AV Fistulas and Grafts

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Ultrasound of hemodialysis access

- Detect abnormalities within the access that may cause
  - Thrombosis
  - Poor function
  - Lack of accessibility for dialysis
  - Produce symptoms in the arm
- Goal: preserve each access for as long as possible

Terminology

- Feeding/inflow artery
- Draining/outflow vein
- Cranial
- Caudal
- Downstream
- Upstream

Peak Systolic Velocity:
- Multiple samples through entire dialysis access
- Use 60° angle or less, align parallel to vessel wall
- In areas of suspected stenosis, record PSV proximal, at and distal to stenosis

Volume Flow Measurement:
- Inflow artery 2 cm proximal to anastomosis
- Outflow vein 8 cm from anastomosis
- Average 3-4 measurements at each site
Measuring Volume Flow

Flow = TAV x Area x 60

- Use a wide sample gate
- Select straight segment with uniform diameter
- Try to avoid measuring flow in areas of extreme turbulence
- May choose to average 3-4 measurements

Difficulties with volume flow

- Must have clear spectrum with no noise
- Consistently measure the diameter at same location
- 5% variation in diameter can change calculated volume flow by 300-400 ml/min

B-mode Image Info

- Observe B-mode for various pathologies including:
  - Peri-graft masses
  - Pseudoaneurysms
  - Thrombus
  - Stenotic valves
  - Webbing
  - Intimal flaps (due to large bore needles)
**Velocity Criteria**

- Normal fistula/graft velocities
  - PSV 150-300 cm/s
  - EDV 60-200 cm/s
- Marked spectral broadening throughout fistula/graft
- Low resistance flow in afferent artery
- Increased velocities and pulsatility noted in efferent vein
  - PSV 30-100 cm/s

**Critical Velocity**

Peak systolic velocity < 150 cm/s indicates a graft in jeopardy of failure

**Graft Occlusion**

- High resistance signal
- Intraluminal echoes

**AVF anastomotic stenosis ≥ 50%**

- At the anastomosis
  - PSV ≥ 400 cm/s
  - Vr >3:1 using PSV 2 cm upstream in inflow artery for comparison
  - Intraluminal defect on grayscale
  - Sharp angles can impact Doppler findings

**AVF draining/outflow vein**

- Stenosis > 50%
  - PSV ≥ 300 cm/s
  - Vr > 2:1
- Stenosis ≥ 75%
  - Vr >3:1
**Volume Flow Criteria**

- **Normal:**
  - Flow > 800 ml/min
- **Early Stenosis:**
  - Flow = 500-800 ml/min
- **Severe Stenosis:**
  - Flow < 500 ml/min
  - Flow > 800 ml/min in PTFE

**Flow Changes**

- **Pre-op**
  - Radial flow 25 ml/min
  - Brachial flow 50 ml/min
- **Post-AVF flow**
  - Can increase 10 – 20x
  - Will reach 40-60% of max within 1 day
  - Max flow achieved in about 4 weeks

**Predicting outcomes**

- Flow > 500 ml/min and vein diameter ≥ 4 mm yields 95% AVF maturity and satisfactory performance
- Flow < 500 ml/min and vein diameter < 4 mm yields only 33% success

**KDOQI Rule of 6’s**

- 6 weeks post creation
- 6 mm diameter
- Less than 6 mm from skin surface
- 600 ml/min

**Case Presentation**

- 67 year old male
- Brachial artery to basilic vein transposition fistula
- Difficulty with dialysis with increased venous pressures
What do you think so far?

- Is the inflow waveform normal?
- Is the anastomotic velocity normal?
- Is the fistula PSV normal?
- Is the fistula flow normal?

Venous Stenosis

- Sonolucent intraluminal material
- Luminal reduction by color flow
- Common at vein bifurcations & valves
- Can result from scarring of puncture sites
**Additional testing**

Based on physician preference and presenting symptoms of the patient:

- Rule out steal from native circulation
  - Measure distal artery velocity or flow with and without compression of fistula/graft
  - Measure finger or wrist PVR with and without compression of fistula/graft
- Rule out central vein thrombosis
  - Standard UE DVT scan
  - High prevalence of SCV thrombus

**Radial artery distal to AVF**

**most display retrograde flow**

**Case Presentation**

- 66 year old female
- Brachial artery to basilic vein transposition fistula
- Presents with pulsatile mass
Thoughts so far...

Normal PSV and normal flow

Aneurysms/Pseudoaneurysms

- Incidence 5-60%
- Confirm with color
- Anechoic mass with no flow
  - Possible seroma
  - Possible hematoma

Pseudoaneurysms

- Frequently multiple
- Contained hematoma
- To-fro flow pattern in pedicle

Dialysis Access Grafts & Fistulas

- Be aware of the type and position of access being evaluated
- Remember: PSV 150-300 cm/s
- High volume flow should be present >800 ml/min
- Volume flow <500 ml/min indicates poor long-term outcome
Conclusion

- Ultrasound can identify graft lesions and monitor graft hemodynamics
- Initial baseline examinations provide reference for follow-up studies
- Ultrasound can help assess the maturity of an arteriovenous fistula measuring size and flow rate
- Criteria have been developed to identify grafts in jeopardy of failure