Ultrasound Evaluation of the CHEST

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Martine Sargent... has nothing to disclose!

• I have no financial relationships to disclose
• I will not discuss off label use and/or investigational use in my presentation

investigational use in my presentation
Crashing Patient!

- 42 yo female presents with BP 75/42, HR 135, T 38.2, SaO2 96% RA

- SOB, epigastric pain, N/V

- EKG - ST elevations inferolateral leads

- 5.2 lactate VBG

- line, labs...P, CXR...P
Why? - Indications

• Unexplained Dyspnea
• Chest Trauma
• Chest Pain
• Cardiac Arrest
• Unexplained Hypotension

Who? - ED Physicians

- Limited Examination - yes/no questions
- Integrated Bedside Assessment
- Code Management
- Facilitate Interventions/Procedures
What? - to look for

- Pericardial Fluid
- Cardiac Activity
How? - Technique

Probe Selection:
- Microconvex or phased array probe
- 3-5 MHz probe
- Cardiac Setting
How? - Cardiac Views

1. Subxiphoid/Subcostal
2. Parasternal Long Axis
3. Parasternal Short Axis
4. Apical Four Chamber
How? - Cardiac Views

- Subxiphoid/Subcostal
- Parasternal Long Axis
- Parasternal Short Axis
- Apical Four Chamber
Subxiphoid
Subxiphoid
Subxiphoid

"FAST" view

Probe under ribs

Indicator to RIGHT shoulder

Use liver as acoustic window
Parasternal Long
Parasternal long
Parasternal Long Axis

- Probe at Left Sternal Border
- 3rd - 5th intercostal space
- Indicator shoulder to hip
- Long axis view of heart
Parasternal Long

- estimating EF
- Visualize mitral & aortic valves
- Thoracic aorta

Parasternal Short
Parasternal Short Axis

- Left sternal border
- 90° counterclockwise to Long Axis view
- Indicator hip to shoulder
- Views best for estimating LVEF
PSSA - aortic valve
PSSA - Aortic Valve

- Aortic valve near base
- Mitral valve at annulus
- LV toward apex
Apical 4 approach

At PMI 5th IC under nipple marker R
Apical 4 chamber view of the heart.
Apical 4-view

- From Apex to the base
- Visualizes all 4 chambers side-by-side
- Relative chamber size
- Best septal view
Troubleshooting

• Pulmonary Hyperinflation - COPD, Ventilation
• Poor Parasternal windows
• Favor Apical & Subxiphoid
• Obese, Pregnant, Abd Pain
• Favor Parasternal windows
Evaluation of The Pump

A. Parasternal views (long/short axis)

B. Subxiphoid view

C. Apical view
The Pump - LV Contractility

How well does the pump function?

Hypercontractile heart

Hypovolemic - small chamber

Obstructive - PE, Tamponade, effusion

Distributive - early sepsis

IVC collapse?
Hypokinesis

Cardiogenic Shock

Look for IVC plethora

Distended neck veins

Pulmonary Edema

Dilated heart

Late Sepsis

Look for Sepsis Source

Pleural or Peritoneal Fluid
Pericardial Effusion

Parasternal Long

Thoracic Aorta

Parasternal Short

RV
Pericardial Tamponade
Tamponade

Systolic collapse of RA, Diastolic collapse RV
Pericardiostentesis

- Facilitate rapid intervention
- Choose best approach
- Avoid unnecessary errors
RV dilatation

Abnormal Septum

Look for IVC Plethora,
DVT

Best view = Apical 4
Chamber

PE & Shock = Consider
Heparin &
Thrombolytics
PSLA - RV Strain

Sign of Obstructive shock via PE
- RV thin walled - suggests acute
- Can assess ‘pipes’ - femoral & popliteal for DVT
RA/RV Thrombus

Thrombus in RA
Ultrasonographic determination of inspiratory inferior vena cava (IVCi) and expiratory inferior vena cava (IVCe).

From Nagdev et al.
In patients undergoing CVC, a ≥ 50% decrease in IVC diameter is associated with a CVP of < 8 mm Hg (Nagdev, et al. Annals March 2010)

<table>
<thead>
<tr>
<th>IVC RESPIRATORY CHANGE</th>
<th>ESTIMATED CVP</th>
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<tbody>
<tr>
<td>TOTAL COLLAPSE</td>
<td>LOW CVP &lt; 5 MMHG</td>
</tr>
<tr>
<td>PARTIAL COLLAPSE</td>
<td>INT CVP 5-10 MMHG</td>
</tr>
<tr>
<td>NO CHANGE PLETHORA</td>
<td>HIGH CVP &gt; 10 MMHG</td>
</tr>
</tbody>
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70% EP CVP assessment concordance w/ECHO (Randazzo M, Snoey E, et al.)
Parasternal View - Aortic Root
Descending Thoracic Aorta
EtoH + car = MVC

- 30 yo F rear seat passenger, unrestrained
- cc: back pain, gluteal pain
- VS field 109/74, 94, 18, 99% RA
- BP dropped 80/P, 120, 20 95% RA GCS 15
Abnormal Lung:
Pneumothorax

Parietal Pleura
AIR
Visceral Pleura
Ultrasound should show pleural movement & artifacts
RUQ: Hemothorax

Normal

Abnormal
RUQ: Hemoperitoneum

Normal

Abnormal
Pneumothorax
Why ultrasound?

- Faster than CXR
- R/O pneumothorax before starting positive pressure ventilation
- R/O pneumothorax in the unstable patient
- s/p CVC placement
### Diagnostic Accuracy of Lung Ultrasound in the Emergency Department

Soldati, et al. CHEST 2007

<table>
<thead>
<tr>
<th></th>
<th>CXR</th>
<th>US</th>
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<tbody>
<tr>
<td>Sens</td>
<td>52%</td>
<td>92%</td>
</tr>
<tr>
<td>Spec</td>
<td>100%</td>
<td>99.4%</td>
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</tbody>
</table>
How? Probe position
Rib

Parietal Pleura

Visceral Pleura

Comet Tails (Artifact)
Abnormal Lung: Pneumothorax

Parietal Pleura

AIR

Visceral Pleura
Parietal Pleura
MOTION
Abnormal Lung M-mode:
PNEUMOTHORAX
Hemothorax
Rationale
Landmark

• Identify the **Diaphragm**
• Look Above and Below
• Extend the FAST exam above the diaphragm
also show the other side for splenic view to reiterate to find the diaphragm and look above
RUQ/perihepatic view:

**Normal**

- Morison’s Pouch
- Costophrenic Recess
- Diaphragm
RUQ with Pleural View
RUQ: Hemothorax

Normal

Abnormal
LUQ/Perisplenic view

Normal

Abnormal
Hemothorax Data

Poor Sensitivity for Small Volumes?


- Brooks et al. *Emergency Ultrasound in the*
A 62 yo female presents to the ED with chest pain for 6 hours, associated with increased dyspnea. She is becoming nauseous and diaphoretic.

Vital signs are BP 89/46, HR 109, RR 16, T 36.9.

CXR shows:
EF - LOW
Ejection Fraction

Parasternal Short Axis View

How well does the heart move?
Ejection Fraction

- Formal echo
- Poor <30%, Moderate 30-55%, Normal >55%
- Concordance 86%
EF - Normal
B lines vs. Comet tails
• B lines = interstitial fluid = “Tank Overload”

• abdominal or linear probe

• look for thickened vertical lines emanating from pleura and down to bottom of screen.

• B lines + Contractility + plethoric IVC = pulm edema

• LR+ of B lines better than BNP

• Liteplo AS - Acad Emerg Med - 01-MAR-2009; 16(3): 201-10 Shortness of breath in patients in whom BNP already being sent
<table>
<thead>
<tr>
<th></th>
<th>clinical</th>
<th>b-lines</th>
<th>echo</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CHF</strong></td>
<td>prior hx</td>
<td>multiple lung zones</td>
<td>decreased IVC plethora</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>orthopnea</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>fluid overload</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>dyspnea</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PNA</strong></td>
<td>fever, cough</td>
<td></td>
<td>normal IVC &lt;2 cm</td>
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<td>elevated WBC</td>
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HIMAF the RUSH

Heart - pericardial effusion/tamponade, RV strain, LV Function

IVC - Assess volume status

Morison’s FAST views including pleural views -

Aorta -

Pneumothorax
A simplified approach? Abdominal & Cardiac Evaluation with Sonography in Shock

- Cardiac
- IVC
- AAA
- FAST

Summary

- Don’t forget to RUSH (while resuscitating!)
- Pump - Heart
- Tank - IVC, FAST with Pleural Views, PTX
- Pipes - Aorta, Veins
- Alternate approaches - HIMAP, ACES
- Decrease morbidity associated with prolonged hypotension/shock
Summary

- Pneumothorax
  - Lung Sliding & Comet Tails are normal
  - M-Mode should show waves & beach
- Hemothorax
  - Use the diaphragm
  - Look above and below


