Arteriovenous Fistula Troubleshooting

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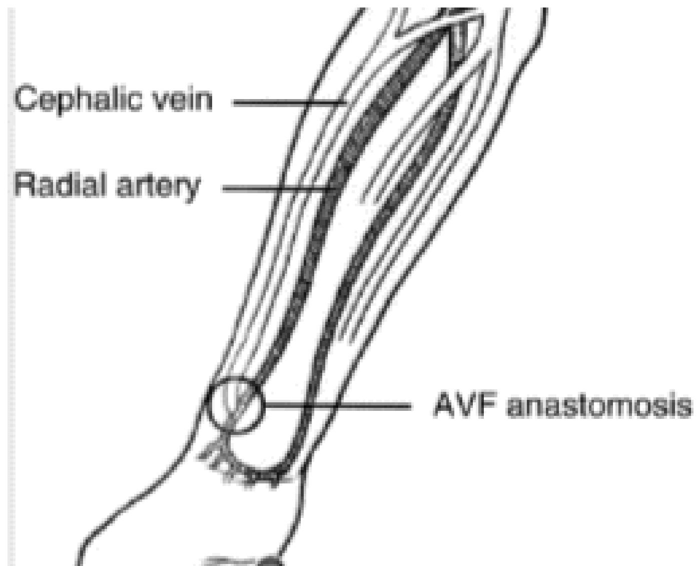
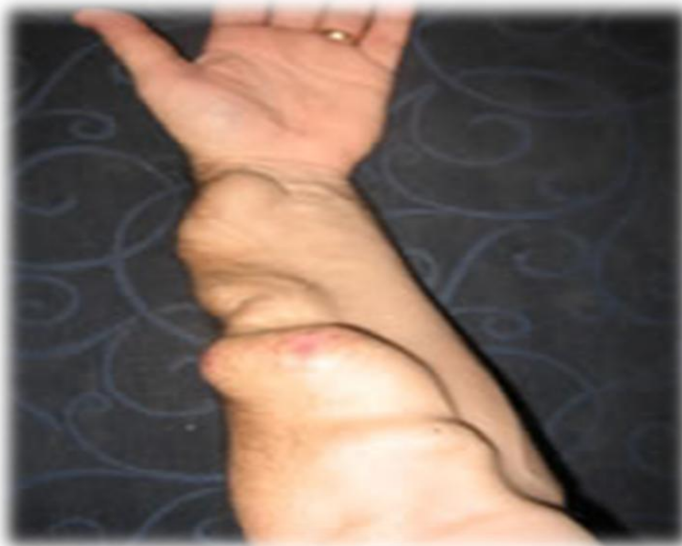
Objectives

- What is an AV Fistula
- Fistula Assessment
- Fistula Access/cannulation
- Complications/Interventions
- Prevention





Arteriovenous Fistula (AVF)

Definition:

A surgically created opening between an artery anastomosed to an adjacent/nearby vein to allow high pressure arterial blood flow into the vein to cause engorgement, enlargement, and wall thickening.

Advantages with AV Fistula

- Lower risk of infection
- Lower rate of thrombosis
- Allows greater blood flow which decreases overall treatment time
- Remains functional longer than other types of vascular access
- Usually less expensive to maintain
- Alleviates potential for allergic response to synthetic materials

Disadvantages of AV Fistula

- The vessel may fail to enlarge or increase wall thickness (i.e., fail to "mature")
- Long maturation time (6 weeks up to several months) required resulting in the necessity for alternative access until maturation is achieved
- Fistula creation and cannulation require different skill sets than grafts and may be more difficult to cannulate

Disadvantages of AV Fistula

- Thrombosed fistulas may be more difficult to restore flow
- The enlarged vessel may be visible especially in the forearm and may be perceived as cosmetically unattractive by some individuals
- Hypertrophied outflow vein may increase cardiac output and myocardial load and may cause *steal syndrome* in patients with compromised peripheral vasculature

Fistula Assessment

Before each treatment examine the fistula (including the surgical incisions) to determine changes from baseline. Focus on maturation/development of AV fistula and detect problems that require immediate physician notification.

LOOK, LISTEN, and FEEL

LOOK

- Check the surgical incision (anastomosis) to ensure it is intact and free of evidence of infection (drainage, redness, tenderness at incision site, fever)
- Changes in the extremity when compared to the opposite extremity (edema, swelling)
- Skin integrity (waxy, color of skin, sores, draining from incision)

DOCUMENT

LOOK

- Bruising or hematoma
- Steal Syndrome (pain or numbness in fingers or hand indicating a shortage of blood to the hand, discoloration, cold to touch, delayed nail bed capillary refill
- Collateral vein distension (veins in access arm close to AV fistula becoming larger)

DOCUMENT

LISTEN

- LISTEN for the **BRUIT** using a stethoscope each treatment to assure that the fistula has blood flow. This is a continuous low-pitched whooshing and should be present. The bruit has the same significance as the thrill and should be continuous and low pitched.

DOCUMENT

FEEL

- Feel for a **THRILL.** The thrill (purring or vibration) indicates blood flow through the AV fistula. A continuous thrill should be present, and will diminish in strength as you move farther away from the anastomosis
- FEEL for a pulse. The anastomosis should be easily compressible. Avoid forceful compression of the AV fistula with the examining finger. A strong pulse is not good, this suggests a downstream obstruction

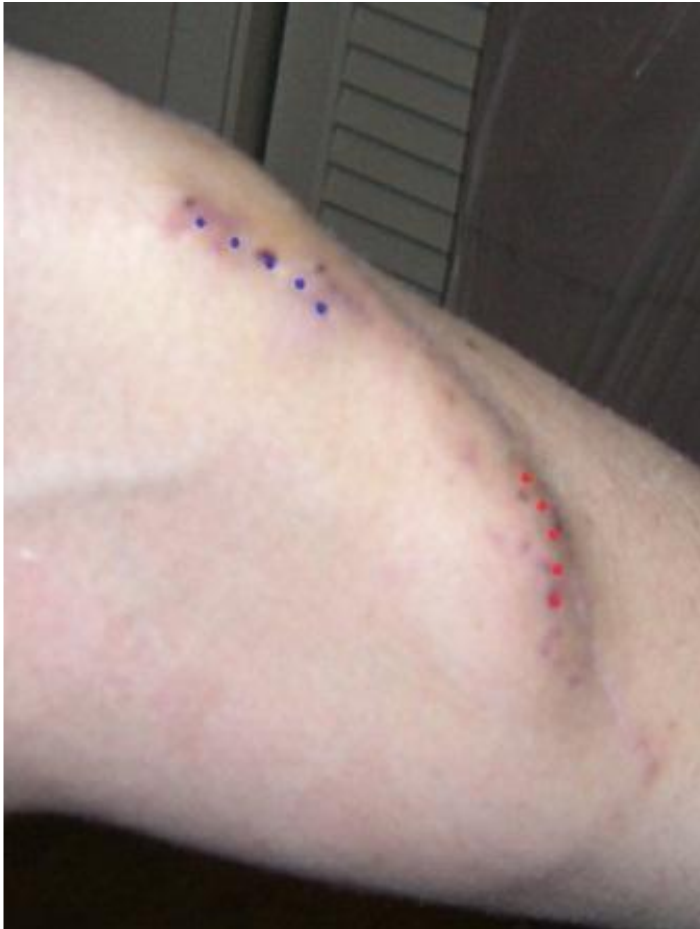
DOCUMENT

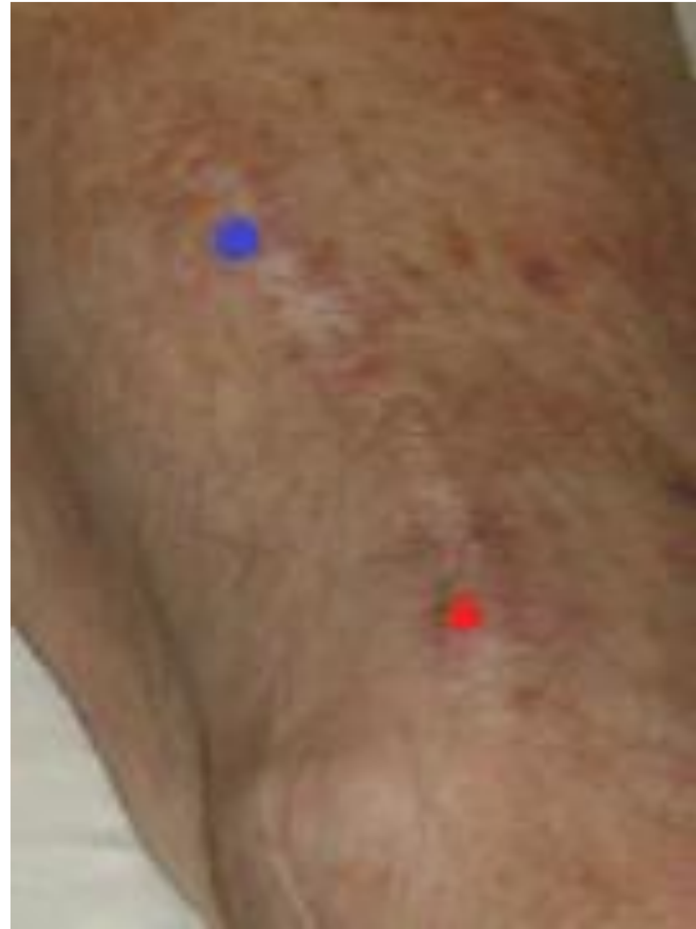
Cannulation

Cannulation

- Good cannulation technique will help preserve the life of the fistula by lowering the incidents of complications
- ALWAYS perform proper site preparation prior to cannulation (wash with soap and water then clean with antiseptic solution, do not palpate area prior to needle insertion)
- There are 2 different strategies for using a needle on a fistula
  1. Ladder Technique: the fistula is "stuck" in a different place along the length of the vessel every time
  2. Buttonhole Technique: the needle "stick" is limited to one site which is used repeatedly

Cannulation





Cannulation

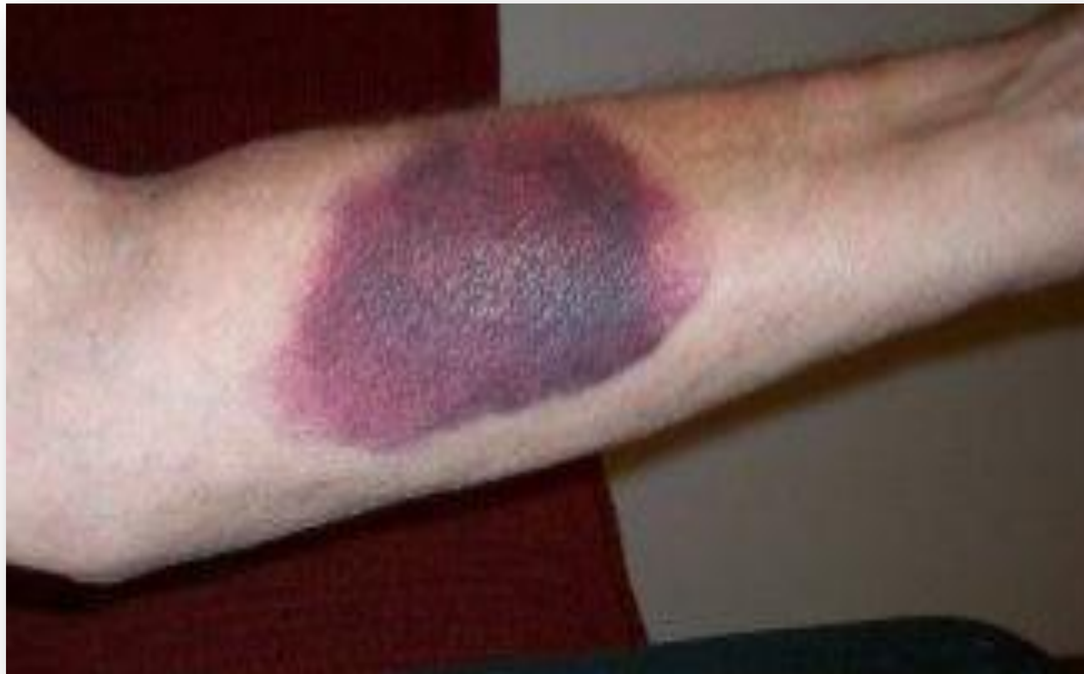
- Dialysis team is the best resource for training proper cannulation techniques and cannulation troubleshooting.
- Patients who have undergone treatments in the past with either dialysis or apheresis may be able to self-cannulate fistula and are a great resource for gauging if there is something wrong with the cannulation

Complications

Failure To Develop

- Nonmaturing outflow vein and early failure
  - Primary nondevelopment of the outflow vein may be secondary to:
    1. Minimal increase in vein size and bruit limited to anastomosis area
    2. Absence of palpable thrill and bruit by auscultation along the outflow vein
  - TREATMENT: surgical revision if possible

Infiltration/Hematoma



Infiltration/Hematoma

- Causes
  - Poor cannulation technique
  - Needles flipped after cannulation (possible tear in vessel was can occur)
  - Poor needle removal technique – pressure on needle while withdrawal of needle causing a possible tear in vessel
  - Stenosis
  - Clotting disorder
  - Clot did not form inside vessel resulting in bleeding into arm

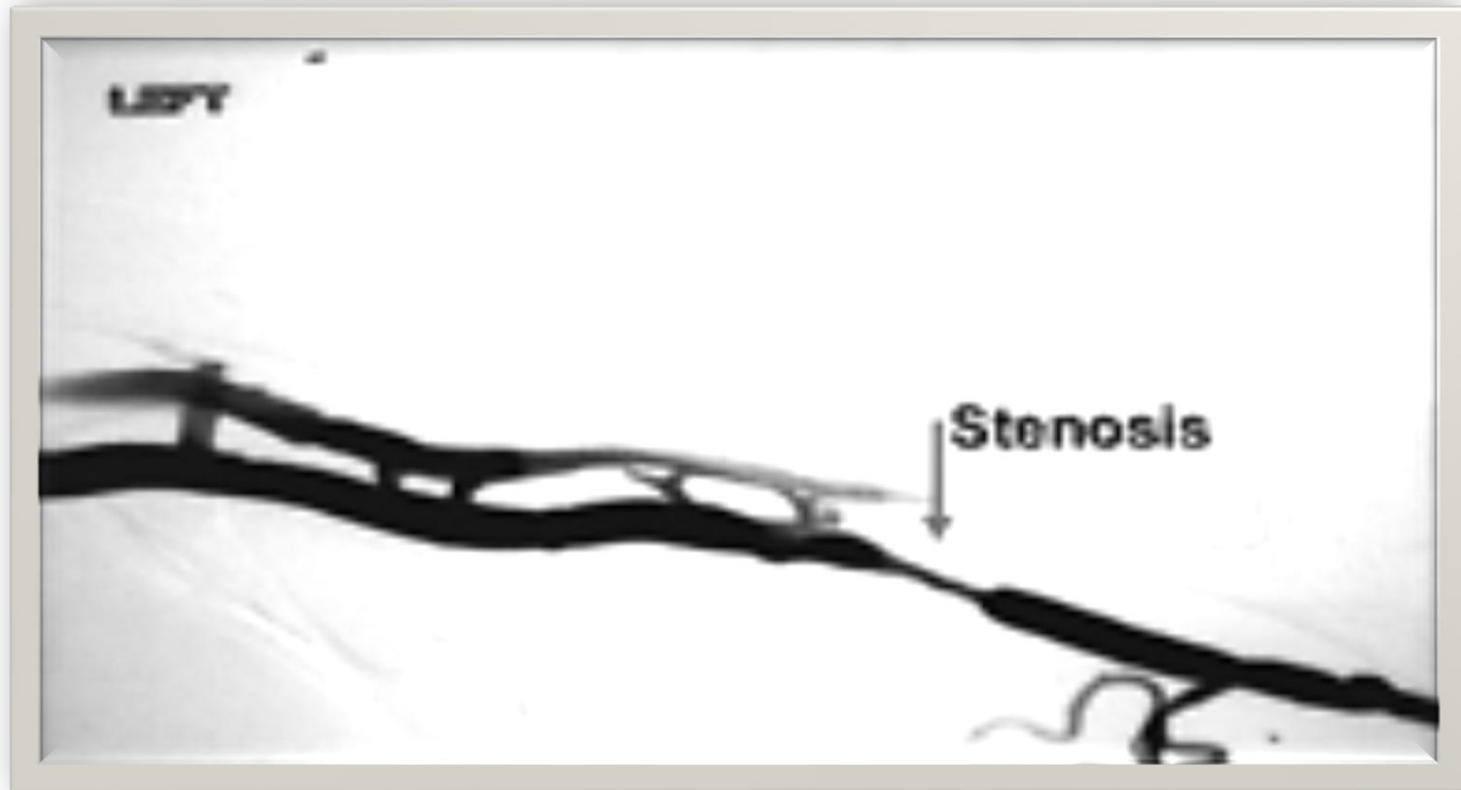
Infiltration/Hematoma

- Treatment
  - Elevate arm above heart
  - Ice 20 minutes on/20 minutes off for 24 hours
  - Warm compresses after 24 hours
  - Let fistula rest
  - Second infiltration: Notify vascular access team – possible intervention needed
  - Don’t use fistula until directed

Infiltration/Hematoma

- Pre Treatment Prevention
  - Do Not flip needle
  - Do Not lift needle while in the vessel
  - Flush needle with normal saline, not blood
- Post Treatment Prevention
  - Apply gauze without pressure when removing needle
  - Remove needle at insertion angle
  - Apply pressure with 2 fingers
  - Hold pressure for at least 10 to 15 minutes

Stenosis



Stenosis

- MOST COMMON COMPLICATION
- Abnormal narrowing of the lumen of the vessel as a result of injury to the vessel causing intimal hyperplasia
- Types:
  - Juxta-anastomotic (most common type of AVF stenosis)
  - Mid-access
  - Outflow
  - Central vessel

Stenosis

- Causes:
  - IV, CVC, PICC lines
  - Surgery to create the fistula
  - Aneurysms creating the backpressure in the vessel
  - Needle-stick injury
  - Continual force of blood rushing through the veins from the fistula which causes formation of scar tissue inside the fistula due to the high blood flow

Stenosis

Symptoms

- Reduction in access flow
- Difficult cannulation
- Painful arm edema (swelling)
- Prolonged bleeding after cannulation and/or after needle removal (due to high venous pressure)
- Sore thumb syndrome: engorgement of thumb veins with sometimes painful throbbing or pulsating of distal veins and edema of thumb that may extend to the entire hand and create cyanotic nail bed
- Swelling of the breast, neck, chest, and face due to increased venous return

Stenosis

- Physical exam for stenosis
  - Perform before patient has needles inserted
- Have patient keep access arm dependent and make a fist
  - Observe fistula for filling
- Have patient slowly raise the access arm
  - The entire AVF should collapse if no stenosis; if entire fistula is not flat, indicative of stenosis
- If a segment of the AVF has not collapsed, stenosis is located at junction between collapsed and noncollapsed segment
- Patient can do this at home

Stenosis

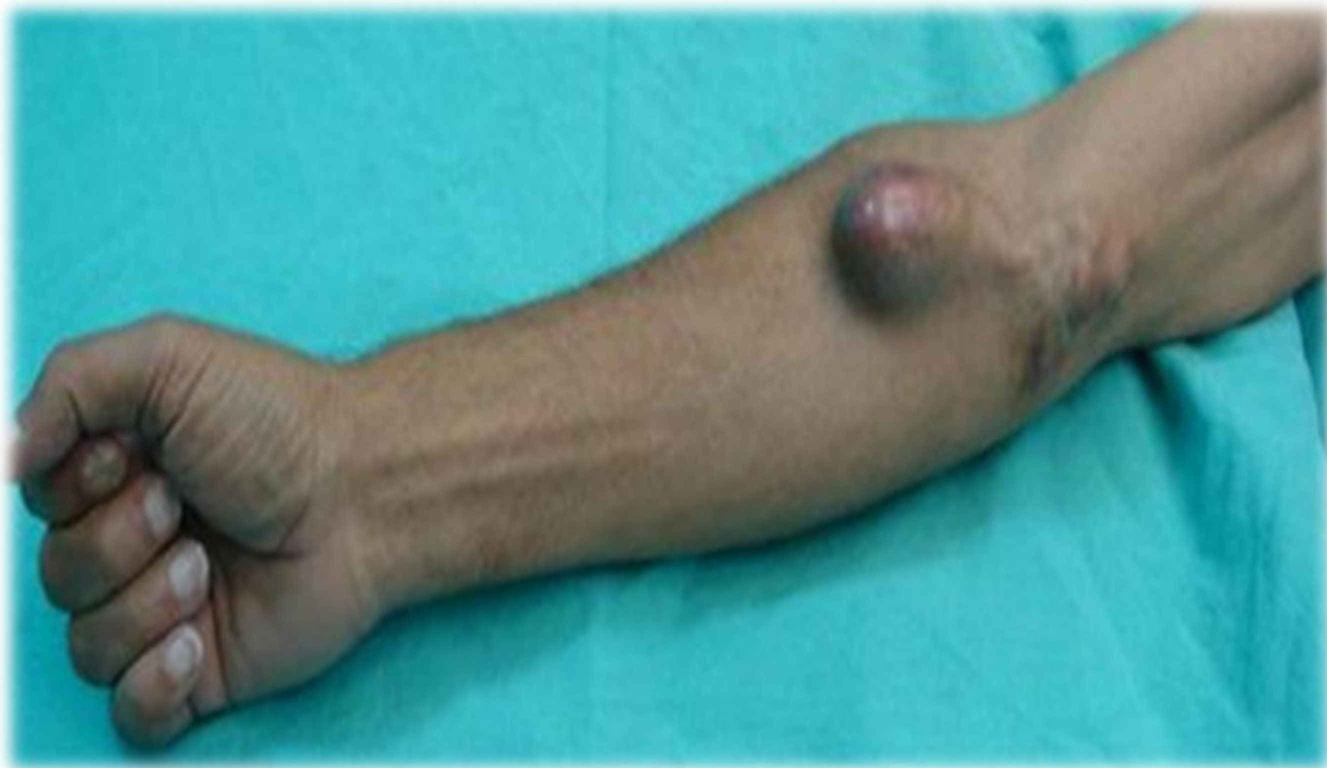
- The following may be performed to visualize the stenosis and help determine the type of intervention needed
  - Doppler ultrasound: measurement and a visual record made of the shift in frequency of a continuous ultrasonic wave proportional to the blood-flow velocity in underlying vessels
  - Fistulogram/venogram: radiograph after infusion of radiopaque substance
  - Angiography: x-ray study of the blood vessels using a radiopaque substance, or dye, to make the blood vessels visible under x-ray

Stenosis

- Intervention can vary depending on the location and severity of the stenosis
  - Percutaneous Transluminal Angioplasty (PTA) is done when >50% stenosis in either the venous outflow or arterial inflow veins in conjunction with clinical or physiological abnormalities
  - Balloon Angioplasty is performed to dilate the narrowed portion of the fistula
  - Ultrahigh pressure or cutting balloons can be utilized for persistent stenosis
  - Stent placement may be performed with recurring stenosis due to vessel wall collapse in spite of ballooning interventions

- **Stenosis should return to within acceptable limits following intervention**

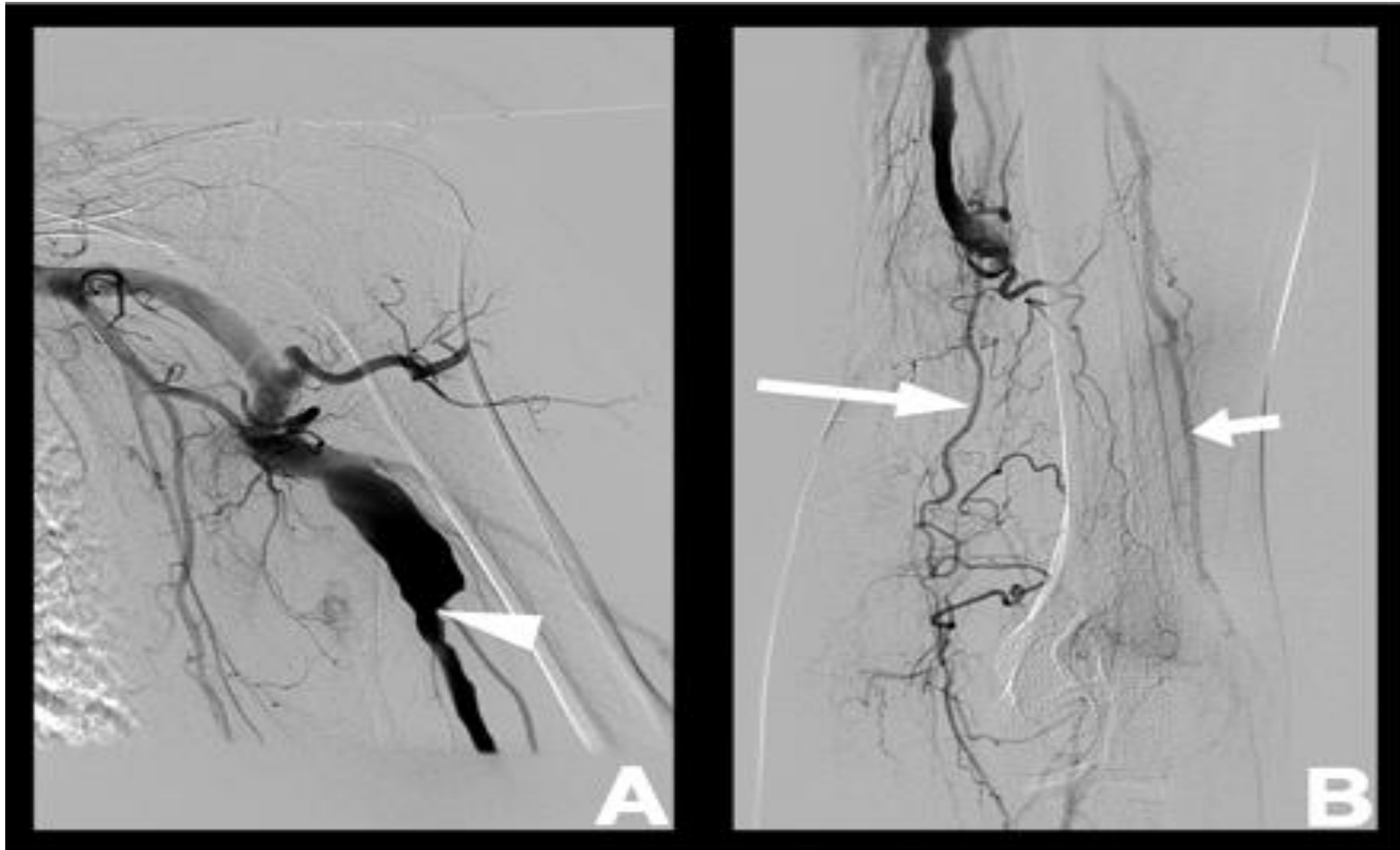
Aneurysm



Aneurysm

- Caused by stenosis as vessel narrowing increases “back pressure,” causing vessel distension and weakening of vessel wall
  - May also be caused or aggravated by frequent cannulations in the same area
- DO NOT CANNULATE THE ANEURYSM

Thrombosis



Thrombosis

- Causes
  - Premature use
  - Poor blood flow
    - Prolonged occlusive compression of access vessel vein (anything that leaves an impression or is too tight)
  - Hypotension
  - Hypercoagulable states
  - Stenosis of outflow vein without collateral circulation and/or significant hypotension

Thrombosis

- Signs and symptoms
  - Absence of thrill and bruit along the vessel despite possible pulse in the artery at the inflow anastomosis
  - Changes in quality of bruit
  - Pulsation rather than thrill
  - Difficulty cannulating or pain with cannulation
  - Evacuation of clots even with proper needle insertion
  - Significant decrease in access flow intra-procedure

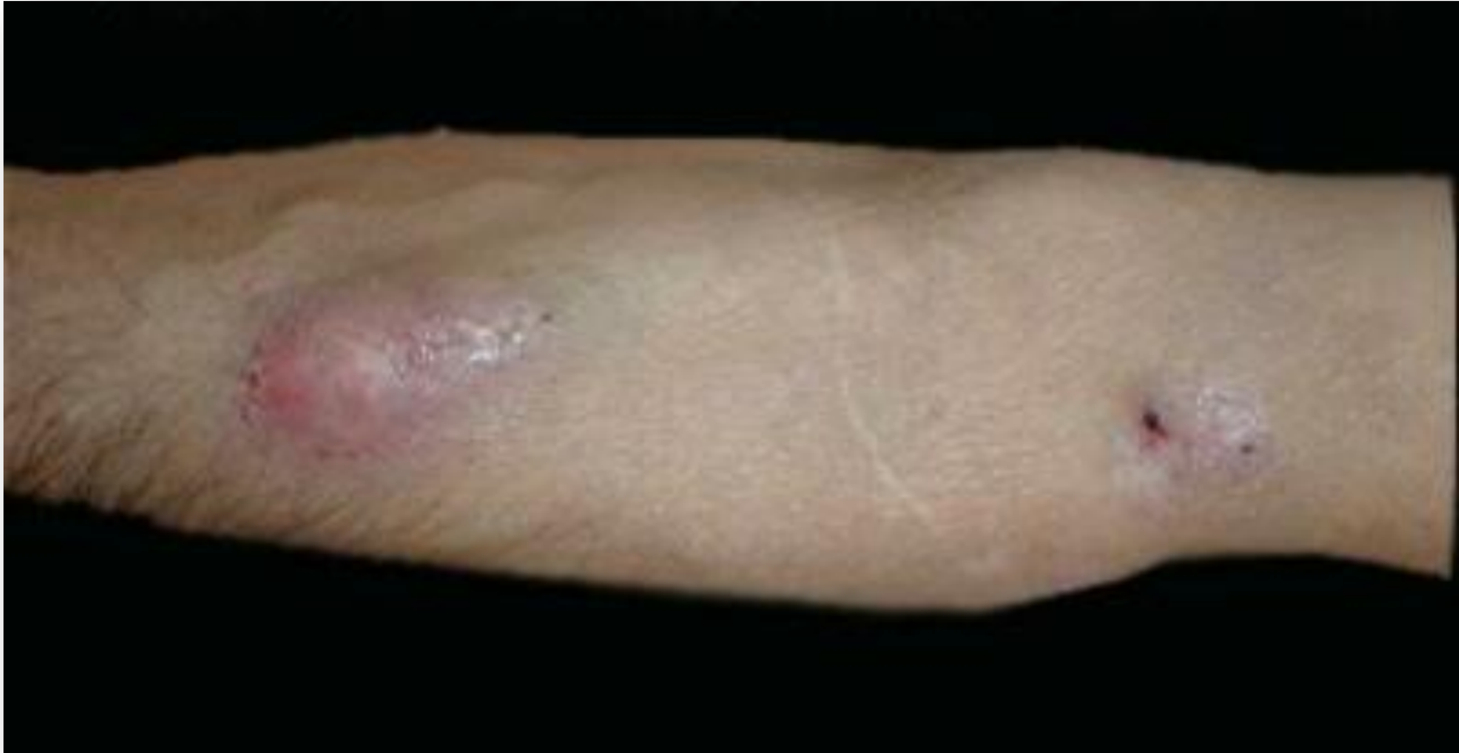
Thrombosis

- Treatment
  - Urgent referral to interventionalist or surgeon to:
    1. Detect and treat stenosis to prevent thrombosis
    2. Perform thrombectomy by lysing with thrombolytic such as tPA (tissue plasminogen activator) to soften or resolve the clot
  - Intraprocedural pressure monitoring to assure normal flows

Thrombosis

- Treatment cont.
  - Anticoagulation (i.e. aspirin) for proven hypercoagulable states
  - Patient and staff education about prevention of:
    1. Prolonged occlusive pressure when removing needles
    2. Hypovolemic hypotension

Infection



Infection

- Fistulas have the lowest risk of infection of <u>any</u> vascular access, however…
- Causes
  - Poor patient hygiene
  - Inadequate skin cleansing prior to cannulation
  - Aseptic technique not used for cannulation
  - Seeding from another infected site in the body

Infection

- Pre and post treatment exam should include checking for signs/symptoms of infection, including
  - Inflammation/redness
  - Pain or tenderness
  - Increase in skin temperature in affected area
  - Swelling, hardness
  - Skin breakdown with drainage along the vessel esp. needle sites
- Patient complaints without other indications of
  - Malaise
  - Fever

Infection

- Intervention and treatment
  - Treat as a subacute bacterial endocarditis
  - Antibiotic therapy is a must, broad-spectrum vancomycin plus an aminoglycoside when initiated
  - Based on results of culture and sensitivities, conversion to the appropriate antibiotic is indicated
  - Infections of primary AVFs should be treated for a total of 6 weeks
  - Fistula surgical excision should be performed in cases of septic emboli which could result in removal of affected portion or <u>all</u> of the vessel
  - Unless the treatment is EXTREMELY urgent, alternate form of vascular assess may be necessary to complete treatments as infected fistulas cannot be accessed unless by order of the physician

Steal Syndrome/Ischemia

- Steal syndrome is a constellation of symptoms related to ischemia (inadequate blood supply to the hand) caused by the AVF "stealing" blood away from the extremity
- Steal syndrome causes hypoxia (lack of oxygen) to the tissues of the hand, resulting in severe pain and identified by nail bed discoloration, a cool hand, and a weak or absent pulse
- Neurological and soft tissue damage to the hand can occur, resulting in mobility limitations (eg, grip strength, dexterity), loss of function, ulcerations, necrosis
- Steal syndrome/ischemia is estimated to occur in approximately 5% of vascular access patients, mostly those with diabetes and peripheral vascular disease (PVD)

Steal Syndrome/Ischemia

- Symptoms may improve due to the development of collateral circulation
- Procedures, such as the DRIL (distal revascularization-interval ligation), can successfully treat steal syndrome and ischemia
- Individuals who are at high risk for developing acute steal syndrome are:
  - Patients with diabetic neuropathy
  - Patients with PVD

Steal Syndrome/Ischemia

- Refer to surgeon immediately if symptoms are recognized to help prevent potential loss of function and amputation
- Necrotic tissue cannot be "fixed"—it must be removed
- Steal syndrome/ischemia places patients at risk for infection and possible hospitalization

High Output Cardiac Failure

- This is seen in AVF and progresses with the maturation of the fistula
- Cause
  - Creation or development of an fistula that shunts more blood through the vessel to the detriment of the peripheral circulation
    - Can be aggravated by preexisting anemia and/or cardiovascular disease
    - Can include the development of left ventricular hypertrophy, high output cardiac failure, exacerbation of coronary ischemia and possible central vein stenosis

High Output Cardiac Failure

- Signs and Symptoms
  - Tachycardia
  - Shortness of breath
  - Pulmonary crackles
  - Cyanosis of lips and nail beds
  - Pulmonary edema
  - Peripheral edema
  - Jugular vein distention
  - Confusion
- Treatment
  - Surgical reduction of flow with a banding or surgical ligation
  - Correct the anemia
  - Review cardiac pharmacology
  - Symptom reduction
  - Elastic bandage wrapped around the fistula and outflow vein to reduce cardiac output of the fistula
    - Requires physician order and index finger MUST be able to comfortably slide under bandage

Summary

- Appropriate and timely interventions may result in an increased duration and/or survival of the fistula
- Problems developing in the early period after AVF construction (first 6 months) should be promptly addressed
- Ensure early detection of access dysfunction, particularly delays in maturation can be performed
  - The patient should be evaluated no later than 6 weeks after access placement

Summary

- Persistent swelling of the hand or arm should be expeditiously evaluated and the underlying pathology should be corrected
- Intervention on a fistula should be performed for the presence of
  - Inadequate flow
  - Hemodynamically significant venous stenosis
- Stenosis, as well as the clinical parameters used to detect it, should return to within acceptable limits following intervention

Summary

- Thrombectomy of a fistula should be attempted as early as possible after thrombosis is detected
- DO NOT cannulate an aneurysm
- Patients with findings of ischemia should be referred to a vascular surgeon emergently
- Infection of primary AVFs are rare and should be treated as subacute bacterial endocarditis with 6 weeks of antibiotic therapy
  - Fistula surgical excision should be performed in cases of septic emboli

Summary

- DOCUMENT, DOCUMENT, DOCUMENT
  - All assessments (subjective and objective)
  - All access attempts and technique used
  - Any changes in appearance or treatment related issues
  - All Interventions and troubleshooting
- Your dialysis team is your friend
  - Consult/refer to them for questions, training, etc.

For More Information

- **National Kidney Foundation**
  30 East 33rd Street
  New York, NY 10016
  Phone: 1-800-622-9010
  www.kidney.org

- **American Association of Kidney Patients**
  3505 East Frontage Road, Suite 315
  Tampa FL 33607
  Phone: 1-800-749-2257
  www.aakp.org

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