Introduction to Vascular Access for Hemodialysis

“THE ACHILLES HEEL OF HD”

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Three Main Options For Vascular Access

- Arterio-Venous Fistulas (AVFs)
- Arterio-Venous Grafts (AVGs)
- Tunneled and Non-tunneled Central Venous Catheters (CVCs)

- AVFs are preferred due to long term superiority and less complications
In the U.S. higher rates of AVGs vs. AVFs
What are AVFs?

- Direct connection of artery to vein
- Non-physiologic by design
- Normal radial blood flow is 20-30 ml/min
- AVF run blood flows between 600-1200 ml/min
- Overtime higher flows through vein causes “arterialization” and maturation of vein to be used in HD
- General Rule: Prefer to start distally at the wrist then work proximal
- Artery side to vein-end anastomosis is the preferred technique
Scribner Shunt
Cimino-Brescia Fistula

Radial artery to Cephalic Vein anastomosis @ wrist

Developed in 1966 and still preferred mode of access!
Side-to-side anastomosis
Artery-side-to-vein-end anastomosis
Brachial Artery to Cephalic Vein and Ulnar Artery to Perforating Vein
Advantages of AVFs

- Good blood flow
- Lower incidence of infection vs. AVGs and CVCs
- Lower tendency to clot vs. AVGs and CVCs
- Stays functional longer
- Decreased mortality and morbidity compared to AVGs and CVCs
Disadvantages to AVFs

- Higher rates of primary failure compared to AVGs
- Can take several months to mature (need early referral)
- May be more difficult to puncture compared to grafts
- May be less cosmetically pleasing to patients compared to grafts
Examples of Dilated AVFs
Order of Preference for AVFs

- Radiocephalic
- Brachiocephalic
- Transposed brachiobasilic fistula
- Other less common fistulas
Arterio-Venous Graft

- Usually made of polytetrafluoroethylene (PTFE)
- Conduit between artery and vein
- Not preferred for initial access
- Indications include hypoplastic or exhausted peripheral vein, obesity, or severe arterial occlusive disease (i.e. Many of U.S. HD patients)
Types of AVGs

- Straight forearm (radial artery to cephalic vein)
- Looped forearm (brachial artery to cephalic vein)
- Straight upper arm (brachial artery to axillary vein)
- Looped upper arm (axillary artery to axillary vein)
- Less common are looped lower extremity (femoral artery to axillary vein) when other options are exhausted
Types of AVGs

Polytetrafluoroethylene axillary vein graft

Axillary vein
Axillary artery

PTFE graft

Axillary vein
Axillary artery

PTFE graft

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AVGs

- Preferred placement is looped in forearm
- Post-operatively may seem infected: redness, heat, swelling around graft. Should resolve in 2 weeks without need for antibiotics
Advantages of AVGs

- Initial high blood flow rates
- First cannulation 2-3 weeks vs. 2-3 months
- Easy surgical replacement
- Less primary failure than AVFs (may be as high as 40%)
Monitoring and Surveillance of AVFs and AVGs

- Inspect for infection, hematoma, swelling, and palpation for venous stenosis
- Impaired access if < 600 ml/min in AVG or 300 ml/min for AVF (usually checked with glucose dilutional technique)
- **Pre-emptive** intervention to prevent thrombus of utmost importance
Complications of AVFs and AVGs

- Thrombosis is a more frequent complication in AVGs than AVFs; usually due to venous outlet stenosis
- Thrombosis more likely to happen with area cannulation technique
Complications of AVFs and AVGs

- In AVGs stenosis usually occurs at the graft-vein anastomosis due to neo-intimal hyperplasia\(^1\)
Complications of AVFs and AVGs

- Most common complication thrombosis
- Treatment of thrombosis in both uses a combination of thrombolytics and thrombectomy techniques
- Even after successful declotting, it is important to always treat underlying stenosis, otherwise thrombosis will always recur.
Procedures on AVFs/AVGs

- Most common indications are inadequate flow, thrombosis, and failure to mature
- Procedures include angiography, thrombectomy, angioplasty, and stenting
Percutaneous Balloon Angioplasty

- Used to relieve stenosis
- Usually used if stenosis is greater than 50% with clinical symptoms or poor blood flow
- Considered successful in no more than 30% stenosis after procedure
- Cannot perform if AVF less than 4-6 weeks old
Percutaneous Thrombectomy

Techniques include thrombo-aspiration and mechanical and pharmo-mechanical thrombolysis
Complications of AVFs and AVGs

Prevention of AVF/AVG thrombosis?

Randomized controlled trials with Coumadin\(^1\) and aspirin and plavix\(^2\) did not show benefit.

Fish oil may have small benefit\(^3\).
Complications of AVFs and AVGs

- Aneurysms and false aneurysms may develop
  - Usually due to repeated area cannulation
  - Should be resected
  - Can lead to infection in AVGs
Aneurysms
Complications of AVFs and AVGs

Steal phenomenon and steal syndrome can develop due to retrograde blood flow

- Grade I: pale/blue and/or cold hand without pain
- Grade II: Pain during exercise and/or HD
- Grade III: Ischemic pain @ rest
- Grade IV: Ulceration, necrosis, or gangrene of hand or digits
Complications of AVFs and AVGs

- High flow steal syndrome can be treated with venous banding, but this may cause more clotting.
- Normal flow steal syndrome can be treated by DRIL procedure (Distal Revascularization and Interval Ligation).
Cardiac Overload in AVFs and AVGs

- High output heart failure due to AVF or AVG is not common except in patients with advanced cardiac disease
- Flow exceeding 1000 ml/min or flow/cardiac output ratio greater than 0.2 concerning for access contributing to cardiac decompensation
- Ligation and narrowing of fistula can be attempted to salvage AVF or AVG
Infections of AVFs and AVGs

- Not common in AVFs. If no purulent drainage, 2 week course of antibiotics can be attempted
- In AVGs infections are more common
- If infection involves anastomotic area, removal of all graft material necessary
- Midgraft infections can be treated with 2 weeks of IV antibiotics, followed by 4 weeks of oral antibiotics
Central Venous Dialysis Catheters

- These are not preferred! They are a necessary evil.
- They have a five to sevenfold increase risk of infection compared to AVF\textsuperscript{4,5} and even increase risk of mortality.
- Too often the first access for incident HD patients
- Two main types: Temporary untunneled catheters and tunneled cuffed catheters
- **Not to be placed in subclavian veins**
- Malfunction common
Infections Central Venous Dialysis Catheters

- Three episodes of infection per 1000 tunneled catheter days
- Localized infections can progress to metastatic complications of osteomyelitis, septic arthritis, epidural abscess, and endocarditis
- Important to distinguish exit site infections vs. tunnel tract infections
- Catheter must be removed in tunnel tract infections
Tunneled Tract Infection
Algorithm for Management of CVC Infections

Management of central venous dialysis catheter infections

1. Clinical suspicion of infection?
2. Obtain cultures and start antibiotics
3. Temporary catheter? -> Remove catheter
4. Type of catheter?
   - Yes?
     - Tunnel tract infection? or Metastatic infection? or Poor clinical response to treatment
     - No?
   - No?
     - May proceed with antibiotic lock or exchange over guidewire
Catheter Associated Bacteremia

- Inpatients with fever, start antibiotics empirically (Vanc/Gent) and obtain blood cultures
- If blood cultures positive, better to remove catheter while treating with antibiotics and replace with new catheter and different site in 48-72 hrs.
- Continue antibiotics for 2-3 weeks
- Can attempt catheter salvage with antibiotic locks (Do not recommend with Staph or Strep)
- Exchange of catheter over guide-wire may be alternative
Interventions for prevention of CVC infections?

- **Meticulous sterile technique handling CVC most important**
- Antibiotic locking solutions may help\(^6\)
- Nasal mupirocin may reduce Staph infections\(^7\)

