PROSTHETIC VALVE BOARD REVIEW
QUESTION 1

This transesophageal image (Fig. 13–29) shows:

A. Aortic dissection
B. Mechanical aortic valve replacement
C. Left ventricular thrombus
D. Tissue mitral prosthesis
E. Stentless tissue aortic valve
The correct answer

D

This two chamber view shows a porcine mitral prosthesis with the typical appearance of the struts although the leaflets are not well seen. The valve cast prominent shadows and reverberations that obscure the left ventricle. A laminated thrombus is seen along the atrial wall. The aorta is obscured by the valve shadowing and is not clearly visible. Most mechanical valves have a low profile and do not protrude into the LV chamber. TEE is not sensitive for diagnosis of LV thrombus because the apex is foreshortened. A stentless aortic valve would look similar to a native aortic valve other than increased thickness of the aortic wall. Stentless valves cannot be implemented in the mitral position.
QUESTION 2

A 48-year-old woman with a mechanical mitral prosthesis returns for annual follow up. Her level of anticoagulation has been subtherapeutic intermittently, and she complains of increasing dyspnea on exertion.

The Doppler tracing shown in Figure 13–30 is obtained. Based on this data, the next best step in management is:

A. Surgical consultation  
B. Cardioversion  
C. Transesophageal echocardiography  
D. Coronary angiography  
E. Pharmacologic nuclear stress study
The correct answer is

C

This Doppler tracing shows a normal trans mitral inflow pattern for a mechanical valve. Prominent valve clicks are present and antegrad e mitral velocity is within normal limits with a normal deceleration slope. She is in sinus rhythm based on the mitral A velocity so cardioversion is not needed. Coronary angiography or nuclear stress study would be helpful if coronary disease were suspected by her exertional symptoms would be better evaluated by stress echocardiography with rest and exercise recording of the tricuspid regurgitation jet velocities for pulmonary artery pressures. TEE is the most appropriate next step to evaluate for prosthetic regurgitation. Clues on the transthoracic study might include increased antegrad e velocity, hyperdynamic left vent ricle or elevated pulmonary pressures. Transthoracic imaging is not sensitive for detection of prosthetic mitral regurgitation so TEE is reasonable
Question 3

This transesophageal image (Fig. 13–31) shows:

A. Flail aortic valve leaflet
B. Mechanical valve prosthesis
C. Normal aortic valve
D. Stented tissue prosthesis
E. Aortic root graft with valve resuspension
The correct answer is E

This image shows a long axis view of the aortic valve and root. The walls of the aorta are right with thickening and shadowing in the LV outflow tract region, suggestive of an aortic to graft replacement, in this case for Marfan syndrome. The aortic leaflets are thin and are seen open in consistently so this image is consistent with our suspension.

Diagnosis of a flail leaflet will require a diastolic image. A mechanical valve would not have normal native leaflets and would have shadows in reverberation. A normal aortic valve would not have shadowing. There are no stents to suggest a stented valve prosthesis although a stentless tissue valve might have disappearance.
QUESTION 4

A 24-year-old man underwent surgical repair of tetralogy of Fallot as a child, with closure of the ventricular septal defect and implantation of a valved conduit from the right ventricle to pulmonary artery. This Doppler tracing (Fig. 13–32) was recorded on his routine annual evaluation. This finding is most consistent with:

A. Severe pulmonic regurgitation
B. Moderate pulmonary hypertension
C. Residual ventricular septal defect
D. Mild aortic regurgitation
E. Moderate tricuspid regurgitation

Figure 13–32
The answer is A

This continuous wave Doppler tracing shows flow across the pulmonic valve. The antegrade flow is only slightly increased in velocity at 1.8 m/s consistent with no significant stenosis. However there is a dense diastolic signal that reaches the baseline before ended diastole which is consistent with severe pulmonic regurgitation.

This signal cannot be tricuspid valve flow because sinus rhythm is present and there is no A velocity in diastole which would be expected with tricuspid inflow. The onset of systolic flow also is later than the QRS than would be seen with tricuspid regurgitation. Aortic regurgitation would have a higher diastolic velocity reflecting the diastolic pressure difference between the aorta and the left ventricle. Similarly the residual ventricular septal defect would have a high velocity flow signal in systole because of the high pressure gradient between the two ventricles.
A 48-year-old woman has persistent heart failure symptoms after aortic valve replacement. On the parasternal views, color Doppler shows a flow disturbance at the anterior aspect of the valve sewing ring, adjacent to the right ventricular outflow tract and ventricular septum. The CW Doppler signal at that site was recorded to help identify the origin of the abnormal flow signal. Based on this Doppler signal (Fig. 13–33), the most likely diagnosis is:

A. Aortic rupture and pseudoaneurysm
B. Coronary blood flow
C. Aortic-to-right ventricular fistula
D. Ventricular septal defect
E. Paravalvular aortic regurgitation
The correct answer is

C

The Doppler spectrum shows a high velocity flow that is present in both systole and diastole with the lowest velocity at end diastole and the highest at end systole. This is most consistent with an aortic to right ventricular fistula in this diagnosis was confirmed catheterization. The high velocity flow in systole reflects the difference between aortic and right ventricular pressure in systole with persistent but decelerating flow in diastole reflecting the diastolic aortic pressure decline.

Flow into the contained aortic rupture or pseudo-aneurysm typically is low velocity to and fro flow in a contained space. Coronary blood flow occurs predominantly in diastole with little systolic flow. A ventricular septal defect is characterized by high velocity systolic flow. Aortic regurgitation occurs only in diastole.
QUESTION 6

A 72-year-old man with prior bileaflet mechanical aortic valve replacement presented with a new murmur and fever. This echocardiographic image (Fig. 13–34) is consistent with:

A. Ventricular septal defect  
B. Normal prosthetic valve function  
C. Paravalvular regurgitation  
D. Coronary blood flow  
E. Artifact

![Figure 13–34](image-url)
The correct answer is

C

This parasternal long axis image shows an eccentric colored jet that originates from the anterior aspect of the valve sewing ring and extends across the outflow tract to the anterior mitral leaflet consistent with paravalvular regurgitation which raises the concern of prosthetic valve endocarditis in a clinical setting of fevers and the new murmur.

A ventricular septal defect would be directed into the right ventricle outflow tract. Normal prosthetic regurgitation originates within the valve ring and typically has a uniform color. Coronary blood flow would be seen in the septum but not extending into the ventricular chamber. An artifact is unlikely because the color signal does not extend over tissue boundaries.
QUESTION 7

This TEE image (Fig. 13–35) in a patient with an aortic homograft valve implanted 10 years ago is consistent with:

A. Aneurysm of the aortic mitral intervalvular fibrosa
B. Paravalvular abscess
C. Normal postoperative changes
D. Aortic dissection
E. Lipomatous hypertrophy of the interatrial septum
The correct answer is

B

In this TEE long axis view of the aortic valve there is marked thickening in both the anterior and posterior aspects of the aortic root with areas of echo density and echolucency suggestive of a paravalvular abscess.

Although early after surgery this appearance might be nonspecific these findings are not expected 10 years later. In aneurysm of the aortic mitral intravalvular fibrosis would be seen as an echolucency between the aortic and mitral valves with communication into the left ventricle at the base of the anterior mitral leaflet.

An aortic dissection typically would have an intimal flap

The atrial septum is not seen in this view and lipomatous hypertrophy does not extend into the posterior aortic root
A patient with a 10-year-old prosthetic heart valve is referred for echocardiography. This Doppler tracing (Fig. 13-36) shows all of the following except:

A. Atrial fibrillation
B. Mitral regurgitation
C. Mechanical valve
D. Hypertension
E. Aortic stenosis
The correct answer is E

This Doppler tracing of flow across a bileaflet mechanical mitral valve replacement shows the absence of an atrial contribution to filling consistent with atrial fibrillation, prominent valve clicks consistent with the mechanical valve and a systolic signal consistent with the presence of mitral regurgitation.

LV systolic pressure is higher than 200 mmHg based on the 7 m/s mitral regurgitation jet. This indicates an LV to LA systolic pressure difference of 196 mmHg. LV systolic pressure would be this pressure difference plus LA pressure.

This signal cannot be aortic stenosis because the diastolic signal is clearly not aortic regurgitation and the systolic signal extends right up to the onset of mitral inflow.
QUESTION 9

A patient is referred for echocardiography. He has a median sternotomy scar and knows he has a heart valve but is not sure which one. Based on this echocardiographic image (Fig. 13–37), which type of valve does the patient most likely have?

A. Stentless
B. Homograft
C. Stented bioprosthesis
D. Mechanical
E. Valve resuspension

Figure 13–37
The correct answer is  
D

In this parasternal long axis image the aortic valve is not well seen. However the increased echogenicity and reverberation originating from the aortic valve region is diagnostic for a low-profile mechanical valve.

A stented bioprosthetic valve would have the characteristics stent protruding into the aortic sinus.

This ventless tissue valve and homograph belt both would be characterized by increased thickness in echogenicity in the ascending aorta but the leaflets would look like native valve leaflets with no reverberation.

With valve resuspension there may be shadowing caused by the prosthetic material used to stabilize the annulus but reverberations would not be seen.
QUESTION 10

A patient is seen for evaluation with a history of tricuspid valve replacement 20 years ago. What is the most likely explanation for the 2D and color Doppler patterns seen in Figure 13-38?

A. Prosthetic valve stenosis
B. Pacer lead entrapped in valve
C. Ball cage valve
D. Disk escape
E. Valve dehiscence
The correct answer is

C

These images show a normally functioning ball cage valve in the tricuspid position. These valves are not commonly used. The case protrudes into the right ventricle with the bright echo in the middle of the right ventricle caused by the leading edge of the ball. Color demonstrates the ball as a circular area without color in the center of the flow stream.
QUESTION 11

Another patient who has had valve surgery but does not know what type is referred for echocardiography and you obtain this image (Fig. 13-39). The most likely valve type is:

A. Stentless  
B. Homograft  
C. Stented bioprosthesis  
D. Mechanical  
E. Valve resuspension
The correct answer is

C

This short axis view of the aortic valve shows the characteristic appearance of the three stents seen with bio prostatic stent valves
QUESTION 12

This TEE image (Fig. 13-40) is most consistent with:

A. Coronary fistula
B. Paravalvular abscess
C. Aortic pseudoaneurysm
D. Aortic valve prosthesis
E. Transposed great vessels
The correct answer is

D

This TEE long axis image shows the left atrium with the mitral valve closed in systole. This section of the descending aorta is seen but aortic valve region is completely black with an apparent extension into the echo free space anterior to the aorta that might be misinterpreted as an abscess. In fact this is a mechanical aortic valve with prominent shadowing of the anterior part of the valve by the posterior sewing ring.

The echo free space anterior to the aorta is partly artifact because of shadowing

The right coronary artery arises in the region shattered by the valve prosthesis but this image does not show evidence for a coronary fistula.

This transposition of the great vessels was present the aorta would be anterior to the pulmonary artery.
QUESTION 1

Echocardiography is requested in an 82-year-old woman for dyspnea on exertion. The following measurements are recorded:

- LV dimension, end-diastole: 34 mm
- End-systole: 20 mm
- Wall thickness, septum: 10 mm
- Posterior wall: 9 mm
- Ejection fraction: 68%
- Left atrial dimension: 4.8 cm
- Tricuspid regurgitant jet: 3 m/s
- Estimated right atrial pressure: 5 mm Hg

Her LV inflow, tissue Doppler, and LA inflow velocities are shown in Figure 9–35.

These findings are most consistent with:

A. Dilated cardiomyopathy
B. Hypertrophic cardiomyopathy
C. Restrictive cardiomyopathy
D. Hypertensive heart disease
E. Pulmonary heart disease
F. Normal heart
ANSWER 1: F

This elderly woman has a normal (to small) ventricular chamber with wall thickness at the upper limits of normal. Systolic function is normal based on ejection fraction. The Doppler tracings show a reduced transmitral and tissue Doppler E velocity, consistent with impaired relaxation (mild diastolic dysfunction), and the left atrium is moderately enlarged. However, all these findings are typical for the patient’s age with no convincing evidence of ventricular dilation, hypertrophy, systolic dysfunction, or significant diastolic dysfunction to suggest a cardiomyopathy. Based on the tricuspid regurgitant jet velocity and estimated right atrial pressure, there is mild pulmonary hypertension with a systolic pressure of 41 mm Hg—again, a finding typical for age.
QUESTION 2

A 58-year-old man is referred for echocardiography for evaluation of a murmur during a hospital admission for gastrointestinal bleeding. His past medical history is remarkable for smoking, diabetes, hypertension, and hyperlipidemia. He has a positive family history for heart disease, with an uncle who died at age 56 years and his father, who died at age 62 years. The Doppler signal shown in Figure 9–36 is recorded.

The most likely diagnosis is:
A. Dilated cardiomyopathy
B. Hypertrophic cardiomyopathy
C. Restrictive cardiomyopathy
D. Hypertensive heart disease
E. Pulmonary heart disease
F. Normal heart

QUESTION 3

A 37-year-old woman is referred for echocardiography for dyspnea. She denies a previous cardiac history. Evaluation of cardiac risk factors reveals she does not smoke, has a normal blood pressure, has no family history of heart disease, and has not had her cholesterol or glucose checked. Early in the examination, the pulmonic valve M-mode shown in Figure 9–37 is recorded. At this point, the most likely diagnosis is:
A. Dilated cardiomyopathy
B. Hypertrophic cardiomyopathy
C. Restrictive cardiomyopathy
D. Hypertensive heart disease
E. Pulmonary heart disease
F. Normal heart

QUESTION 4

A colleague asks you to look at the parasternal long axis view shown in Figure 9–38.

The most likely clinical diagnosis is:
A. Dilated cardiomyopathy
B. Hypertrophic cardiomyopathy
C. Restrictive cardiomyopathy
D. Hypertensive heart disease
E. Pulmonary heart disease
F. Normal heart
ANSWER 1: F

This elderly woman has a normal (to small) ventricular chamber with wall thickness at the upper limits of normal. Systolic function is normal based on ejection fraction. The Doppler tracings show a reduced transmitral and tissue Doppler E velocity, consistent with impaired relaxation (mild diastolic dysfunction), and the left atrium is moderately enlarged. However, all these findings are typical for the patient's age with no convincing evidence of ventricular dilation, hypertrophy, systolic dysfunction, or significant diastolic dysfunction to suggest a cardiomyopathy. Based on the tricuspid regurgitant jet velocity and estimated right atrial pressure, there is mild pulmonary hypertension with a systolic pressure of 41 mm Hg—again, a finding typical for age.

ANSWER 2: D

The figure shows an anteriorly angulated apical four-chamber view, with a pulsed Doppler sample volume positioned in the LV outflow tract at the mid-ventricular level. The baseline has been shifted to the top of the scale to measure the peak systolic velocity, so the mitral inflow toward the transducer is effectively aliasing and is shown at the bottom of the display. This late peaking outflow velocity signal with a maximum velocity of 1.8 m/s is atypical for hypertrophic cardiomyopathy based on location (mid-ventricular instead of subaortic) and the abrupt brief late systolic peak, suggesting cavity obliteration, rather than the smooth concave upward velocity curve seen with dynamic obstruction related to systolic motion of the anterior mitral leaflet. This patient has a history of hypertension, so mid-LV obstruction most likely is caused by the combination of concentric hypertrophy, normal systolic function, and a small chamber related to hypovolemia with gastrointestinal bleeding.

ANSWER 3: E

Using the electrocardiogram for timing, note that in mid-systole, the opened pulmonic valve leaflet briefly partially closes; this mid-systolic closure, sometimes called a “flying w,” suggests significant pulmonary hypertension. This M-mode finding is equivalent to the mid-systolic notch seen on the pulmonary artery antegrade flow spectral Doppler tracing. This M-mode tracing suggests a possible diagnosis of pulmonary hypertension, mandating a careful search for the highest tricuspid regurgitant jet velocity. Pulmonary hypertension may be secondary to left sided heart disease, such as a cardiomyopathy, with a chronically elevated left atrial pressure. However, given the absence of risk factors for heart disease in this patient, it is more likely that primary pulmonary hypertension is present.
A colleague asks you to look at the parasternal long axis view shown in Figure 9-38. The most likely clinical diagnosis is:

A. Dilated cardiomyopathy
B. Hypertrophic cardiomyopathy
C. Restrictive cardiomyopathy
D. Hypertensive heart disease
E. Pulmonary heart disease
F. Normal heart

Figure 9-38
ANSWER 4: D

This parasternal long axis view at end-diastole shows a normal-size LV chamber with mildly increased thickness (about 12 mm) of the septum and posterior wall. There is prominence of the basal septum due to the increased angle between the aorta and long axis of the left ventricle. All these features are typical for hypertensive heart disease. In addition, there is mild mitral annular calcification and mild aortic leaflet thickening, also typical features of hypertensive heart disease.

This is not a dilated cardiomyopathy, because the LV is not dilated and the lack of asymmetric hypertrophy argues against hypertrophic cardiomyopathy. There are no findings to suggest pulmonary heart disease with a normal diastolic shape of the septum and a normal-size RV outflow tract. It is more difficult to exclude restrictive cardiomyopathy, but the increase in wall thickness is only mild and hypertensive heart disease is far more common than a restrictive cardiomyopathy.
QUESTION 5

A 38-year-old woman with hypertrophic cardiomyopathy presents with decreased exercise tolerance over the past year. Her echocardiogram shows septal hypertrophy with a maximum thickness of 2.6 cm, a normal ejection fraction, and impaired early diastolic relaxation but an outflow tract velocity of only 1.8 m/s. Pulmonary systolic pressure is estimated at 42 mm Hg.

The most useful next step in evaluation of her symptoms is:

A. Pulmonary function tests
B. Transesophageal echocardiogram
C. Coronary angiography
D. Saline contrast echo study
E. Exercise echocardiography

QUESTION 6

A 26-year-old man with hypertrophic cardiomyopathy has both subaortic outflow obstruction and moderate mitral regurgitation. From an apical view, the two Doppler signals shown in Figure 9–39 are recorded.

Which specific feature convinces you that the velocity curve B is due to outflow obstruction?

A. Peak velocity
B. Duration of flow
C. Time from onset of flow to peak velocity
D. Density of signal
E. Diastolic flow signal

![Figure 9-39](image-url)
Exercise echocardiography to evaluate the severity of outflow obstruction after exertion would be the most helpful next step. Many patients who have only mild outflow obstruction who would develop more severe obstruction at rest will have only mild outflow obstruction who would develop more severe obstruction at rest. Pulmonary function tests should be considered when cardiac catheterization is not feasible or when symptoms are persistent. Transthoracic echocardiography is the least invasive imaging of septal thickening, but it is not helpful for evaluation of systolic dysfunction because Doppler flow velocity is not helpful for patients with risk factors for aortic stenosis. Exercise echocardiography is reserved for patients with risk factors for aortic stenosis and is not helpful.
QUESTION 7

A 28-year-old woman with a diagnosis of primary pulmonary hypertension is referred to re-evaluate pulmonary pressures after 6 months of medical therapy with bosentan. You obtain a pulmonary pressure of 36 mm Hg, based on a tricuspid regurgitant jet velocity of 2.8 m/s and an estimated right atrial pressure of 5 mm Hg. Her previous study was done at another laboratory with the tricuspid regurgitant jet shown in Figure 9-40.

Comparing your results to the previous study and assuming no change in right atrial pressure, you conclude that pulmonary systolic pressure has:

A. Decreased
B. Increased
C. Not changed
(arrow) is shown in Figure 9.41. Based on a maximum tricuspid regurgitant jet velocity of 2.8 m/s, pulmonary systolic pressure is unchanged compared with the previous study.

**ANSWER 7: C**

This Doppler recording from the previous study is difficult to measure. The Doppler gain is too high and the color (instead of gray scale) displays noise with hue and intensity similar to the Doppler signal. The Doppler velocity can be discerned as the dense smooth rounded curve within the combined noise and signal displayed in color. Doppler flow curves reflect physiologic pressure differences, with smooth increases and decreases in velocity. The Doppler curve should show a smooth dense outer edge, often called “envelope of flow,” indicating the modal Doppler velocity. The Doppler curve and correct peak velocity
QUESTION 8

A 64-year-old man is referred for a new diagnosis of heart failure. Echocardiography shows an ejection fraction of 28%. The feature most helpful in distinguishing whether this is a primary dilated cardiomyopathy or results from coronary artery disease is:

A. Pulmonary systolic pressure
B. Severity of mitral regurgitation
C. Right ventricular systolic function
D. Regional wall motion abnormalities
E. Left atrial size
QUESTION 8

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A. PULMONARY SYSTOLIC PRESSURE

B. SEVERITY OF MITRAL REGURGITATION

C. RIGHT VENTRICULAR SYSTOLIC FUNCTION

D. REGIONAL WALL MOTION ABNORMALITIES

E. LEFT ATRIAL SIZE
THE ANSWER IS

C

RIGHT VENTRICULAR SYSTOLIC FUNCTION