Visualizing the Venous System: Upper Extremity & Thorax

Heather E. Gunter, Harvard Medical School Year III
Gillian Lieberman, M.D.
Some of the imaging options

Distinguished by

- Image capabilities
- Cost
- +/- radiation, contrast

Butty et al, 2002
Cosgrove, 2002
Patient H.V. will guide our discussion

- 52 year old woman with end stage renal failure
- Dialysis access through a catheter placed in the left internal jugular vein since August, 2002

**indication:** Confirm catheter location in SVC

**study:**
- ✔ Chest X-ray
- □ Ultrasound
- □ Trad. venography
- □ MRI
Plain film assessment of central line

- Images are appropriate
  - Venous anatomy is implied by catheter path
  - Catheter contrasts with surroundings in thorax
- Methods are appropriate
  - Inexpensive
  - Readily available
  - Not operator dependent

Venous drainage of upper arm
Path of IJ central line
Catheter is well placed in R. atrium
Pt. H.V.’s dialysis access is changed

- AV fistula placed in January, 2003
- AV fistula connects
  - End of L cephalic v.
  - Side of L brachial a.

Venous drainage of upper arm
Pt. H.V. has new onset L upper extremity edema

- DDx local edema
  - Venous obstruction
  - Lymphatic obstruction
  - Peripheral/ Central

- Clinical history guidance
  - Long term catheter placement is associated with stenosis of vessels
  - Flow disturbances in AV fistula predispose to thrombosis

Venous drainage of upper arm
First look for peripheral occlusion

- Turbulence in brachiocephalic AV fistula may have led to thrombotic occlusion
- Catheter placement may have led to stenosis along its path (i.e. left internal jugular vein-)

**indication:** Evaluate for peripheral venous occlusion

**study:**
- ☐ Chest X-ray
- ☐ Trad. venography
- ☑ Ultrasound
- ☐ MRI
Ultrasound evaluation of peripheral vessels

- images are appropriate
  - Fluid contrasts with surrounding soft tissue
  - Flow is represented
- methods are appropriate
  - Inexpensive
  - Readily available
  - No ionizing radiation
- notes
  - Operator dependent

Venous drainage of upper arm
Region not evaluated by US
Blood is flowing through the fistula

Cross section of fistula
Image from BIDMC PACS

Structural data is black and white
Flow data is colored (doppler)

Proximal to fistula
Image from BIDMC PACS

Konner, 2003

Mixed reds and blues indicates turbulent flow

Konner, 2003
Fistula flow has decreased in past two months

April, 2003

June, 2003

Images from BIDMC PACS
Left upper extremity veins are patent

- Compression with transducer collapses low pressure vessels
- Doppler demonstrates flow in non-occluded vessels
Left jugular is not patent

- Vein does not compress
  - Either high pressure or not patent
- Vein does not have flow
  - Not patent

Visualization of collaterals (not in these images) points to a chronic process

Images from BIDMC PACS 13
Second, look for central occlusion

- Distal obstruction ruled out with US
- US demonstrated blockage in peripheral path of catheter, which may continue centrally

**indication:** Evaluate for central venous occlusion

**study:**  
- ☐ Chest X-ray  
- ☐ Trad. venography  
- ☐ Ultrasound  
- ☑ MRI
MRI evaluation of venous flow

- Images are appropriate
  - Vessels in thorax visible
  - Flow is represented
  - Soft tissue anatomy visible
  - Volumetric images
- Methods are appropriate
  - No ionizing radiation
  - Gadolinium contrast (non iodinated)
- Note
  - Lengthy study, expensive

Image from BIDMC PACS
MRV confirms filling defect of LIJV
L. brachiocephalic is occluded (reaction to catheter)

- Proximal left brachiocephalic artery is not visualized with intervenous contrast
SVC stenosis (reaction to catheter)

- Filling defect in SVC is quantified with transverse slices.
- Appearance is consistent with stenosis due to fibrous sheath.
Recanalization of LBCV to improve circulation

Fibrous reaction to previous catheter placement has resulted in a L. brachiocephalic occlusion and SVC stenosis.

**indication:** Recanalize the obstructed vein

**study:**
- [x] Chest X-ray
- [ ] Ultrasound
- [%] Trad. venography
- [ ] MRI
Contrast venography for stenosis dilation

- Images are appropriate
  - Real time display
  - Vessels visualized
  - Interventions visualized

- Methods are appropriate
  - Compatible with intervention

- Notes
  - Iodinated contrast
  - Ionizing radiation
  - Operator dependent
  - Expensive
Angio demonstrates obstruction and collaterals

- Digital subtraction enhances contrast, but minimizes appearance of anatomical landmarks
- Dye injected into upper extremity venous access does not pass through left brachiocephalic vein
SVC is dilated in order to access obstruction

- Contrast demonstrates stenosis in SVC
- Balloon inflation dilates SVC
- Stented vessel permits instrument passage

Images from BIDMC PACS
Brachiocephalic V. flow is restored

1. Sharp recanalization
2. Balloon angioplasty
3. Stent placement

- Prior to treatment contrast does not pass through BC obstruction and fills collateral vessels
- Following treatment contrast passed through patent BC and does not fill collateral vessels

Images from BIDMC PACS
Patient H.V. follow up

• L upper extremity edema resolved following recanalization procedure
### Menu of tests and their distinguishing features

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>MRI</th>
<th>venography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$</td>
<td>$$</td>
<td>$$</td>
</tr>
<tr>
<td>Flow imaging</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Tissue imaging</td>
<td>some</td>
<td>extensive</td>
<td>some</td>
</tr>
<tr>
<td>Real time</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Anatomic restrictions</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Ionizing radiation</td>
<td>none</td>
<td>none</td>
<td>yes</td>
</tr>
<tr>
<td>Contrast</td>
<td>no</td>
<td>yes (gad)</td>
<td>yes (I)</td>
</tr>
<tr>
<td>Operator dependent</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
</tbody>
</table>
**Additional approaches (not in wide spread use)**

**CT venography**

**Radionuclide venography**

- Nuclear studies of thrombosis
  - radiolabelled fibrinogen
  - radiolabelled apcitide

*Lawler, 2003*

*Krishnan, 2002*
References

Acknowledgements

- Phoebe Lewit Olhava, M.D.
- Elvira Lang, M.D.
- Pamela Lepkowski
- Larry Barbaras