Echocardiography as a diagnostic and management tool in medical emergencies

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Objective of this presentation

• Indications for TEE in medical emergencies
• Image acquisition
• Interpretation of obtained imaging
• Therapeutic consequences
• Pitfalls
• Summary
• Quiz
Pt. presents with chest pain—cardiac causes detectable by echocardiography

- Acute coronary syndrome
- Aortic dissection (low sensitivity of transthoracic echocardiography)
- Pulmonary thromboembolism
- Cardiogenic Shock
- Pericarditis / Endocarditis
- Aortic dissection (low sensitivity of transthoracic echocardiography)
- Hypertrophic cardiomyopathy
- Aortic stenosis
- Mitral valve prolapse/acute severe MR (ruptured cord)
- Prosthetic valve dysfunction
- Intracardiac mass
- Possible mechanical complication of acute myocardial infarction

Comprehensive TEE Exam
Case 1

- A 49 year old Afro-Caribbean woman presents to A&E after a 30 minute episode of severe, burning central chest pain radiating to her back. Episodes of a similar but less severe pain had occurred daily for the previous 10 days.

- The patient has multiple risk factors for coronary disease (including type II diabetes, hypertension, and being a smoker), but the clinical presentation is not absolutely typical for coronary artery disease and the initial ECG is normal. There is also a history from the patient of an exercise stress test one week before, which she believed to be normal.

Aortic Dissection

- Chest pain is typically severe
- Pain is migrating in the presence of a malperfusion syndrome
- Echocardiography can be performed without delay to visualise the aortic root and arch specificity is high (90%)
- Presence of a mobile intimal flap separating the true and false lumen can be observed in the ascending aorta (type A)
- Acute aortic regurgitation, pericardial effusion, or regional wall motion abnormalities suggestive of dissection involving a coronary artery.
- Distinguish between type A and type B (surgical emergency vs medical management)
Aortic Dissection Classification

Debakey:
I. Involving the ascending and descending aorta and aortic arch (10%)
II. Involving only the ascending aorta and aortic arch (80%)
III. Involving only the descending aorta only (10%)

Stanford:
A. Debakey types 1 and 2
   i.e., involves the ascending aorta.
B. Debakey type 3:
   i.e., involves only the descending aorta.

Aortic Dissection - CXR
Descending Aortic Dissection

Acute Aortic Dissection
Type A - Aortic Dissection

Aortic Dissection true vs false lumen

<table>
<thead>
<tr>
<th>Size</th>
<th>Large in aortic root &amp; ascending Ao</th>
<th>Small in aortic root &amp; ascending Ao</th>
<th>Small in descending Ao</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration</td>
<td>Round or oval</td>
<td>Crescentic</td>
<td></td>
</tr>
<tr>
<td>Flap curvature</td>
<td>Concave</td>
<td>Convex</td>
<td></td>
</tr>
<tr>
<td>Doppler signal</td>
<td>Dense</td>
<td>Systolic</td>
<td>Sluggish</td>
</tr>
<tr>
<td>Timing of signal</td>
<td>Systolic</td>
<td>Systolic</td>
<td>Out of phase</td>
</tr>
<tr>
<td>Thrombus</td>
<td>Rare</td>
<td>Common</td>
<td></td>
</tr>
<tr>
<td>Cob webs* *Intimal remnants</td>
<td>Never</td>
<td>100% specific</td>
<td></td>
</tr>
<tr>
<td>Outer wall calcification</td>
<td>Very specific</td>
<td>Absent</td>
<td></td>
</tr>
<tr>
<td>Side branches</td>
<td>Common</td>
<td>Equally common</td>
<td></td>
</tr>
</tbody>
</table>
Case scenarios – Case 2

- A 35-year-old patient with a history of hypertension, drug and alcohol abuse was brought in by EMS with CPR in progress.
- The patient had been intubated and received two rounds of epinephrine for PEA.
- No pulses at two locations and chest compressions were restarted.
- TEE revealed an EF of 15%.
- A rapid check of the carotids revealed flow on color and pulse wave Doppler indicated blood flow measuring up to 75 cm/s.
- No pulses were felt, but chest compressions were halted. Dobutamine and Levophed were started through the central line.

TEE in the Emergency Setting

- Patients in cardiopulmonary arrest present a special challenge to the clinician. Pathology such as cardiac tamponade, myocardial rupture or pulmonary embolism may require specific and critical interventions that would not be otherwise undertaken in the majority of cardiopulmonary arrest patients.
- Transesophageal echocardiography (TEE) is not affected by body habitus, subcutaneous air, emphysema or many of the other factors limiting transthoracic scans and would seem an ideal choice in cardiopulmonary arrests allowing for image acquisition even during chest compressions.
CFD in Carotid Artery and IJ

PWD Carotid Artery
Acute Chest Pain: other causes

- **Pulmonary embolism**
  - Chest pain is frequent (65%) in pulmonary embolism, associated with dyspnea
  - Transesophageal echocardiography diagnoses pulmonary embolism with a sensitivity 90–95% and the specificity is 100%
  - Dilatation of the right heart chambers and of the inferior vena cava
  - Abnormal motion of the interventricular septum
  - Abnormal ratio of right ventricular (RV) diameter or area to left ventricular (LV) diameter or area.
  - Ratio between end diastolic right to LV diameter > 0.6 and a ratio of end diastolic right to LV area > 1.0 are consistent with massive pulmonary embolism associated with RV dysfunction

Pulmonary embolism - TEE findings

- Hypokinesis of the mid RV free wall and preserved contraction of the RV apex: the so-called McConnell sign
- Bernoulli equation: PA systolic pressure = right atrial pressure + 4V²
- Right atrial pressure is estimated by clinical examination of the jugular veins or by the diameter of the inferior vena cava and its respiratory changes.
- Direct visualisation of thrombotic material in the main PA and right/left PA
- Acute pulmonary embolism, systolic PA pressure cannot increase to more than 40–50 mm Hg
Pulmonary Embolism – TTE findings

Acute Chest Pain: other causes

- **Cardiac Tamponade**
  - accumulation of fluid in the pericardial space that increases intrapericardiac pressure above intracavitary pressure. Diastolic filling is reduced and ventricular ejection is compromised. Compensatory tachycardia and vasoconstriction result.
  - Pulsus paradoxus is present: LV stroke volume decreases during inspiration because of reduced LV preload and paradoxal motion of the interventricular septum resulting from RV volume overload.
Cardiac Tamponade
Acute Chest Pain: other causes

- **Pericarditis**
  - Chest pain increased in the lying position and during inspiration.
  - ECG may show ST segment elevation.
  - Pericardial friction rub is audible in one third of patients and frequently transient
  - Elevated cardiac troponin can be detected in half of the patients.
  - Echocardiography is helpful if pericardial effusion is detected
  - Regional wall motion abnormalities may be present if pericarditis is associated with myocarditis
  - Pericardial effusion is a frequent complication of acute myocardial infarction.

TEE - Pericarditis
Endocarditis

Hypotension and jugular venous distention

- Hypotension and elevated jugular venous pressure may be present in different clinical conditions:
  - acute heart failure
  - cardiac tamponade
  - RV infarction
  - severe pulmonary embolism
  - exacerbation of chronic obstructive pulmonary disease (COPD).
Acute decompensated heart failure

LVF

• **LV diastolic function**
  - LV diastolic dysfunction is commonly seen in patients with hypertension, coronary artery disease, cardiomyopathy and many forms of valvular heart disease, and is a potential cause of pulmonary edema in patients with documented normal LV systolic function.
  - Doppler assessment of mitral inflow, the pulmonary venous flow pattern and tissue Doppler imaging of the mitral annulus.
  - Note that the pseudonormal mitral inflow trace can be distinguished from a normal mitral inflow trace, by examining the pulmonary venous flow, which should display atrial reversal.
Hypertrophic Cardiomyopathy - HOCM

Cardiogenic Shock vs Septic Shock
Echocardiography in the emergency room: Key points

- **Acute coronary syndrome**
  - Echocardiography is helpful in patients with non-diagnostic ECG and negative troponin.

- **Acute heart failure**
  - Rapid diagnosis in patients presenting with hypotension and jugular vein distension.
  - Immediate risk stratification provides help in clinical decision making.
  - Distinction between heart failure due to systolic versus diastolic dysfunction.

Echocardiography in the emergency room: key points

**Pericardial Effusion**
- <1 cm small, usually only behind the left ventricle
- 1-2 cm large, surrounds the whole heart
- Usually hypoechoic, but can be echogenic if blood or pus are present.

**Cardiac tamponade**
- Association of pericardial effusion, right atrial diastolic collapse and respiratory changes (>40% of decrease) in mitral E velocity during systole with inspiration (pulsus paradoxus)
Echocardiography in the emergency room: key points

**Pulmonary embolism**
- Association of right ventricular dilatation, hypokinesis of the mid right ventricular free wall, significant pulmonary hypertension and elevated BNP.
- Enlarged right ventricle.
- Normal RV EDV is 21 mm ±1 mm, >25-30 is definitely abnormal
- It is also normally less than ½ the size of the left ventricle in 4 chamber view

**Myocardial Ischemia**
- Hypokinesis-decreased wall thickness and motion
- Akinesis-absent wall thickening and motion
- Dyskinesis-paradoxical wall motion

**Valvular Disease**
- CFDoppler echocardiography can rapidly reveal valvular heart disease, such as severe aortic stenosis, severe acute aortic regurgitation.
- Mitral regurgitation resulting from papillary muscle or primary chordae rupture, or severe dysfunction of a prosthetic valve.
- Mitral stenosis

**RHF - Elevated CVP - IVC Size Respiratory Change RA Pressure** <1.5 total collapse 0-5 1.5-2.5 >50% collapse 5-10 1.5-2.5 <50% collapse 11-15 >2.5 <50% collapse 16-20 >2.5 No Change >20. Tricuspid Regurgitation.
Conclusion

- Echocardiography should be available in the emergency room for immediate or rapid observation at the bedside of many possible abnormalities that help diagnose cardiovascular syndromes or diseases and guide management. This quite versatile imaging method can find a place in the diagnostic algorithm of most clinical acute presentations.
Quiz

[Image of ultrasound scan]

QUIZ

[Image of anatomical structure]
Thank You!