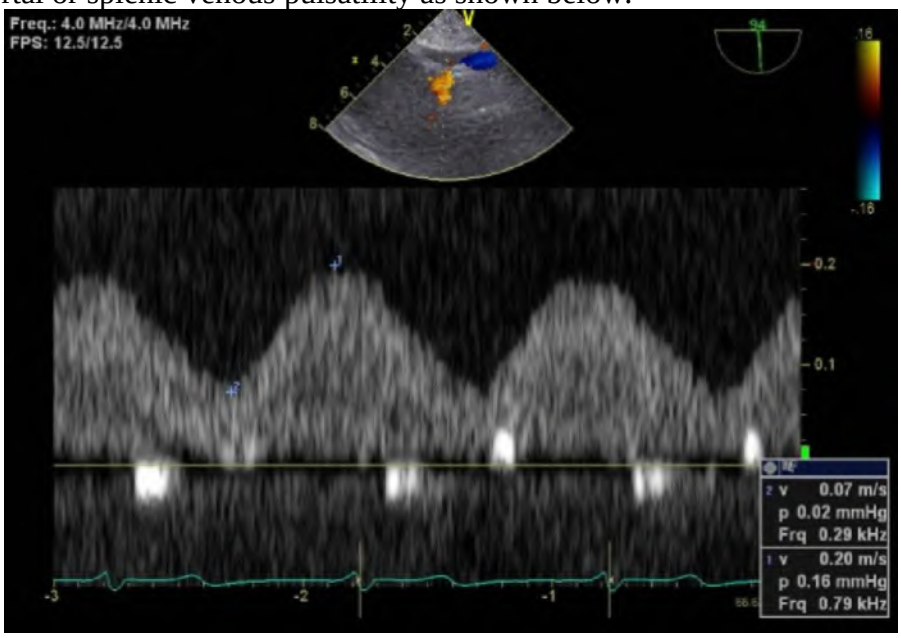
Although TELUS has a high sensitivity to detect left side pleural effusion, effusion as big as 200 ml can be missed on the right lung. Also, since air tends to accumulate in the non-dependent area of the lung, which is inaccessible to TELUS in supine patient, it is highly unlikely that a TEE approach could be of any diagnostic value for non-tension pneumothorax.

Q6 78-year-old man undergoing percutaneous tricuspid valve replacement. What are the findings? video Chap32_Q6

A) Pericardial effusion
B) Pleural effusion
C) Ascites and bowel edema
D) Normal left ventricular function

Answer: C

Note the floating liver into the ascites. In addition, there is significant stomach edema which is characteristic for severe venous congestion often accompanied by portal or splenic venous pulsatility as shown below.



Q7 What is the structure anterior to the aorta in this 73-year-old man prior to aortic valve replacement and ascending aorta surgery? (see video Chap32_Q7A)

A) Left pleural effusion
B) Mediastinal mass
C) Stomach
D) Hemothorax

Answer: C

In the lower portion of the thoracic aorta, part of the stomach can be seen adjacent to the aorta in some patients. The irregular contour, the proximity to heart which makes the area pulsatile and the peristaltism confirms the diagnosis. The use of biplane (see video Chap32_Q7B) further demonstrates the non-pleural origin of this structure.

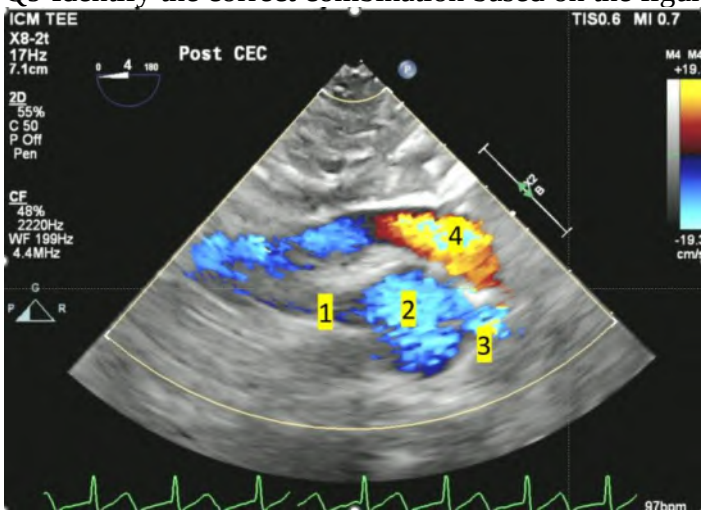
Q8. What is the etiology of systemic and cerebral desaturation in this 80-year-old woman after coronary revascularization (see video Chap21_Q8)?

A) Tamponade
B) Hypovolemia
C) Hemothorax
D) Right heart dysfunction

Answer: C

A complex effusion typical of an hemothorax is present using transesophageal lung ultrasound. Hypovolemia is likely to be present but does not explain the systemic desaturation. In addition, the normal horizontal aspect of the right ventricular pressure waveform in diastole argues against the diagnosis of right ventricular dysfunction.

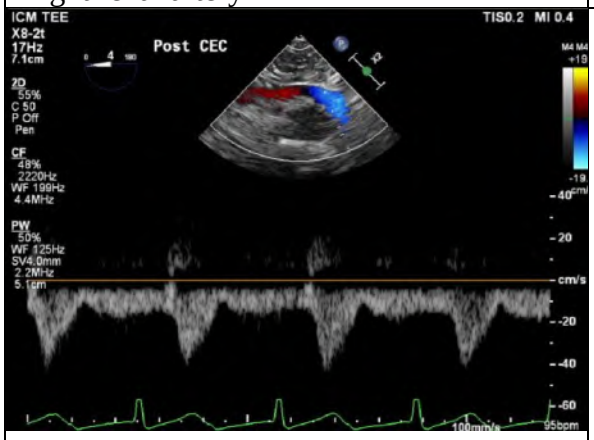
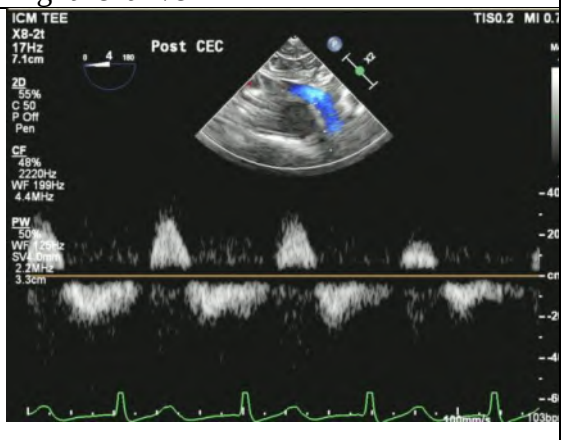
Q9 Identify the correct combination based on the figure and on video Chap32_Q9



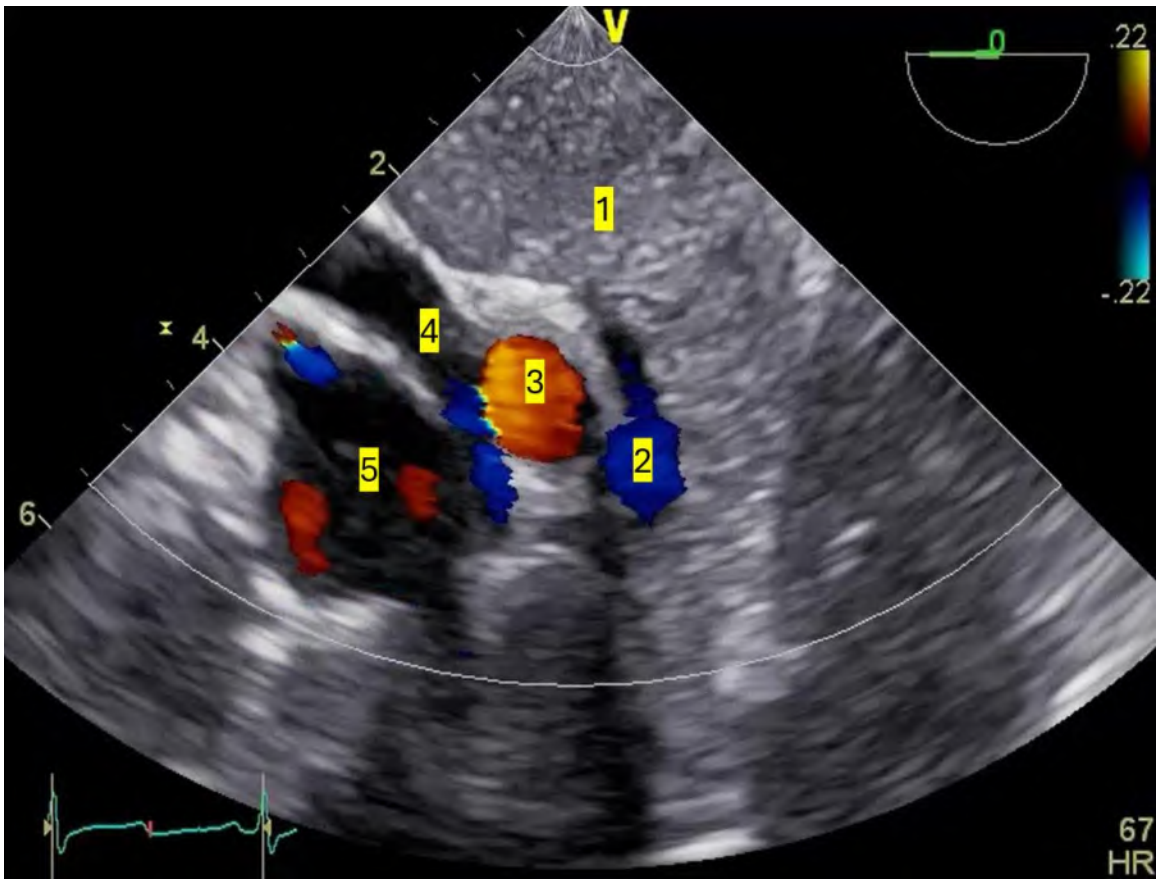
A) 1 right renal artery, 2 aorta, 3 left renal artery, 4 left renal vein
B) 1 left renal artery, 2 aorta, 3 right renal artery, 4 left renal vein
C) 1 right renal artery, 2 aorta, 3 left renal artery, 4 splenic vein
D) 1 left renal artery, 2 aorta, 3 mesenteric artery, 4 mesenteric vein

Answer: B

See figure 32.27. In this view both renal arteries are seen. In transgastric abdominal ultrasound, the ultrasound beam is directed posteriorly. In such a position, structures on the left side of the screen are anatomical the left side structures. Those on the right portion of the screen are on the right anatomical side of the patient. In order to reach the inferior vena cava, the left renal vein has to go beyond the aorta to the right under the superior mesenteric artery. In some patient, there is compression of the renal vein causing a "nutcracker syndrome". In this case this might explain why the diameter of the left renal vein is slightly larger prior to reaching the inferior vena cava. The Doppler signal of the right renal artery and left renal vein are shown below. Note the abnormal renal vein Doppler signal with systolic reversal which corresponded to the abnormal right ventricular diastolic function after mitral valve repair in this 37-year-old man.

Right renal artery	Right renal vein
	

Q10 Identify the following structures (see video Chap32_Q10)



A) 1 Pancreas, 2 mesenteric vein, 3 celiac trunk, 4 right renal vein, 5 aorta
B) 1 Spleen, 2 splenic vein, 3 celiac trunk, 4 left vein, 5 aorta
C) 1 Pancreas, 2 splenic vein, 3 celiac trunk, 4 left renal vein, 5 aorta
D) 1 Spleen, 2 mesenteric vein, 3 celiac trunk, 4 right renal vein, 5 aorta

Answer: C

It is important to identify correctly the splenic vein from the renal vein. Pulsatility in the splenic vein is abnormal but normal in the renal vein. See Figure 32.27

Chapter 33
Intracardiac Echocardiography (ICE) -

Q1: What is a primary advantage of intracardiac echocardiography (ICE) compared to transesophageal echocardiography (TEE)?

A) Higher image resolution
B) Avoidance of general anesthesia
C) Lower procedural cost
D) Easier catheter navigation

Answer: B

Avoidance of general anesthesia. ICE can be performed without general anesthesia, unlike TEE, which typically requires sedation or anesthesia. This reduces invasiveness and procedural risks.

Q2: Which structure is primarily visualized in the "home view" of ICE imaging from the right atrium?

A) Mitral valve and left atrium
B) Right ventricle and tricuspid valve
C) Pulmonary artery
D) Left ventricular outflow tract

Answer B

Right ventricle and tricuspid valve. The "home view" in ICE imaging focuses on the tricuspid valve and the right ventricle, serving as the starting point for further imaging.

Q3:What is the primary role of ICE in guiding left atrial appendage (LAA) occlusion?

A) Determining device compression
B) Confirming thrombus absence and device placement
C) Reducing fluoroscopy use
D) Assessing pulmonary vein stenosis

Answer B

Confirming thrombus absence and device placement. ICE ensures there are no thrombi in the LAA and aids in accurate device placement during occlusion procedures.

Q4: Clinical Case: A 72-year-old patient undergoes a patent foramen ovale (PFO) closure. ICE imaging shows incomplete apposition of the device's left atrial disc. What is the appropriate next step?

A) Remove and replace the device
B) Adjust the device under fluoroscopic guidance
C) Reposition the guidewire
D) Increase traction on the delivery cable

Answer A

Incomplete apposition can lead to complications. Removing and replacing the device ensures proper closure and stability.

Q5: Which of the following motions is key for navigating vascular tortuosity during ICE catheter advancement?

A) Leftward tilt
B) Anterior or posterior deflection
C) Rightward tilt
D) Pulling the catheter out slightly

Answer B

Anterior/posterior deflection and/or clock/counter-clock tension of the catheter can help cross vascular tortuosity. It helps guide the catheter through tortuous anatomy while maintaining a clear path forward. The catheter is relatively stiff, so avoid advancement against resistance to prevent vascular or cardiac trauma.

Q6: What complication is most effectively detected using ICE during pulmonary vein isolation?

A) Thrombus formation
B) Pulmonary vein stenosis
C) Esophageal thermal injury
D) Device dislodgement

Answer C

ICE imaging allows real-time monitoring of esophageal temperature, which is crucial for preventing thermal injury during ablation procedures.

Q7: What is the role of the "tug test" in left atrial appendage occlusion?

A) Verifying adequate compression of the device
B Ensuring device anchoring and stability
C) Confirming thrombus absence
D) Testing residual blood flow

Answer B

The tug test ensures the device is securely anchored before final release to prevent migration or dislodgement.

Q8: Which of the following is the best ICE view for monitoring catheter positioning during transseptal puncture?

A) Bicaval view
B) Descending aorta view
C) Pulmonary artery view
D) Left atrial short-axis view

Answer: A

The bicaval view provides clear visualization of the interatrial septum, aiding safe and precise transseptal puncture.

Q9: Clinical Case: A patient with a history of atrial fibrillation is undergoing ICE-guided ablation. During ablation, increased echogenicity is observed near the pulmonary veins. What should the operator do?

A) Continue the ablation
B) Stop the ablation and evaluate for thrombus
C) Increase power settings
D) Switch to fluoroscopic imaging

Answer B

Stop the ablation and evaluate for thrombus. Increased echogenicity may indicate thrombus formation. The procedure should be paused to assess and address this complication.

Q10: Full TEE assessment of left atrial appendage to rule out thrombus should include:

A) Single view
B) Two views
C) Three views
D) Four views

Answer: D

Four views (0.45,90,135) On 2D imaging, the LAA typically appears in ME views at 0°, 45° (SAX), 90° and 135° (LAX), allowing measurements of the LAA ostium, landing zone (LZ) and depth.

Chap 34
Indications and Training Guidelines for TEE

Q1. General indications for intraoperative TEE include all of the following EXCEPT for:
A) Unexpected refractory hypotension during an elective hemicolectomy.
B) Cardiac monitoring during an open thoracoabdominal aortic aneurysm repair.
C) Procedural guidance for cardiac transcatheter procedures.
D) Hemodynamically stable patients undergoing semi-urgent laparotomy.

Answer : D.
The indications for intraoperative TEE include when the nature of the planned surgery or the patient's known or suspected cardiovascular pathology might cause severe hemodynamic, pulmonary, or neurologic compromise and when unexplained life-threatening circulatory instability persists despite corrective therapy

Q2. The 2020 guidelines for the use of TEE to assist with surgical decision-making in the OR by the ASE/SCA and the Society of Thoracic Surgeons include all of the following EXCEPT for:
A) Confirmation of the preoperative diagnosis.
B) Identification of atrial septal defect prior to neurosurgery in the sitting position.
C) Intraoperative hemodynamic management.
D) Assessement the results of a surgical procedure.

Answer: B
The guidelines recommend the use of two-dimensional (2D), 3D, color flow imaging and/or spectral Doppler to confirm the preoperative diagnosis, evaluate interval changes, guide surgical interventions and hemodynamic management, assess the results of the surgical procedure and diagnose the etiology of hemodynamic disturbances

Q3. The National Board of Echocardiography offers three pathways to certification. Which of the following answers represents these three pathways:
A) Supervised training, practice experience, and an extended CME pathway
B) Supervised training, online learning experience, and extended CME pathway
C) Supervised training, practice experience, and a CME pathway
D) Supervised training, grandfathering, and an extended CME pathway

Answer: A
There are three pathways to certification: the supervised training pathway, the practice experience pathway, and an extended CME pathway. The supervised training pathway is the common route for those training directly from residency programs into fellowships. The practice experience pathway is for those grandfathered into the system from before the certification process; therefore, this is unavailable to those completing their fellowship after June 2009. The pathway for each level requires different numbers of examinations reviewed, performed, and reported independently.

Q4. The principal advantage of TEE simulation in training is:

A) Simulators increase access to hands-on training.
B) Modern simulators are now as realistic as patients.
C) Simulators provide the necessary exposure to pathology required for certification.
D) It can replace practice on patients.

Answer: A

Echocardiography simulators offer the opportunity to develop this skill in a fully interactive and realistic hands-on way. These learning pathways provide a much more intuitive introduction to echocardiography and may expedite the transition from a novice to an expert. However, they do not fully replace real-life experience.

Q5. TEE simulators currently can perform:

A) 2D and spectral Doppler imaging
B) 2D, spectral Doppler and 3D imaging
C) 2D and bi-plane imaging
D) 2D and 3D imaging

Answer: B

Q6 All those elements are characteristics of an ideal simulator EXCEPT?

A) Availability of both normal and pathological exams images in one location.
B) Removes the requirement for an instructor.
C) Uses images taken from human hearts, rather than computer-generated datasets.
D) Allows for real-time feedback of probe location, measurements, structure and pathologies identification.

Answer: B.

See Table 34.1 summarizes the ideal simulator characteristics. This allows a student to link intuitively the change in the US plane based on probe movement. As no patient is involved, the trainee can learn these complex skills without time pressure or patient and with less need for an experienced instructor. There is ample published literature that validates simulation as an effective tool for teaching echocardiography. A systematic review reported that most studies on simulation had a positive outcome for teaching echocardiography.

Q7. Which statement is true regarding the difference between augmented reality (AR) and virtual reality (VR)?

A) AR is less expensive than VR.
B) In both cases, the learner sees a computer-generated 3D image.
C) VR is superior to AR to better understand 3D ultrasound anatomy.
D) AR overlays virtual objects into our real world and VR immerses you in a virtual world.

Answer: D.
AR is another technology that overlays virtual objects into our real world. This permits a wide range of applications, from gaming to education to procedural guidance. VR immerses you in a virtual world, while AR enhances your real-world experience with digital elements to better understand 3D US anatomy. By using a QR code, we can view a TEE superimposed on a table at home or in a classroom. This technology can be added to all books and is now available in some TEE simulators. The Vimedix® simulator includes an AR system, where the learner can visualize a computer-generated 3D holographic image superimposed on a portable hardware TEE simulator manikin (see **Error! Reference source not found.**). VR differs in that the learner sees only a computer-generated 3D image. Because AR requires hololens glasses, it is more expensive than VR.

Q8. The following video Chap34_Q8 is an example of?
A) Virtual reality
B) Augmented reality
C) Remote monitoring
D) Mixed reality

Answer B.
The device is like the Vimedix® and BodyWorks® systems, but the mannequin has a smaller thorax without the capability of lung, abdominal or pelvic US (**Error! Reference source not found.**). An advantage of this simulator is the lifelike US knobs and time-gain-compensation controls, which are more realistic than the other two systems that rely on computerized controls using the mouse. The echocardiography images derived from CT-rendered images of actual patients, providing high-quality echocardiography views.

Q9. The following video Chap34_Q9 is an example of?

A) Virtual reality
B) Augmented reality
C) Remote monitoring
D) Mixed reality

Answer D.
Newer methods of education include electronic learning (e-learning), ubiquitous learning (u-learning), mobile learning (m-learning) game-based learning (g-learning), virtual reality (VR), augmented reality (AR) and mixed reality. Extended reality is an umbrella term that encompasses augmented reality (AR), mixed reality (MR), and virtual reality (VR) In mixed reality, a virtual environment interwinds with wit the real world that remain visible for instance with the use of holographic images.

Q10. The following video Chap34_Q10 is an example of?
A) Virtual reality
B) Augmented reality
C) Online augmented learning
D) Mixed reality

Answer: C

The advancement of web-based technology and ease of access to online resources have led to a growth in internet teaching resources. These range from didactic video lectures, a free online mouse-controlled simulator from the University of Toronto (https://pie.med.utoronto.ca/tee/ see **Error! Reference source not found.**) to complex interactive learning modules. The ability to review these resources in their own time before exposure to a time-limited proctored learning experience allows trainees the most efficient use of resource-intensive training sessions with actual patients or with experienced staff. Note that this online resource is free.

Chapter 35 Imaging modalities

Q1 What would be the advantage of using cardiac magnetic resonance (CMR) in the following case? (see video Chap35_Q1A and Chap35_Q1B)

A) CMR is superior to transesophageal echocardiography (TEE) in detecting thrombus.
B) CMR can identify myocardial viability.
C) CMR with gadolinium allow precise detection and quantification of myocardial fibrosis and scar.
D) CMR imaging is better than TEE in patients with non-sinus rhythm.

Answer C

Gadolinium-based contrast agents show late gadolinium enhancement sequences for the precise detection and quantification of myocardial fibrosis and scar (**Error! Reference source not found.**). The late enhancement imaging approach yields white (necrosis, fibrosis) on black (normal myocardium) contrast, elegantly exploiting a higher volume of distribution in necrotic and fibrotic tissue and delayed contrast clearance in those tissues. Image quality is reliably very good, but a regular R-R interval on the EKG is necessary for EKG-gating, limiting the image quality in patients with arrhythmias. Myocardial viability is better assess using PET scan.

Q2 All the following elements regarding the importance of the calcium score derived from computed tomography (CT) are true EXCEPT?

A) A high calcium score correlates with high plaque burden and high relative risk of cardiac events.
B) The presence of a positive score alone increases cardiovascular event risk by four times in 3–5 years.
C) High calcium score is a proven predictive factor for myocardial infarction (MI) and death.
D) This score does not include uncalcified coronary plaques but accounts for the total plaque burden.

Answer D

The calculation of the calcium score uses a low-dose, unenhanced cardiac CT acquisition that detects the total coronary calcium burden. Although this score does not include uncalcified coronary plaques and only accounts for a portion of the total plaque burden, it remains a proven predictive factor for myocardial infarction (MI) and death. A high calcium score correlates with high plaque burden and high relative risk of cardiac events. The presence of a positive score alone increases cardiovascular event risk by four times in 3–5 years.

Q3. What is the etilogy of is this 58-year-old woman with hemodynamic instability after cardiac surgery?

A) Right pneumothorax
B) Regional tamponade
C) Mediastinal tamponade
D) Left hemothorax

Answer: C

This is circumferential thickening mostly in the upper region of the thorax which in this case was compressing the superior vena cava. On the bicaval view, thrombus is surrounding the anterior portion of the right atrium with a small amount of free fluid. (see video Chap35_Q3).

Q4 Which statement is FALSE regarding the role of the chest radiograph (CXR) in the diagnosis of cardiac chamber enlargement or specific pathologies.

A) The left atrial appendage (LAA) curvature is usually not visible on the frontal CXR, unless it and/or the left atrium is dilated.

B) A right heart border displaced toward the right of the spine in the frontal film suggests right ventricular enlargement.

C) RV enlargement is unlikely when the RV contacts more than one-fourth of the length of the distal sternum on the lateral film or fills more than one-third of retrosternal clear space.

D) A displaced left heart border inferiorly, posteriorly, or toward the left suggests an enlarged left ventricle (LV).

Answer: B

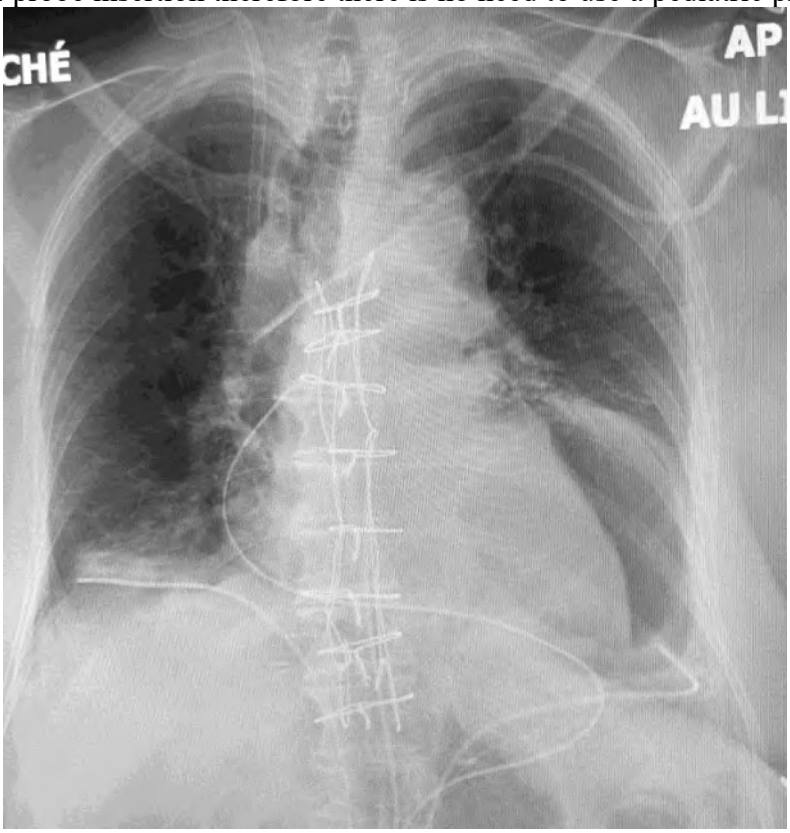
CXRs can give clues to specific cardiac chamber enlargement. A displaced left heart border inferiorly, posteriorly, or toward the left suggests an enlarged LV. The LA appendage curvature is usually not visible on the frontal CXR, unless it and/or the LA dilates. A right heart border displaced toward the right of the spine in the frontal film suggests right atrial enlargement. Finally, when the RV contacts more than one-fourth of the length of the distal sternum on the lateral film or fills more than one-third of retrosternal clear space, enlargement is likely.

Q5 What is the impact of this computed tomography prior to cardiac surgery? (see video Chap35_Q5A, video Chap35_Q5B and video Chap35_Q5C)

A) It is an absolute contra-indication for using TEE.
B) TEE can be used without any added precautions.
C) Careful evaluation of the risk-benefit ratio of the procedure is to be considered.
D) A pediatric TEE probe needs be used to reduce complications.

Answer: C

There are many relative contraindications (see Table 8.5). These include various esophageal pathologies, hiatal hernia, previous gastroesophageal surgeries, bleeding diathesis, cervical abnormalities, or anatomic distortion from arthritis or radiation therapy. Relative contraindications may not preclude TEE examination but warrant careful evaluation of the risk-benefit ratio of the procedure. The chest radiograph obtained after the procedure below illustrates the irregular position of the nasogastric tube with the risk of perforation. In such patient, there is no issue in TEE probe insertion therefore there is no need to use a pediatric probe.



Q6. In myocarditis, which pattern of injury is typically seen on CMR?

A) Ischemic, subendocardial
B) Patchy, non-coronary distribution
C) Transmural, involving a single coronary artery
D) Concentric thickening of the myocardium

Answer: B

The inflammation pattern follows a non-ischemic distribution of injury, with patchy lesions randomly distributed beyond the perfusion territory of a single coronary artery.

Q7. What limits the use of CMR in valve assessment?

A) Inadequate image resolution
B) Inability to use contrast
C) Low temporal resolution
D) Limited magnetic strength

Answer: C

CMR can assess the left and right heart chambers with exquisite anatomical detail. In-plane spatial resolution is as high as 0.8 mm x 0.8 mm with a slice thickness of 5-8 mm. Low temporal resolution limits the imaging of small and rapidly moving structures, making anatomic heart valve assessment difficult.

Q8 Advantages of computed tomography (CT) include all the following EXCEPT?

A) CT is superior to TEE in calculating ejection fraction.
B) CT angiography is the most sensitive technique to assess valve calcification. The literature shows a good correlation between calcification quantification and the severity of aortic stenosis, the need for valve replacement, and prognosis.
C) Coronary computed tomography angiography (CCTA) is a fast and non-invasive method of evaluating coronary vessel patency as compared to conventional intra-arterial catheter angiography.
D) CCTA can detect significant coronary stenosis of over 50% with high sensitivity (100%) and specificity (94%).

Answer: A

The calculation of ventricular volumes and ejection fraction (EF) can occur over the entire cardiac cycle using a retrospective EKG-gated acquisition CT. However, the limited temporal resolution with cardiac CT may underestimate LV ejection fraction, as there is an overestimation of end-systolic volumes and an underestimation of end-diastolic volumes.

Q9. Identify the adequate correlation between CT chamber, TEE and angiographic views using S-curve.

A) Mid-esophageal (ME) two-chamber view and right anterior oblique (RAO) cranial view
B) ME commissural view and RAO caudal view
C) ME four chamber view and left anterior oblique (LAO) caudal view
D) ME long-axis chamber view and LAO cranial view

Answer: A

See eFigure 35.23.

Q10 What is the major difference between S-curve of the TV annulus showing the LV and the RV projection?

A) For the LV the mid-esophageal four-chamber view is in the LAO cranial view but in the LAO caudal view for the RV.
B) For the LV the mid-esophageal LAX view is in the LAO cranial view but in the LAO caudal view for the RV.
C) For the LV the mid-esophageal two-chamber view is in the RAO cranial view but in the RAO caudal view for the RV.
D) For the LV the mid-esophageal four-chamber view is in the LAO cranial view but in the LAO caudal view for the RV.

Answer: C

As shown in eFigure 35.22 and eFigure 35.23, the LV the mid-esophageal two-chamber view is in the RAO cranial view but in the RAO caudal view for the RV.