IVC
‘The pro-BNP of ultrasound’

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Critical Care Ultrasound Course
IVC SUMMARY

- Subxiphoid probably best window
- Combine long axis and transverse view
- Hepatic vein confluence
- Maximum diameter (IVCD)
- Change with inspiration (IVCCI: IVC collapsibility index)
- Only really useful at extremes
- Fat/ round … or flat & skinny?
The inferior vena cava (IVC)

- Largest vein in the body
- To the anatomical right of aorta
- Oval, thin walled
- Breathe in: diameter \(\downarrow\) (opposite if ventilated)
- Dehydration: ‘flattens out’.
- Downstream occlusion (eg tamponade) or fluid overload (eg CCF): ‘fattens up’.
Subxiphoid longitudinal: shocked & dry
Subxiphoid transverse: massive PE
The IVC can help us in the resus room.

**Diagnosis:** Is there fluid overload or a downstream occlusion (eg PE, tamponade)?

**Resuscitation:** Should I give more IV fluids to this shocked patient?
Parameters

Shape (fat or flat?)

Maximum IVC diameter (IVCD)

IVC collapsibility index (IVCCI) = (max – min)/max x100
IVCCI (hypovolaemia) = 69%
IVCCI (CCF) = 10%
IVC: the good news

Cheap
Easy to find & measure
Noninvasive
Rapid
Repeatable
IVC: the bad news

Poorly validated
Only useful at extremes
No-one really knows where / how to measure it
How to image the IVC

What probe?
What preset?
Where?
How?
What probe should we use?

Curved or sector
What preset?

Abdo (FAST) or cardiac
Where should we put the probe?

How should we align it?
Where should we put the probe?

How should we align it?

NO-ONE KNOWS!
Subxiphoid long axis
Subxiphoid long axis

- Most studies & experts measure here
- Probe sagittal
- Angled up through the liver
- Find the right atrium: confirm IVC entering RA
- Find the hepatic veins entering IVC
- ‘Hepatic vein confluence’
Subxiphoid long axis
Long axis pitfall #1
cylinder effect
Long axis pitfall #1
cylinder effect
Long axis pitfall #2
IVC lateral movement
Subxiphoid short axis
Subxiphoid short axis

- RUSH protocol (& a small study by Akilli) recommend this one
- Probe in same spot as before
- But turned to transverse
- IVC imaged in short axis
Subxiphoid short axis
Short axis pitfall: IVC slides craniocaudally!
Midaxillary long axis: ACEP website recommends as an alternative.
Subxiphoid trans: MAX & MIN.
Watch how the IVC collapses (subxiphoid)
Watch how the IVC collapses (RUQ)
Subxiphoid long axis approach: probably OK (if you’re careful).

Midaxillary longitudinal approach: probably not OK.

Any transverse view: dunno.

Transpyloric window: dunno.

No-one’s really sure.
Where should we measure the IVC?
Where should we put the calipers?

No-one knows!
The IVC collapses non-uniformly
The IVC collapses non-uniformly
Most of us measure at/near the confluence with the hepatic veins.

This is where most of the numbers / guidelines come from.

Below the liver (eg transpyloric) might be OK, but is probably more prone to probe pressure.
Should I use M-mode?
M-mode pitfalls:
wrong angle, and IVC moves
Top tip:

When starting out, avoid M-mode.
Sniff test (great in healthy volunteers)
If the patient is well enough to perform a sniff test, you probably don’t need to be looking at their IVC.
predicting Fluid responsiveness
<table>
<thead>
<tr>
<th>IVC diameter (cm)</th>
<th>IVCCI</th>
<th>Estimated RA pressure (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1.7</td>
<td>&gt;50%</td>
<td>0-5</td>
</tr>
<tr>
<td>&gt;1.7</td>
<td>&gt;50%</td>
<td>6-10</td>
</tr>
<tr>
<td>&gt;1.7</td>
<td>&lt;50%</td>
<td>11-15</td>
</tr>
<tr>
<td>‘dilated’</td>
<td>none</td>
<td>&gt;15</td>
</tr>
</tbody>
</table>

ASE guidelines 2005
Not validated in critically ill patients.

Based on sonographer measurements (which don’t correlate with clinician measurements).

Validated against CVP, not against anything useful.
<table>
<thead>
<tr>
<th>IVC diameter (cm)</th>
<th>IVCCI</th>
<th>Estimated RA pressure (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1</td>
<td>&lt;1.7</td>
<td>&gt;50%</td>
</tr>
<tr>
<td></td>
<td>&gt;1.7</td>
<td>0-5</td>
</tr>
<tr>
<td></td>
<td>&gt;1.7</td>
<td>&gt;50% 6-10</td>
</tr>
<tr>
<td>‘dilated’</td>
<td>none</td>
<td>&gt;15</td>
</tr>
</tbody>
</table>

ASE guidelines 2005
So what can the IVC really tell us?
### In shocked patients:

<table>
<thead>
<tr>
<th></th>
<th>IVCD</th>
<th>IVCCI</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spontaneously</strong></td>
<td>&lt;0.9cm</td>
<td>&gt;50%</td>
<td><em>Probably empty / fluid responsive</em></td>
</tr>
<tr>
<td>breathing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>?</td>
<td>&lt;15%</td>
<td><em>Probably full &amp; unresponsive</em></td>
</tr>
<tr>
<td><strong>Anything else</strong></td>
<td></td>
<td></td>
<td>Dunno</td>
</tr>
<tr>
<td>Ventilated</td>
<td>&lt;1.2cm</td>
<td>&gt;18%</td>
<td><em>Probably empty/ responsive</em></td>
</tr>
<tr>
<td></td>
<td>&gt;2.5cm</td>
<td>&lt;10%</td>
<td><em>Probably full/ unresponsive</em></td>
</tr>
<tr>
<td><strong>Or PE/ PTX/ tamponade</strong></td>
<td></td>
<td></td>
<td>Or other stuff that raises CVP</td>
</tr>
</tbody>
</table>
Why is this so?

1. IVC just isn’t that precise.

2. CVP isn’t great as a marker of fluid status.
IVC ultrasound: summary
1: How to image the IVC

- Subxiphoid long axis (or midaxillary trans)
- Curved or sector probe
- Abdo (FAST) preset if possible
- Don’t use M mode
- Don’t do a sniff test
- Eyeball assessment is probably fine
2: How to assess the IVC

- Practise with calipers (IVCD, IVCCI)
- But once you get your ‘eye in’, eyeball assessment is fine
- Stick to extremes:
  - Flat & collapsing = probably empty
  - Full & not collapsing = probably full!!
3: Beware the ‘mimics’

- Flat & collapsing IVC
  - Probe pressure
  - Raised intra-abdo pressure
  - Manner of breathing

- Full & not collapsing
  - Tension PTX
  - Tamponade
  - Massive PE
  - Severe COPD, Status asthmaticus?
  - Any right heart disease
4. Be a doctor

- Clinical assessment is always the best
- Add lung US (wet or dry? PTX? Chunky?)
- Add basic echo (Tamponade? Massive RV?)
- And the rest: CXR, ECG, etc etc
- If US findings don’t match clinical assessment, turn off the machine
Thanks to

Dr Kylie Baker (for that literature review)
Dr Adrian Goudie (for that IVC long axis image)
Drs Mike Blaivas, Matt Dawson, Mike Mallin, Cliff Reid & Scott Weingart (for their advice & input)
References

- ACEP http://www.acep.org/Content.aspx?id=80791
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- Lang RM, Bierig M, Devereux F et al. Recommendations for chamber quantification: a report from the American Society of Echocardiography’s guidelines and standards committee and the chamber quantification writing group, developed in conjunction with the European Association of Echocardiography, ad branch of the European Society of Cardiology. J Am Soc Echocardiogr 2005; 18: 1440-63.
References

- Muller L et al. Respiratory variations of inferior vena cava diameter to predict fluid responsiveness in spontaneously breathing patients with acute circulatory failure: need for a cautious use. Critical Care 2012, 16:R188


ultrasoundpodcast http://www.ultrasoundpodcast.com/?s=ivc )
References


References