Transesophageal Echocardiography Imaging

PERIOPERATIVE POCUS MODULE 5: TEE ULTRASOUND WINDOWS
Objectives

- Describe the use of perioperative TEE (PTE) as an advanced cardiac monitor
- Identify eleven windows used for hemodynamic monitoring and cardiopulmonary instability
- List six advanced uses of advanced perioperative TEE
- Identify additional ultrasound windows used with advanced perioperative TEE
Ultrasound and Transesophageal Echo

- Probe passes sound waves through a medium or tissue
  - Transducer emits brief pulses of sound by converting electrical energy into sound
  - Returning sound waves are converted into energy which generates an image

- Best image is generated when the beam is perpendicular to the structure

- Ultrasound beam is manipulated by advancing, tilting, anteflex/retroflex of the TEE probe

- Omniplane is used to rotate the ultrasound beam
Probe Position and Imaging

- Probe is placed in the esophagus in one of four positions and US beam generated.
- Reflected signals are collated to produce an image.
- A two-dimensional (2-D) or 3-D image is generated of the structures.
TEE Probe Manipulation and Imaging
Information Available by Basic TEE

- Left and right ventricular function
- Heart wall motion
- Heart chamber volume
- Vessel integrity
- Valve function and integrity
- Heart tumors
- Pericardial effusion
Utility of Basic Perioperative TEE

- Entire perioperative pathway
  - Preoperative for EF and murmur
  - Intraoperative hemodynamic monitoring
  - Postop for effusion and volume status

- Subspecialties already utilizing TEE
  - Liver transplant
  - Vascular/neuroanesthesia
  - Intensive care/ER
  - Cardiac anesthesia
  - Obstetrics
# Absolute and Relative Contraindications to TEE

<table>
<thead>
<tr>
<th>Absolute</th>
<th>Relative</th>
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<tbody>
<tr>
<td>Perforated viscous</td>
<td>Radiation to neck/mediastinum</td>
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<tr>
<td>Esophageal stricture/tumor</td>
<td>GI surgery/upper GI bleed</td>
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<tr>
<td>Esophageal perforation/laceration</td>
<td>Barrett’s esophagus</td>
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<tr>
<td>Esophageal diverticulum</td>
<td>Dysphagia/hiatal hernia</td>
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<tr>
<td>Active upper GI bleed</td>
<td>Neck immobility/cervical disc disease</td>
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<td></td>
<td>Symptomatic hiatal hernia</td>
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<td>Esophageal varices</td>
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<td>Coagulopathy</td>
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Probe/Equipment Considerations

**Probe Insertion**
- Bite block used
- Generous lubrication
- Jaw thrust may be utilized
- Insert to 30-35 cm
- Contraindications include esophageal and gastric pathology

**Intraoperative Complications**
- Esophageal perforation (<0.01%)
- Gastrointestinal/pharyngeal hemorrhage (0.03-0.8%)
- Dental damage (0.03%)
- Oral/lip damage (most common, 13% with cardiology)
- Airway compromise (0.03%)
- Distraction from patient
- Misinterpretation
Basic vs. Comprehensive TEE

**Basic Perioperative TEE**
- Use of TEE as advanced hemodynamic monitor using 11 views
- Diagnose general etiology of cardiopulmonary instability
  - Gross valve pathology
  - Biventricular function
  - Filling status
  - Simple congenital defects
  - Obstructive pathology
- If complex pathology present refer to advanced echocardiographer

**Comprehensive TEE**
- Use of TEE as advanced hemodynamic monitor using up to 28 views
- Diagnose specific pathology and sources of cardiopulmonary instability
- Use of Doppler for assessment of degree of valve stenosis, regurgitation and area
- Use of Doppler to assess surgical intervention
- Use or knowledge of 3D imaging

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Chamber Size
Ventricular Function
Anterolateral/Infecoseptal WMA
Mitral Valve disease
Tricuspid Valve Disease
Atrial Septal Defect
Pericardial Effusion
LAA Mass/Thrombus
LV Size and Function
Anterior/Inferior WMA
MV Disease
MV Annulus Measurement
LV Function
Anteroseptal/Inferolateral WMA
MV Disease
AV and Aortic Root Disease
Interventricular Septum Pathology
Cardiac Air
Role of Omniplane in Window Acquisition
ASD (Secundum, Sinus Venosus)
Atrial Pathology/PFO
Lines/Wires
Venous Cannula (SVC, IVC)
Aortic Valve Disease
Atrial Septal Defect (ASD secundum)
LA Size
Coronary Artery Pathology?
Pulmonary Artery Pathology
Pulmonary Embolus
Ascending Aorta Pathology
Patent Ductus Arteriosus (PDA)
PAC Position
Atherosclerotic Disease
Aortic Pathology
Pericardial Effusion
Pulmonary Embolus
Aortic Pathology
Color Flow Reversal (AI Severity)
IABP/Percutaneous Bypass wire Position
Left Pleural Effusion
Atherosclerotic Disease
Descending Aorta Long Axis

Aortic Pathology
Color Flow Reversal (AI Severity)
IABP Position
Transgastric SAX

- Left Ventricular Size/function
- Interventricular septal motion
- Ventricular Septal Defect
- Pericardial Effusion
- Volume Status
Color Doppler and Color Flow Mapping

- Doppler ultrasound provides **direction** and **velocity** of flow
- Direction and velocity of blood is depicted as:
  - Red-towards the transducer
  - Blue-away from the transducer
- "BART"
- Higher velocities assigned a more intense degree of color
Ejection Fraction
(“Eyeball EF”)
LV Filling and Volume Status
ECG continues to be more sensitive

TEE confirms or “rules in” ischemia through wall motion assessment

17 segments required for full assessment

Wall motion assessed by thickening and inward movement
Pharmacologic Interventions Based on TEE Findings

- **Pump**
  - Left Ventricular Function
  - Right Ventricular Function

- **Tank**
  - Ventricular Filling
  - Mitral Valve Disease

- **Pipes**
  - Blood pressure/ejection velocity
  - Treatment of obstruction (Lytics, pericardiocentesis)
Deep Transgastric Long Axis

Paravalvular Leak prosthetic aortic valve
AV gradient spectral doppler
LVOT Gradient spectral doppler
Obtaining the Deep TG LAX View
Same as four chamber view
HOCM (septal measurements)
Aortic insufficiency
LVOT turbulent flow
ME Commissural View

Mitral Valve Disease
LV Function
LA Pathology
Mitral Valve Disease
Aortic Valve Disease
Aortic Root Dimensions and Pathology
LVOT Pathology
Ventricular Septal Defect
LV Size, function
Ventricular Septal Defect
Mitral Valve Planimetry Area
LV Function
Mitral valve Subvalvular Pathology
RV Function
Tricuspid Subvalvular apparatus pathology
Tricuspid Valve Pathology
Transgastric Long Axis

Mitral Valve Pathology
VSD
LV Systolic Function
Aortic Valve: Spectral and Color Doppler
LVOT: Spectral and Color Doppler
Modified ME 4 Chamber (CS) View

CS Cardioplegia Catheter
Tricuspid Regurgitation Severity (CS Flow Reversal)
Aortic Pathology
Color Flow Reversal in Aortic Insufficiency
Aortic Arch Pathology
Pulmonic Valve Disease
Patent Ductus Arteriosus
ME Modified Bicaval (CS) View

CS Cardioplegia Catheter
Tricuspid Regurgitation
Interventricular septal motion
Aneurysmal Apex
Deep IVC View

- Tricuspid regurgitation
- Mass (tumor, thrombus)
- IVC wire/cannula
- IVC respiratory variation
LAA Pathology
(Diameter 1.6 +/- 0.5 cm; length 2.9 +/- 0.5 cm)
LAA Flow
LUPV Flow
Aortic Aneurysm
Severity of AI from color flow reversal
Arch Subclavian View

Aortic Dissection
Atherosclerotic Disease
IABP Position
Aortic stent placement
Coarctation
Perioperative Use of Advanced TEE

- Advanced use as monitor
- Additional views for diagnostic and interventional uses
  - Valve area
  - Advanced valve function assessment
  - Guide device deployment
  - Advanced Doppler and quantitative assessment
- Assessment of cardiac surgical intervention
Additional Imaging Used in Advanced TEE

- Diagnostic and interventional uses of TEE require advanced skill set
- Additional views offer surgeon and interventionalist 2-D and 3-D imaging
- Full perioperative use of echocardiography is no longer limited to TEE but includes limited transthoracic echo (TTE)
Focused Assessed Transthoracic Exam (FATE)

- Four ultrasound/TTE positions
- Basic anatomical and functional assessment complementing other assessments
  - Biventricular function
  - Valvular function
  - Volume status
  - Pericardial/pleural effusion
  - Exclusion of pulmonary pathology

Monitoring and treatment of the unstable patient involves:
- Estimation of preload
- Estimation of contractility
- Estimation of heart chamber and wall dimensions

An abbreviated two dimensional cardiac ultrasound offers these assessments.

The FATE protocol offers useful information in 97% of ICU patients.

Imaging for the FATE Exam
Is there pericardial fluid or tamponade physiology?
Is the LV normal size and contracting normally?
Is the septum normal size and moving normally?
Is the RV normal size and contracting normally?
Is the LA and RA normal size and interatrial septum normal?
Is the MV/TR annulus moving up and down (good LV/RV function)?
Measure the IVC
Assess IVC collapsibility
Compare to LV size, obliteration of chamber during systole
Responsiveness to volume administration

<table>
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<tr>
<th>IVC Diameter</th>
<th>% Collapse</th>
<th>CVP</th>
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<tr>
<td>&lt; 2 cm</td>
<td>&gt; 50%</td>
<td>0-5</td>
</tr>
<tr>
<td>&gt; 2 cm</td>
<td>&gt; 50%</td>
<td>5-10</td>
</tr>
<tr>
<td>&gt; 2 cm</td>
<td>minimal</td>
<td>15-20</td>
</tr>
<tr>
<td>&gt; 2 cm</td>
<td>none</td>
<td>&gt; 20</td>
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</tbody>
</table>
Is there pericardial fluid or tamponade physiology?
Is the LV normal size and contracting normally?
Is the septum normal size and moving normally?
Is the RV normal size and contracting normally?
Is the LA and RA normal size and interatrial septum normal?
Is the MV/TV annulus moving up and down (good LV/RV function)?
Is LV contracting normally, euvolemic without regional WMA?
Is RV smaller than LV (60%) and D-shaped?
Is there any pericardial fluid/tamponade?
Is there pericardial fluid or tamponade physiology?
Is the RV normal size and contracting normally?
Is the septum normal size and moving normally?
Is the LV normal size and contracting normally?
Does the anterior MV leaflet approximate the septum (normal EF)?
Is the aortic root normal size; is there a dissection flap?
Is the LA normal size?
Summary

- Basic perioperative TEE offers full assessment of the etiology of cardiopulmonary instability using only 11 windows.
- Advanced TEE incorporates up to 28 windows and 3-D to offer more precise diagnostic information.
- Use of basic TTE extends the use of echocardiography throughout the entire perioperative period.