DIALYSIS ACCESS SURVEILLANCE AND CASE PRESENTATION

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I HAVE NO CONFLICT OF INTEREST TO DISCLOSE

CLINICAL INDICATIONS FOR THE EXAM

Pre-op Evaluation	Maturation	Distal Limb Ischemia	Loss of Thrill
Peri-graft Fluid / Mass	Poor Dialysis Effectiveness	Elevated Pressure During Dialysis	Unexplained Urea Reduction <60%
Difficult Cannulation	Thrombus Aspiration	Increased Bleeding Time during Dialysis	Pain During Dialysis

COMMON DIALYSIS ACCESS POINTS

- Radiocephalic AVF (Brescia Cimino)
- Radiobasilic AVF
- Brachiocephalic AVF
- Brachiobasilic AVF – Transposition
- Radial Artery – Available Vein (forearm)
- Brachial artery to available vein (UA)
- Perforator vein* to radial artery (ACF)
- Loop or straight graft
- Brachiobasilic AVG
- Brachioaxillary AVG

PREDIALYSIS ACCESS
SCAN PREPARATION

- High resolution transducer – high frequency less penetration
- Linear L7-9 to L12-5 MHz
- Curved C8-5 MHz for subclavian
- Tourniquet
- Warm temperature
- Non-dominant arm

PREDIALYSIS ACCESS
VENOUS PLANNING

Central Venous Mapping

- Innominate, Subclavian, Axillary and brachial veins for patency and flow pattern (features DVT)
- Axillary vein is less common for obstruction, collateral will indicate central stenosis or occlusion
- SCV obstruction may reverse the flow in the axillary

Superficial Venous Mapping

- Cephalic and Basilic: phlebosclerosis, anatomical variation/branches, inner-inner caliber for native >2.5mm and graft ≥4mm, BV connection to brachial vein
- Medial cubital vein and perforator vein: caliber and patency; length for perforator
- Depth within 6mm of the skin or wait for superficialization

PREDIALYSIS ACCESS
ARTERIAL PLANNING

Arterial Mapping

- Brachial, radial and ulnar arteries: atherosclerosis and spectral waveform, anatomical variation, high bifurcation, caliber ≥2mm

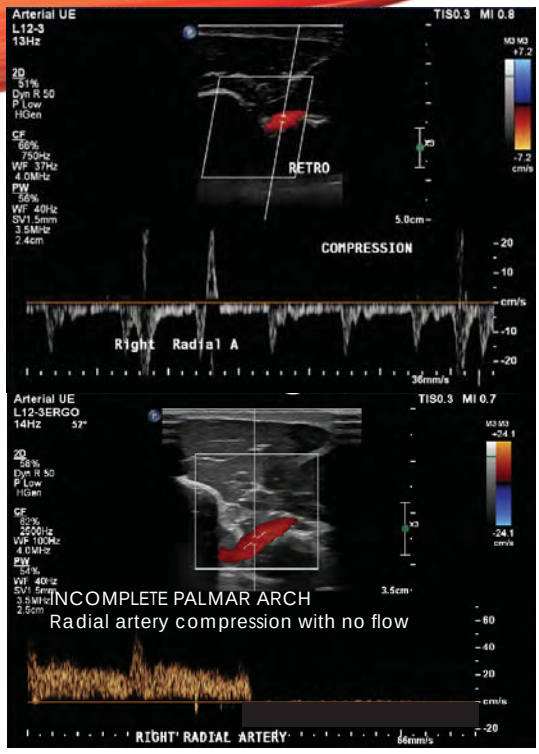
Palmar Arch (Allen's Test, *may be* performed if veins acceptable)

- Modified palmar arch
- Compression of ulnar artery while evaluating radial artery using PPG
- PPG's/digital pressure
- Clinical evaluation

Lower Extremity Mapping

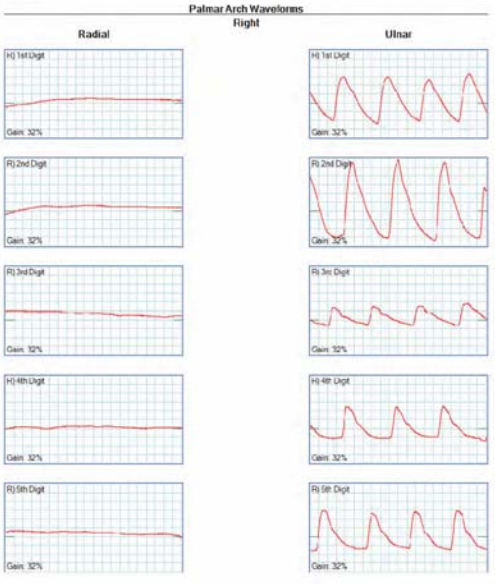
- ABI
- CFA and SFA evaluation for stenosis or calcification
- SFJ, GSV to knee level, CFV, FV, DFV patency/thrombosis; varicosity, branches, diameter, wall thickening

PALMAR ARCH
(ALLEN'S TEST – INCOMPLETE)



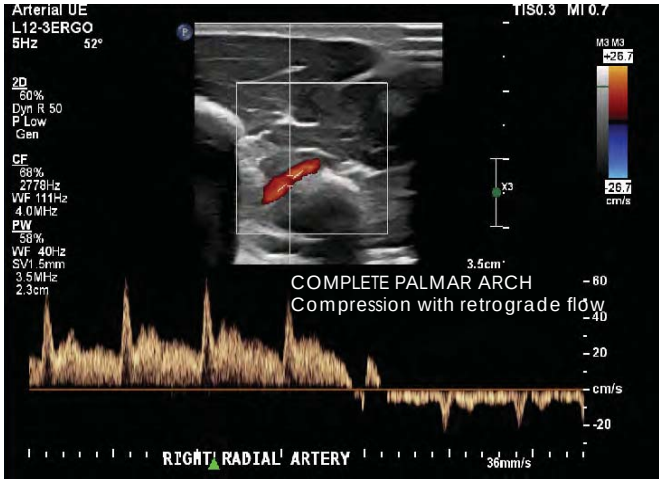
INCOMPLETE PALMAR ARCH
Radial artery compression with no flow

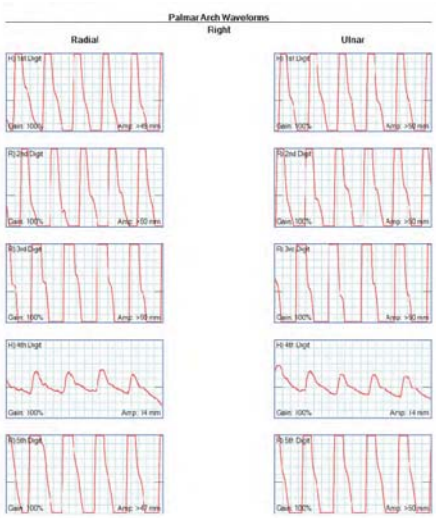
DBI <80mmHg or Pressure drop >30% with radial compression➔ incomplete palmar arch



PALMAR ARCH
(ALLEN'S TEST – COMPLETE)

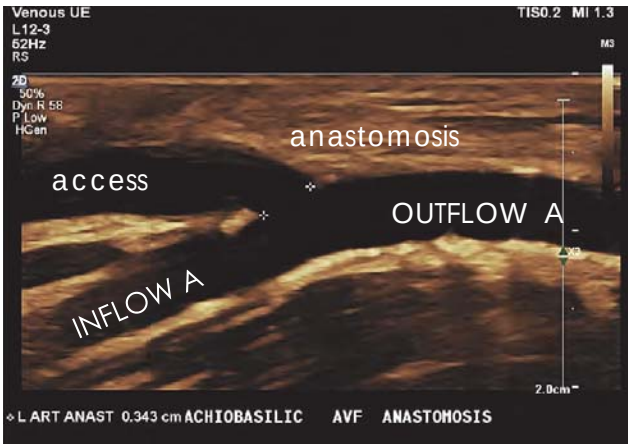
DBI >80mmHg or Pressure drop <30% with radial compression➔ complete palmar arch





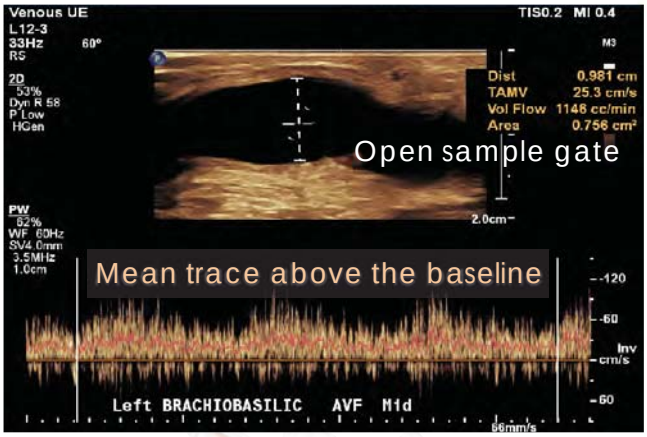
CONDUIT SURVELLIANCE

1. Inflow artery
2. Anastomosis velocity and diameter
3. Outflow artery (look for steal) peripheral



4. Access: peripheral (proximal), mid access and central(distal): depth, caliber and velocity

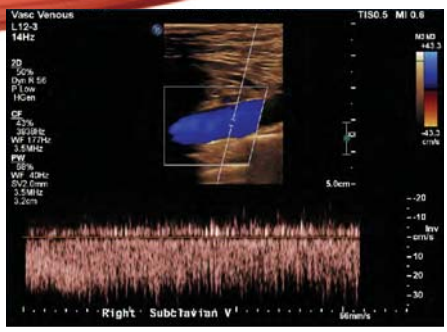
ACCESS MATURATION
VOLUME FLOW

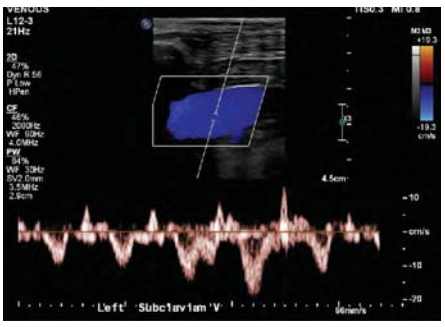


- Duplex 4-6 weeks
- Volume flow <500mL/min ➔ possible failure
- Native fistula less flow than PTFE
- Volume flow ➔ predictive for access failure; velocity ➔ stenosis
- At least 2 or 3 cardiac cycles for the time average velocity (TAMV)
- Not after dialysis (reduction in blood pressure)

RULE OF 6

<6mm depth
>6mm caliber
>600 mL/min





ACCESS MATURATION
LONG-TERM MONITORING

- Central Venous Outflow
  - Innominate and subclavian veins with a patent fistula or graft will have consistent “arterialized” waveforms
  - Graft occlusion central veins lack such pulsatility, are more phasic with respiration, and may be symmetrical with the veins on the contralateral side

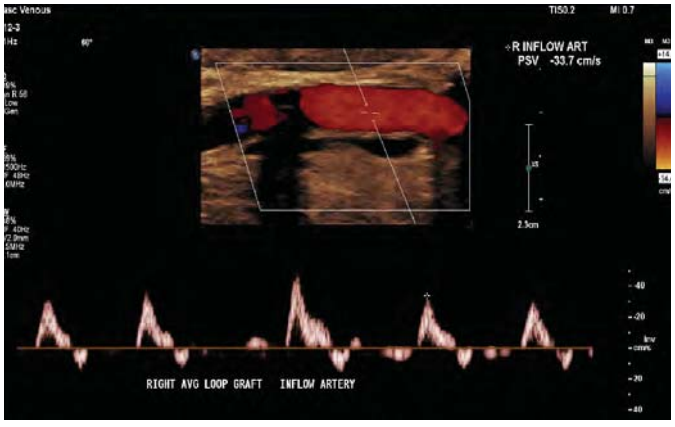
ACCESS MATURATION
LONG-TERM MONITORING

- Failure of dialysis access: narrowing of venous outflow by intimal hyperplasia at or within a few centimeters of the venous anastomosis
- Stenosis anywhere in the access, inflow artery (atherosclerosis) and central veins
- Locations prone to intimal hyperplasia
  - ➢ vein valve and puncture sites
  - ➢ the transposed basilic vein where it turns down into the brachial vein
  - ➢ the cephalic vein confluence to the deep venous system
  - ➢ the central veins

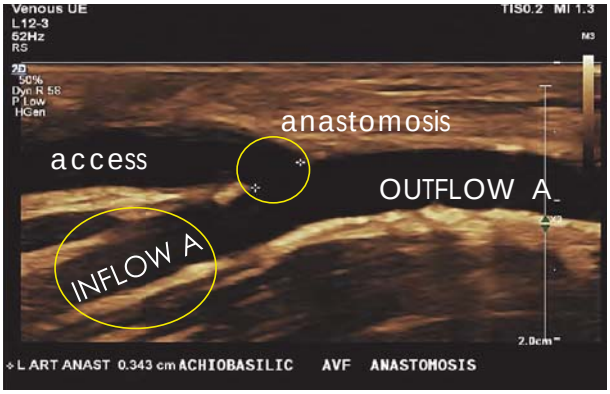
ARTERIAL INFLOW
(PATENT VS OCCLUDED AVG/AVF)

Arterial Inflow

- Doppler waveforms from the inflow arteries to a patent fistula/graft ➔increased velocity and low resistance
- Occluded access: inflow artery will "normalize" ➔ high resistance waveform



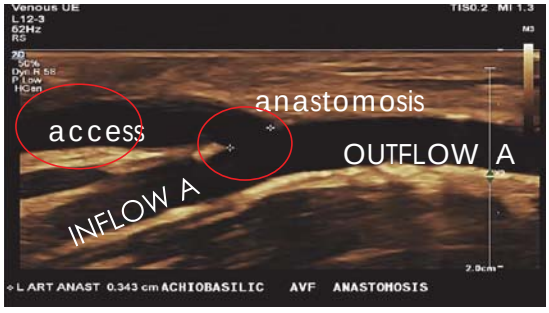
ARTERIAL INFLOW
LONG-TERM MONITORING



- Conduit Surveillance **(Native Vein Fistula)**
  - Central venous outflow
  - Arterial inflow
  - Conduit surveillance
- Anastomosis of 4-5mm – risk of steal
- *Quantifying anastomotic stenosis by PSV ratio (Vr):* max PSV within the anastomosis divided by the PSV of the inflow artery obtained approximately 2 cm proximal to the anastomosis
- Vr ≥ 3.0 (2.0) and a PSV ≥ 400 cm/s ➔ suggestive of a stenosis of at least 50% diameter reduction with B-mode confirmation of an intraluminal defect at the anastomosis
- Vessel angulation false positive

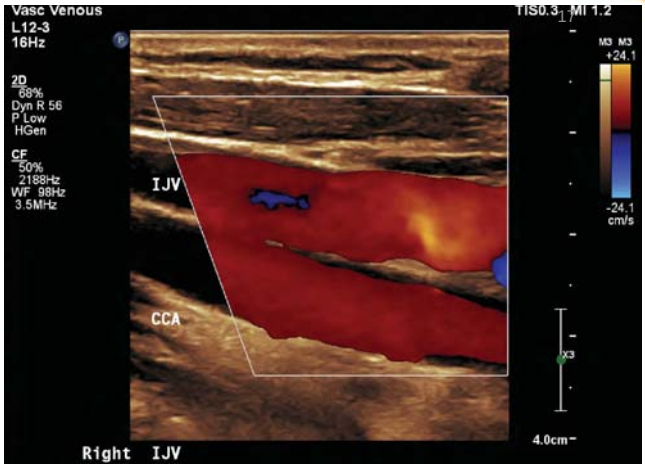
ARTERIAL INFLOW
LONG-TERM MONITORING

- Conduit Surveillance **(Prosthetic Graft)**
  - PSV ≥ 400 cm/s and a focal velocity increase with a Vr ≥ 3.0 are suggestive of a significant stenosis (≥50% diameter reduction)
  - Graft occlusion
    - Intraluminal echoes
    - Absence of flow on Doppler spectral waveforms
    - No color Doppler flow using low velocity scales (PRF)



- Lower Extremity Dialysis Access Surveillance
  - ABI decrease after creation of a lower extremity fistula
  - Clinically significant if arterial occlusive disease is present

COMPLICATIONS

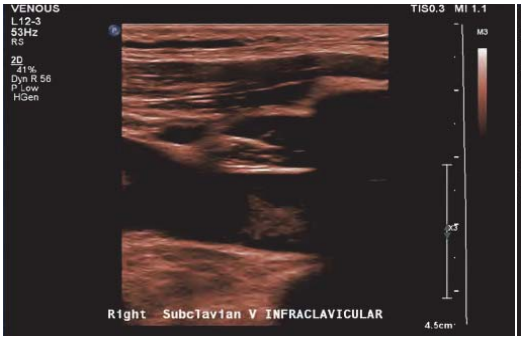


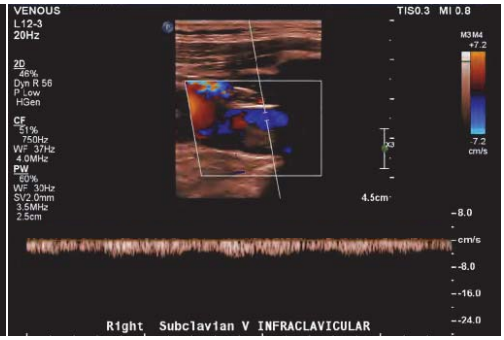
CENTRAL VENOUS OUTFLOW OBSTRUCTION

- Graft may be normal
- Venous stenosis beyond the venous anastomosis
- Native outflow vein
  - Axillary vein ➔ upper extremity graft
  - Transposed basilic vein ➔ turns down into the brachial vein
  - Cephalic vein where ➔ joins the deep venous system
- Within proximal subclavian or innominate veins ➔ scarring from prior central venous lines
- Remarkable Venous collaterals ➔ central vein stenosis or occlusion

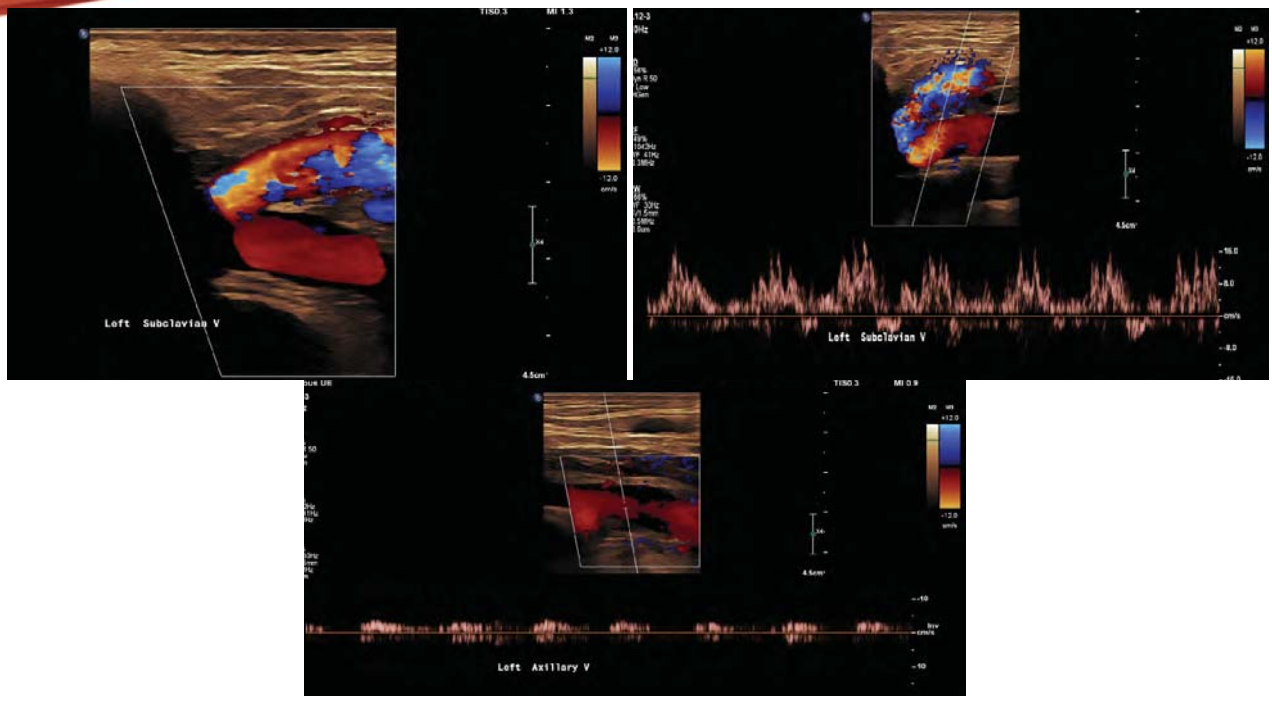
COMPLICATIONS
CENTRAL VENOUS OBSTRUCTION

- CENTRAL VENOUS OUTFLOW OBSTRUCTION
  - Continuous waveform indicates proximal compromise
  - Echogenic/hypoechoic non-compressible lumen
  - Retrograde direction





COMPLICATIONS
CENTRAL VENOUS OBSTRUCTION



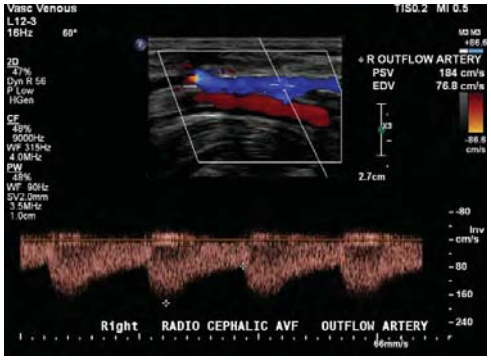
COMPLICATIONS – STEAL

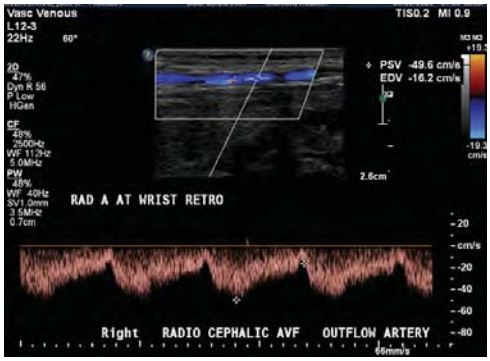
- **STEAL PHENOMENON**
  - Flow to least resistance through the fistula decreasing arterial pressure and flow distally
  - Flow may reverse in the distal artery
  - Occlusive arterial disease proximal or(rarely)distal to the access
    - ➢ Inflow artery stenosis ➔ reduces flow
    - ➢ Outflow artery compromise ➔ ischemia due to steal

COMPLICATIONS – STEAL

On duplex examination:

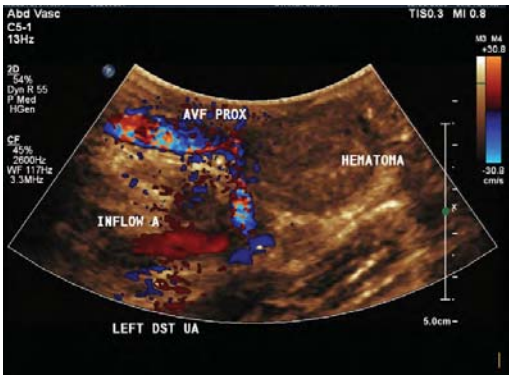
- Arterial stenosis - Diabetic patient
- Retrograde flow (away from the hand) in the radial or ulnar artery peripheral to the anastomosis





COMPLICATIONS - STEAL

- Cold, painful hand, especially while dialyzing
- Extremely high-flow fistulas (>900 mL/min)
- Measurement of digit pressures with an appropriate-sized cuff and flow detection with PPG
- Digit pressure ≥60 mmHg or a digit-brachial index (DBI) ≥0.6 ➔ adequate perfusion
- Manual compression of the fistula/graft PPG pressures on the symptomatic finger

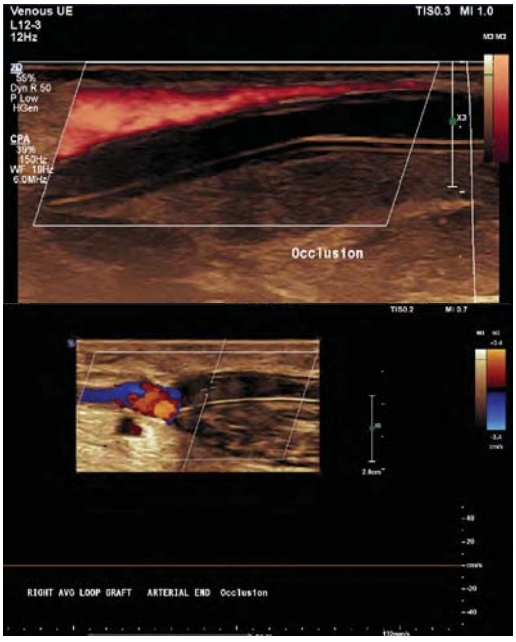


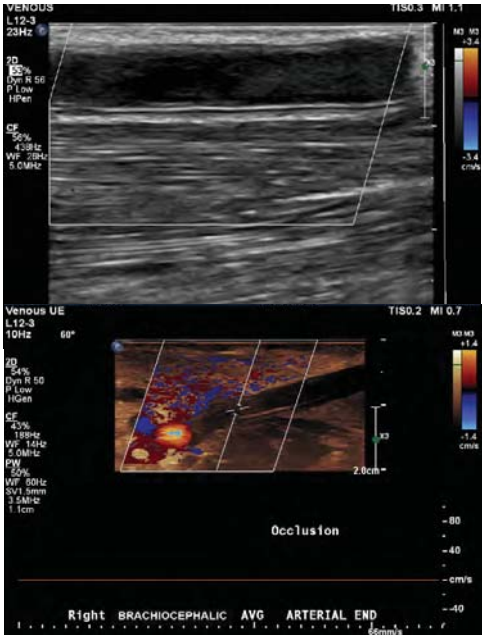
SONOGRAPHIC FINDINGS HEMATOMA

Heterogenous avascular fluid collection

- Post puncture
- Post surgery
- Thrombosed PSA

OCCLUSION



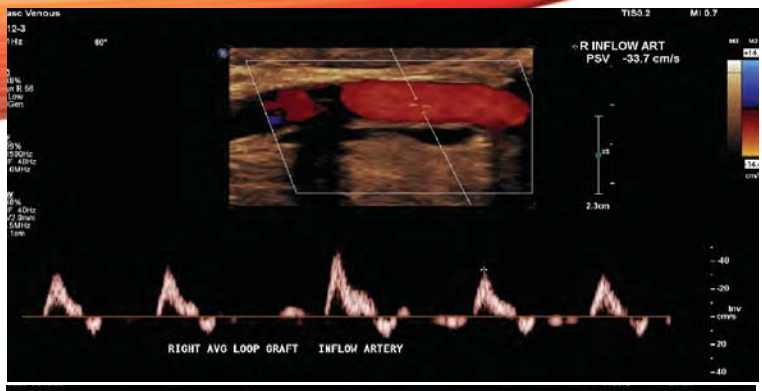


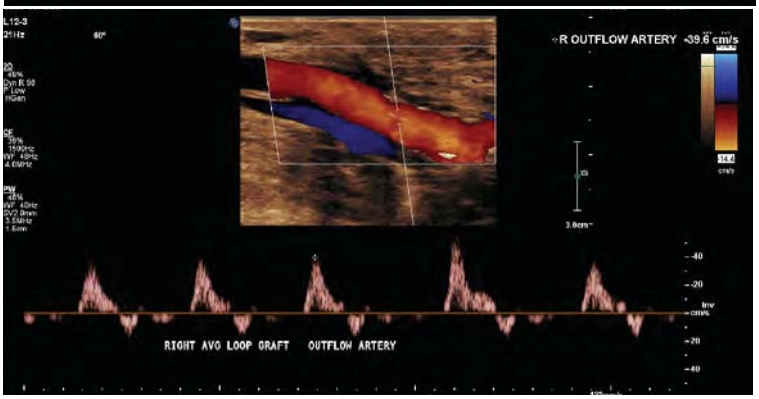
- Intraluminal echoes
- Absence of flow on Doppler spectral waveforms
- No color Doppler flow using low velocity scales (PRF)

ABSCESS

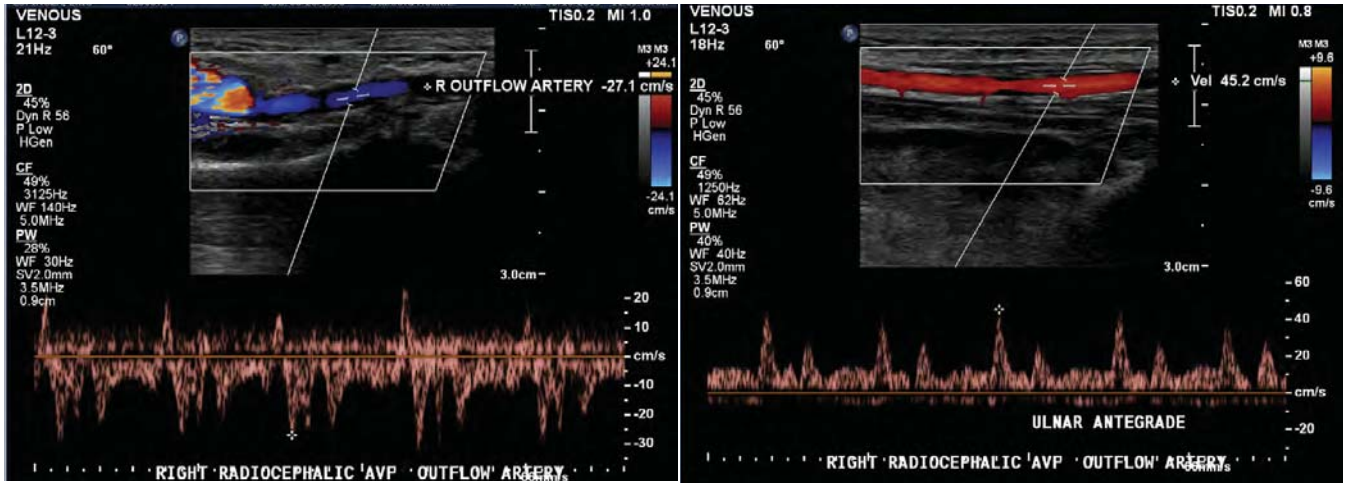
- Heterogeneous fluid collection
- Vascularity
- Clinical signs

OCCLUSION

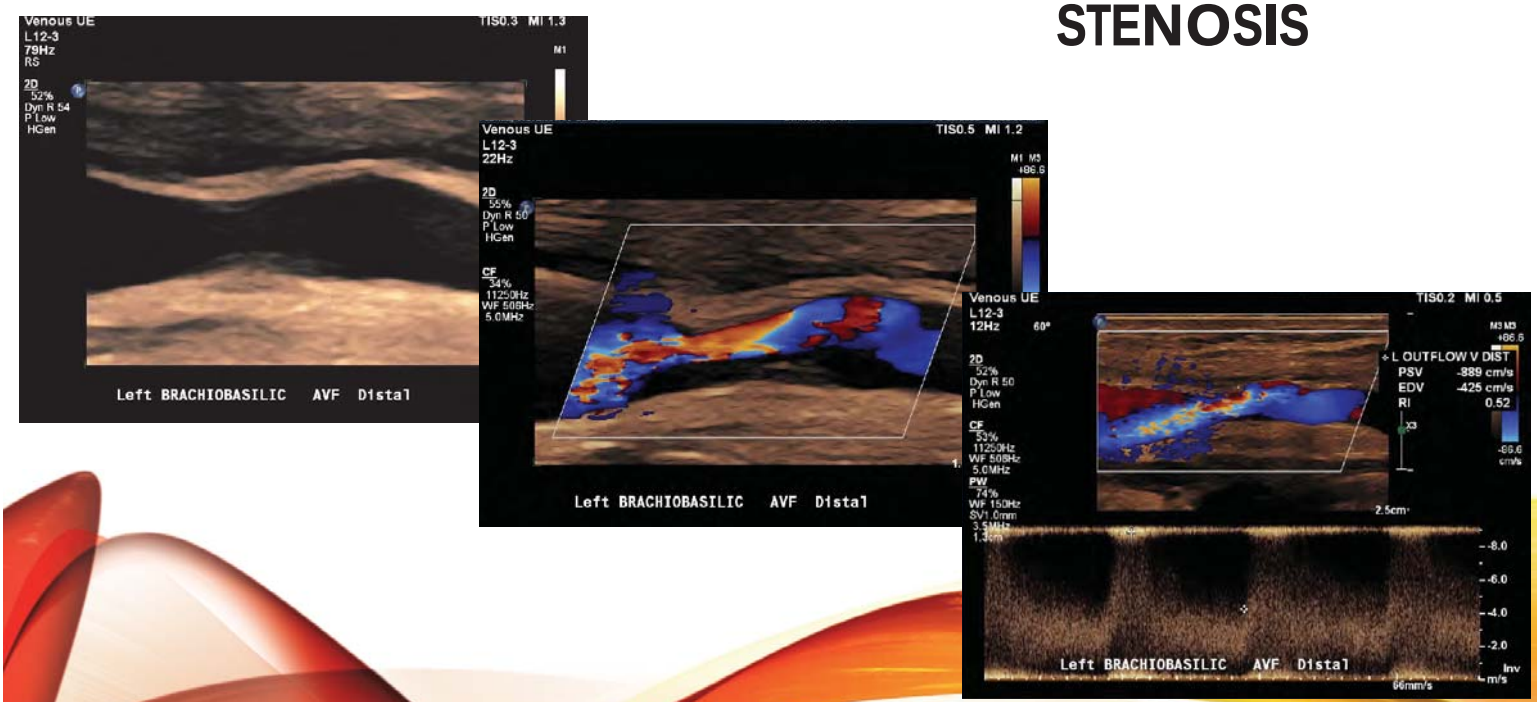




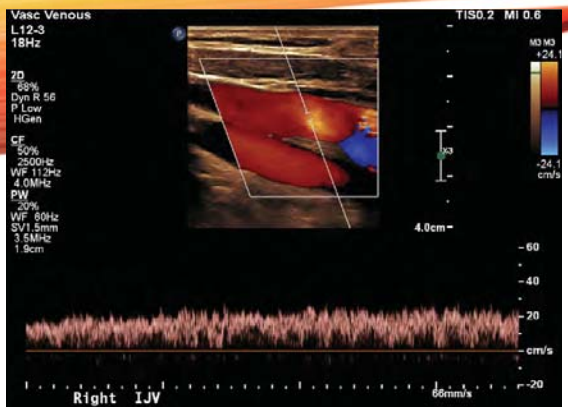
RETROGRADE FLOW

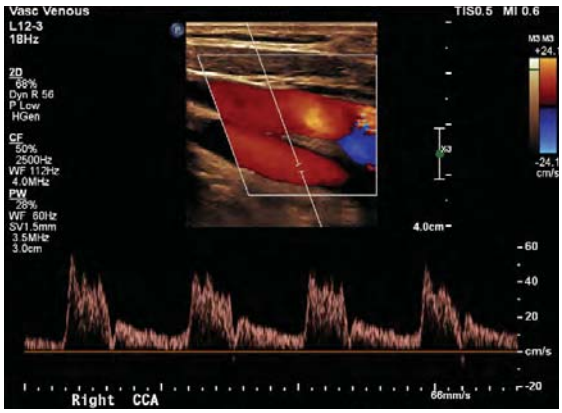


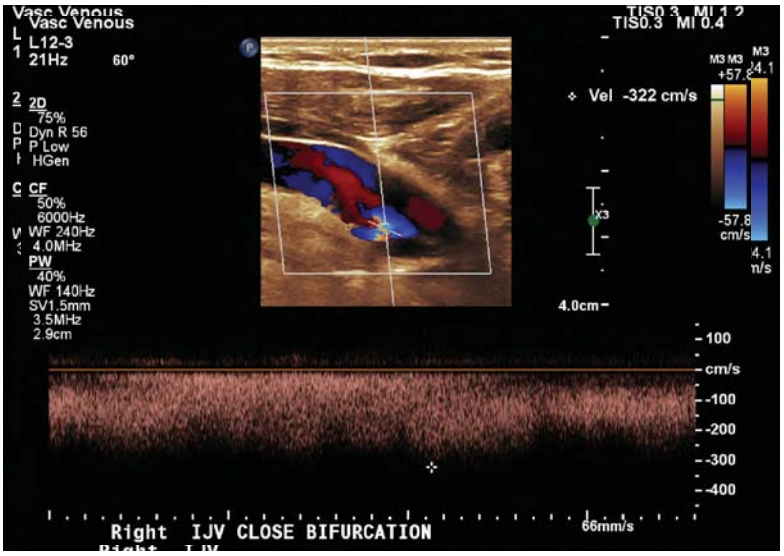
STENOSIS



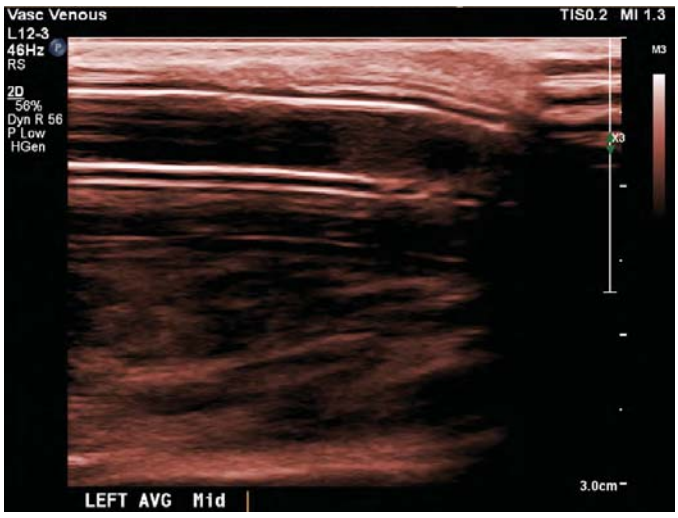
CENTRAL VENOUS OBSTRUCTION

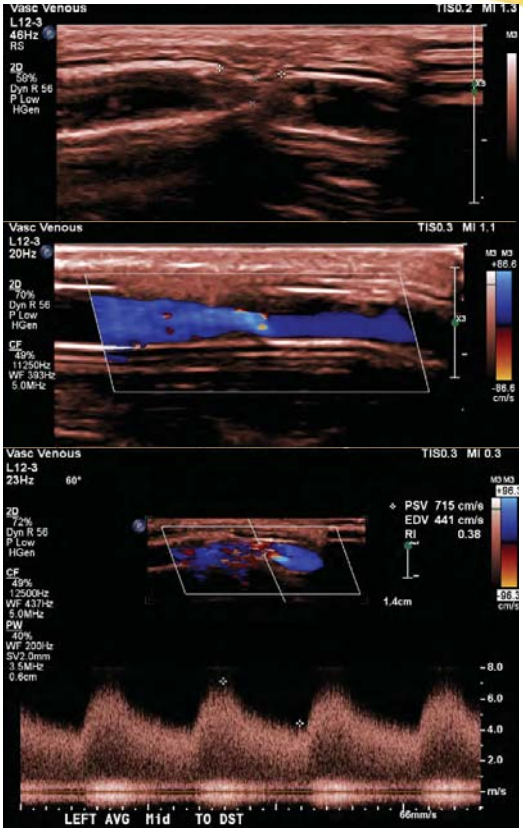






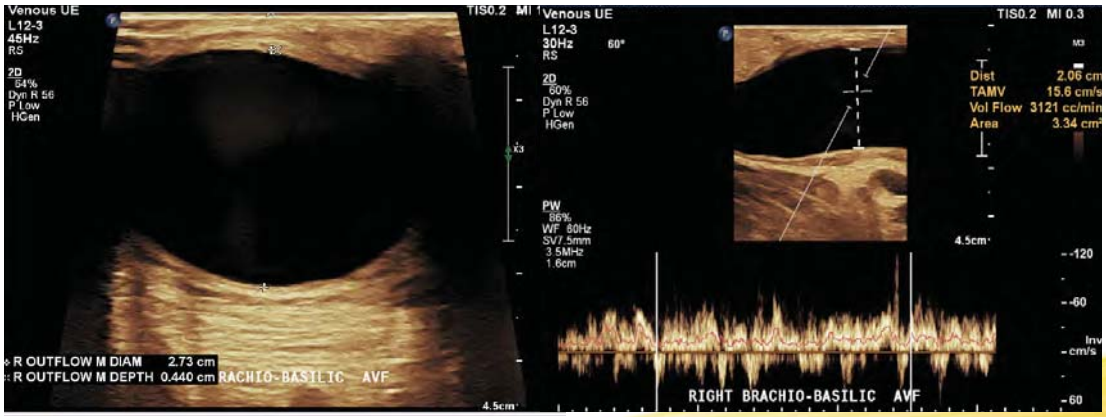
GRAFT -PTFE





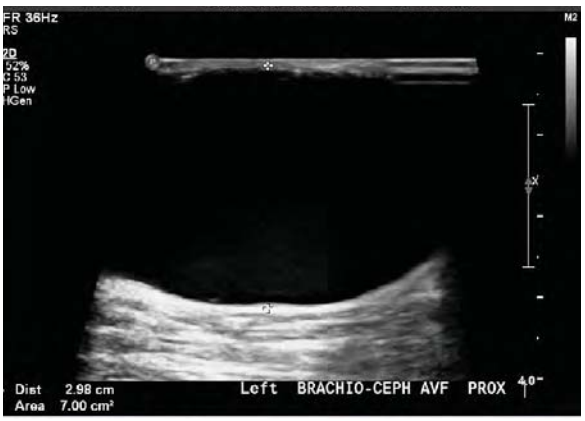
ANEURYSM

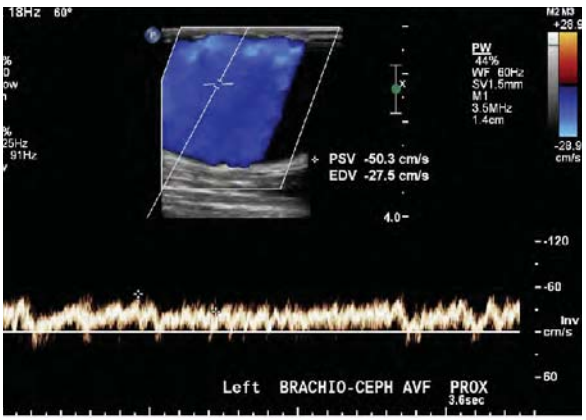
- Abnormal localized dilatation of the vessel
- True aneurysm
- Pseudoaneurysm
- Location and site
  - arterial
  - venous
  - graft
  - anastomosis
  - puncture site



ANEURYSM

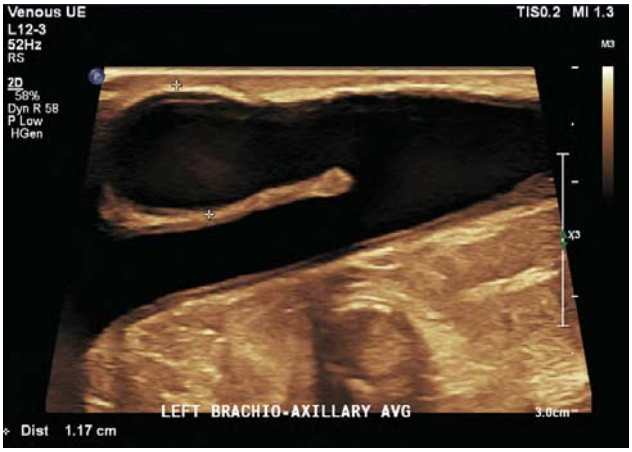
- No standard size
- Evaluate the adjacent caliber (2x)
- Likely AVF > Graft
- Clinical concern: rapid increase in size, pain, thinning and skin degeneration, infection

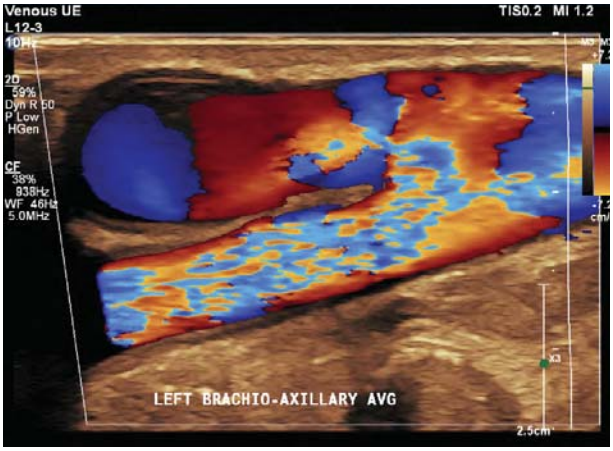




PSEUDOANEURYSM

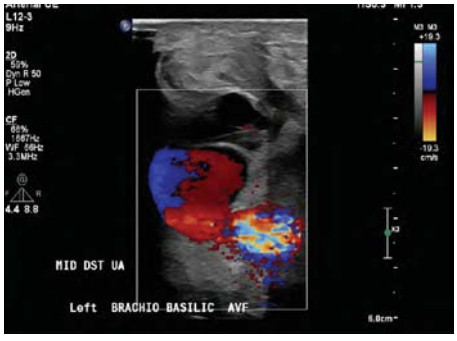
- Common
- Result from puncture
- <5 mm ➔ stable
- >5mm ➔ attention

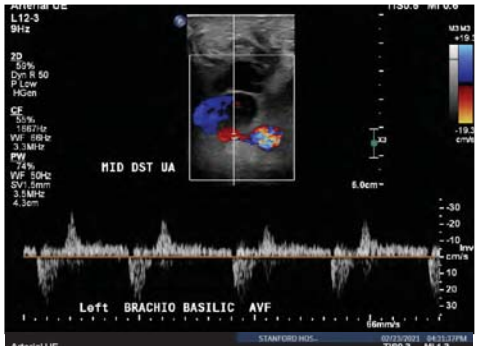


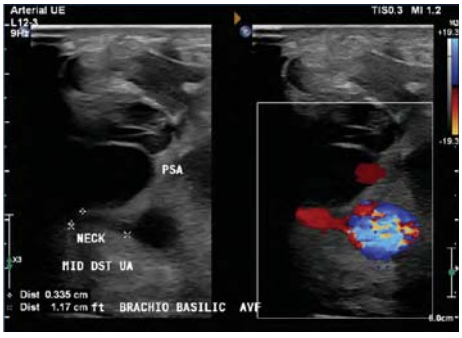


PSEUDOANEURYSM

- To-fro waveform
- Ying-Yang color
- 5mm







CONCLUSION

- Review anatomy
- Known direction of flow with color and spectral
- Remember rule of 6
- Understand arterial and venous waveforms
- Conduit surveillance and sonographic findings
- Referral to your laboratory protocol for nomenclature

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STANFORD MEDICINE

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THANK YOU