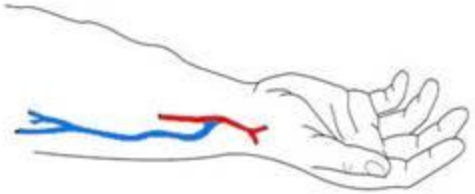
Haemodialysis Access

- Arteriovenous fistula

  動靜脈廔管

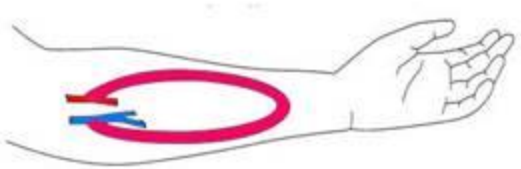
  Artery to Superficial vein



- Arteriovenous graft

  人工血管通路

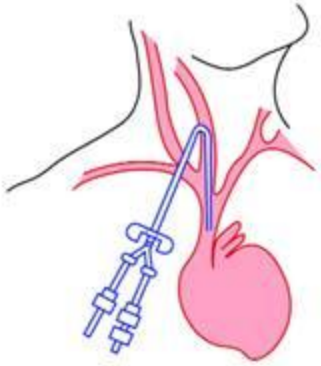
  Artery to graft to vein



- Perm-catheter

  中樞靜脈插管

  Catheter to central vein



Pre-op Ultrasound Evaluation

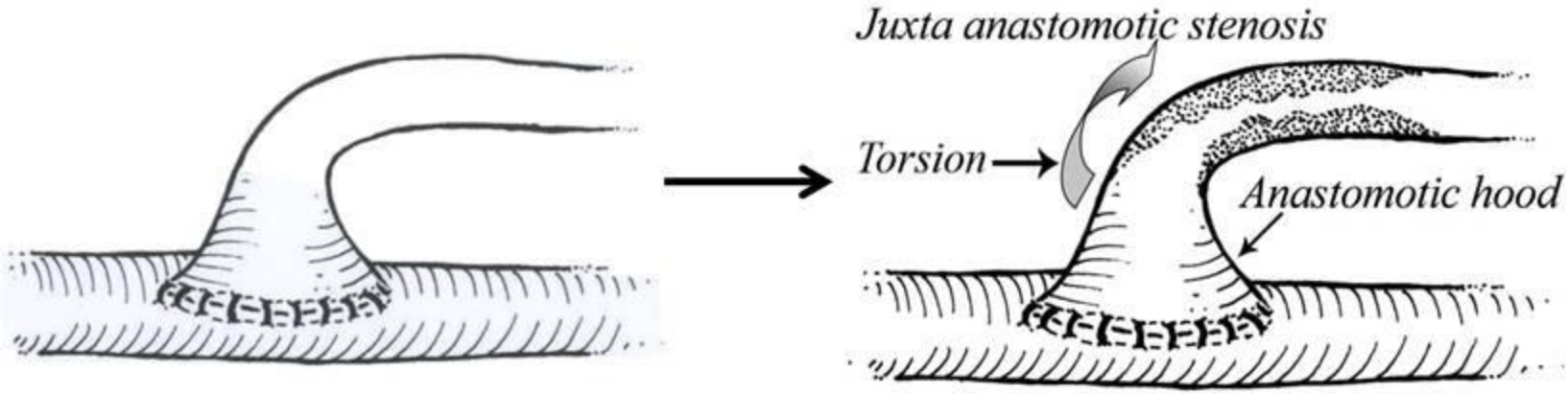
I. Guesswork: Connecting visible superficial vein to palpable artery

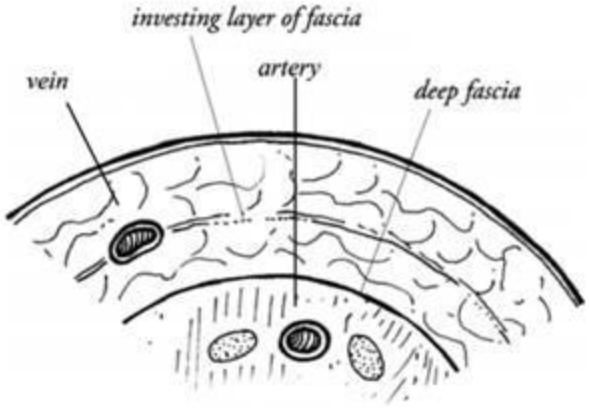
II. Educated guesswork: Ultrasound by surgeon to construct a detail picture of arterial & venous anatomy, to answer:

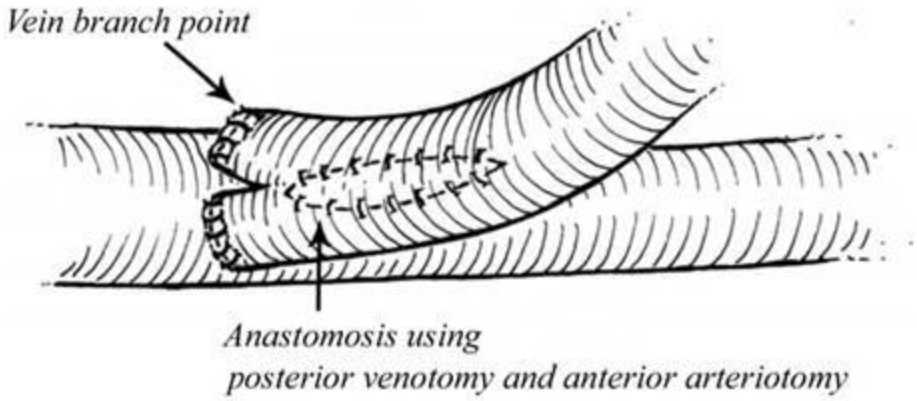
1. Feasibility of AVF
2. Choose the best arm
3. Choose the best site along the arm
4. Predict maturation
5. If chance of success of AVF is too low USG, help to locate venous outflow for AV graft

- Vein
  - Identify vein obscured by subcutaneous fat
  - Select venous conduits
    - Follow the course proximally to the desired level
    - Diameter > 2.5mm
    - Usable length >10cm
    - Depth from surface < 5mm
    - Healthy wall, resilient, not thicken
    - Compressible i.e. no thrombosis
    - No subtle narrowing & segmental stricture
    - No large branches diverting blood from main channel:
      - Large accessory tributaries >50% of main channel diameter
      - Large perforating vein close to AV anastomosis divert blood to deep vein
- Inflow artery
    - Diameter > 2mm
    - Calcification
    - Stenosis

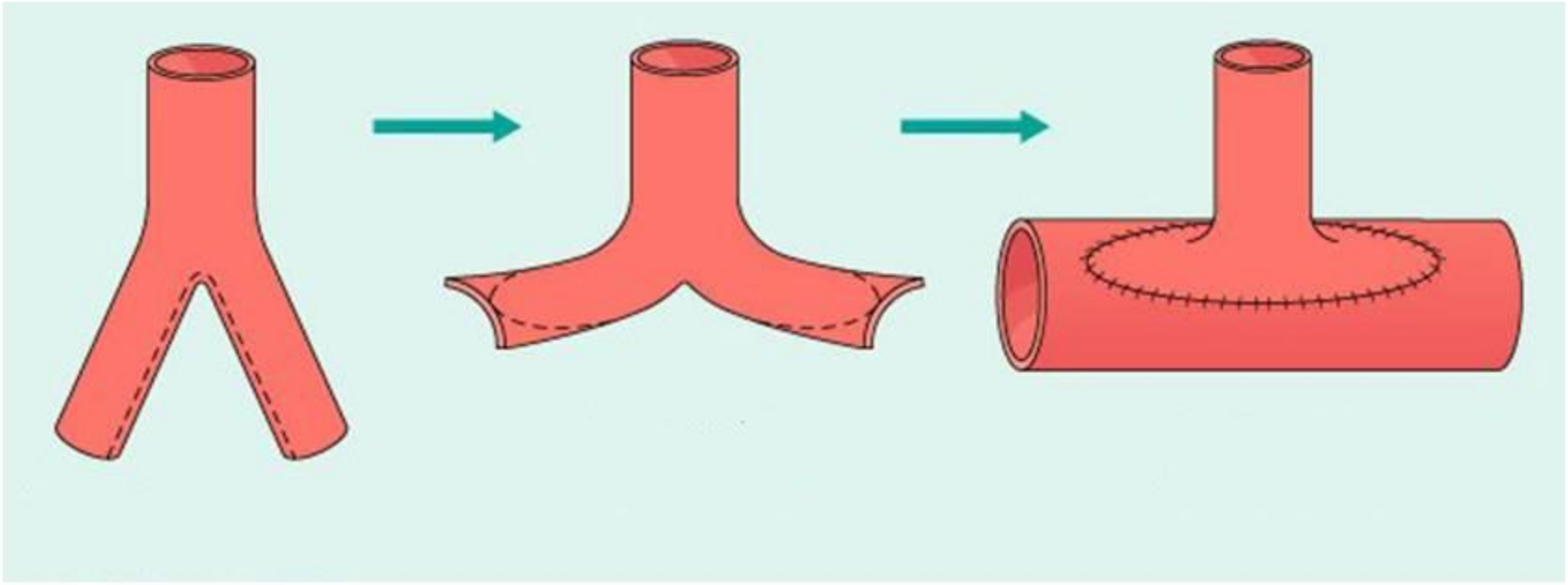
Anastomosis: technique to avoid torsion subsequent Juxta anastomotic stenosis





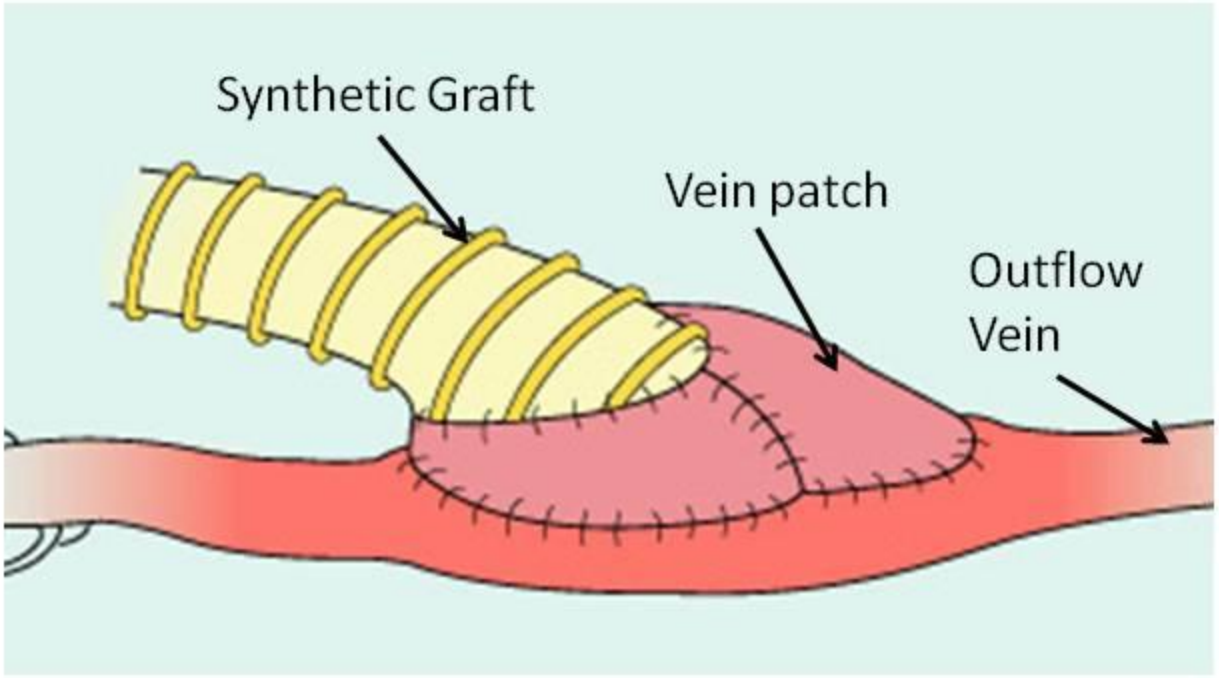


Anastomosis: technique to avoid narrowing of the arterial inflow



Side tributary of the vein is used to create a patchlike anastomosis

Anastomosis: technique to avoid venous outflow narrowing in AVG



Boot shaped vein cuff to adapt the large size discrepancy between the graft and the outflow vein

Distal Wrist (Cimino) AVF

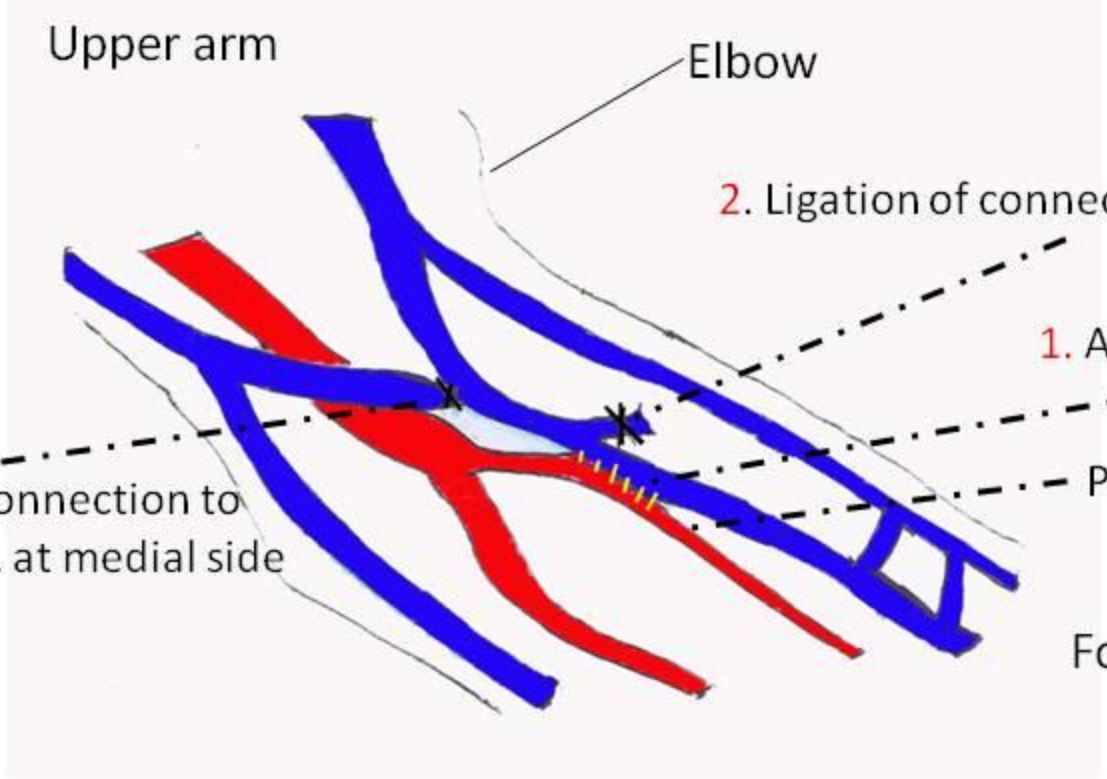
- Only about 30% of AVF in my practice
- Need acceptable inflow and outflow at the wrist
- Limitation: poor quality veins that have been damaged by repeated punctures

Low forearm AVF

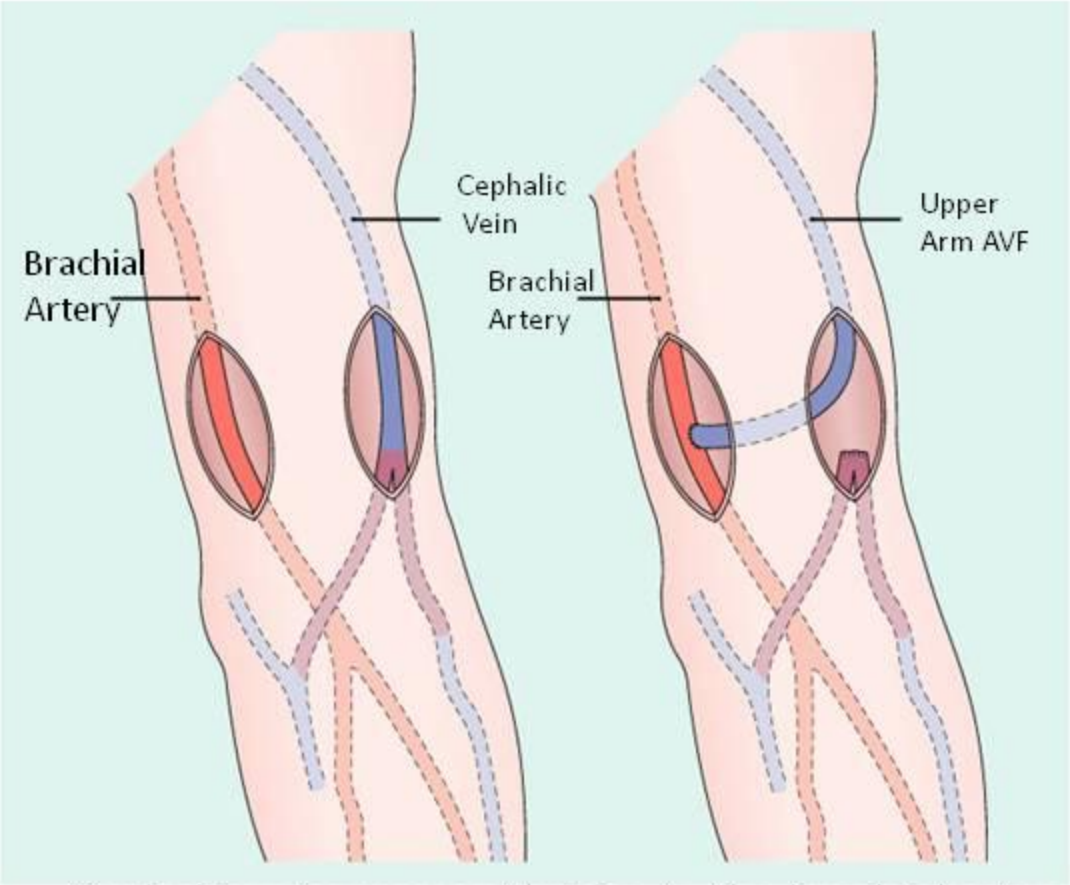
- Usually 7 to 10 cm above the wrist
- USG is used to locate the artery and vein
- Advantages
  - Radial artery is larger, provides better inflow
  - Cephalic vein is larger
- Disadvantage:
  - Shorter length for cannulation
  - Vein and artery not in close proximity and require mobilization
  - Anastomosis necessitates meticulous technique to avoid torsion of the vein during mobilization

Proximal radial artery AVF

- No suitable superficial vein at distal forearm
- DM, long-standing renal failure, arterial calcification prevent adaptation and therefore more proximal inflow for fistula
- Larger proximal radial artery use as inflow
- Perforating vein ligation or use for anastomosis



Brachial-cephalic AVF

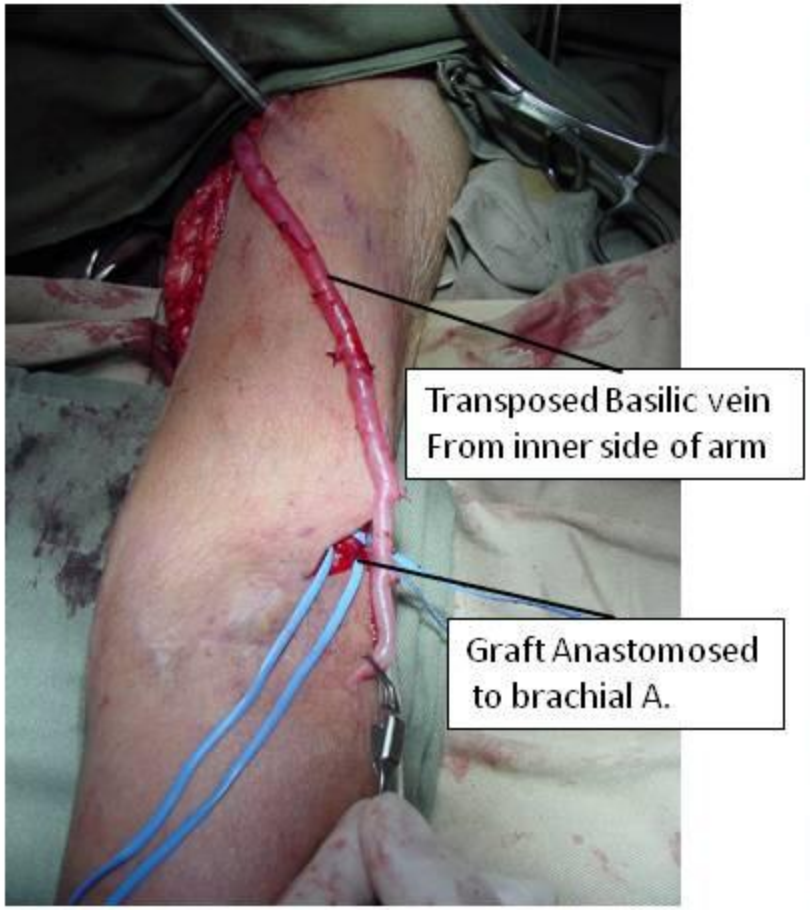


- Cephalic veins may not bridge to the brachial artery
- Need mobilisation with risk of torsion of the outflow vein
- AVF deep and too mobile in obese patient
- Risk of steal: upto 25% develop hand ischaemia in 1 yr. and 10% require treatment
- Limit anastomosis to 4 mm to avoid vascular steal from a high-flow fistula

Basilic Vein Transposition: One / Two stages

One stage for vein > 4mm
Two stage for small veins to avoid unnecessary morbid dissection in those fistulae that do not mature

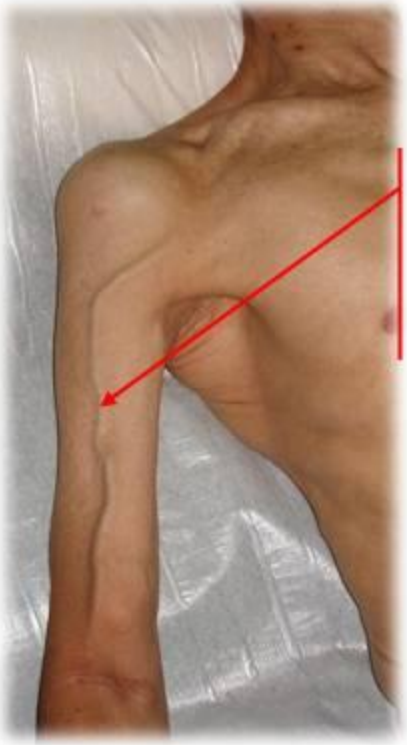
Hybride AV Graft and Vein



Matured AVF

"The Rule of 6s," ie, 600 mL/min blood flow, >6 mm diameter, and <6 mm deep" Straight length of 10 to 15cm

Forearm AVF
Radiocephalic
前臂動靜脈廔管



Upper-arm AVF
Brachiocephalic
上臂動靜脈廔管

Fail to use

Fail to mature

- 30% - 40% of radiocephalic AVF
- 10% - 20% of upper arm AVF

Cause of failure to mature

- Feeding artery stenosis
- Juxta-anastomotic stenosis
- Outflow / central vein stenosis
- Unhealthy vein
  - Thicken
  - Segmental stenosis
- Large calibre accessory veins
- Large perforating vein divert blood to deep vein

Fail to cannulate

- Obesity
- Deep and tortuous vein
- Short cannulation route
- Unfavourable location

Enhance maturation

1. Balloon / Patch angioplasty of inflow artery
2. Balloon / Patch angioplasty of anastomosis
3. Interposition / jump graft
4. Proximal re-anastomosis, larger vein and larger artery
5. Accessory vein ligation

- Preserve proximal venous collateral, needed if primary channel fails
- If flow is later found to prevent adequate flow through primary AVF
- Ultrasound localisation of the tributaries
- Local anaesthesia, small stab incisions and ligation of the tributaries
  - Large accessory vein (i.e. >50% of main vein diameter) divert flow from main channel AVF
  - Large perforating vein close to AV anastomosis divert blood to deep vein

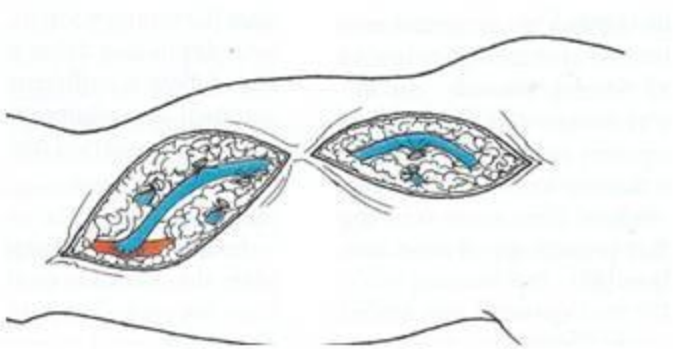
Enhance cannulation

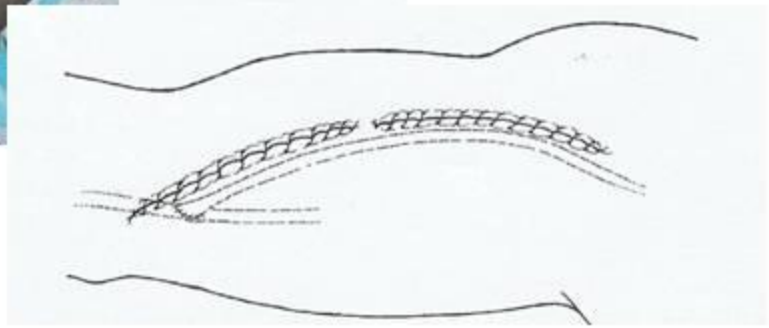
- Superficialisation
- Transposition
- Button-hole technique

Enhance cannulation- Superficialisation

- Superficialisation for well matured AVF but
  - Too deep
  - Too mobile to cannulate
- Performed 4-8 weeks after creation to ensured only matured fistula has the second operation
- The fistula is mobilised, tributaries ligated and cut
- Subcut. fat approximate beneath the fistula
- Skin closed over the fistula, superficialize the vein under the wound

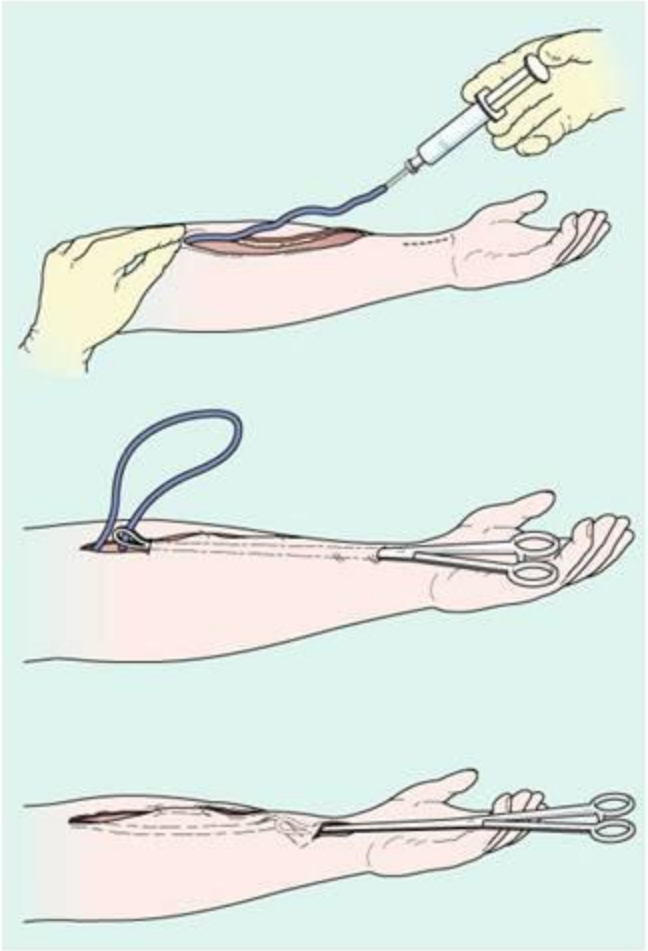
Superficialisation





Enhance cannulation- Vein transposition

- Two-staged operation
- First stage – creation of AVF and wait for maturation
- Vein dissected and transected 2cm from the AV anastomosis
- Vein tunneled to a favorable subcutaneous position
- Reanastomosis to the vein stump



ArterioVenous Graft (AVG)

Arteriovenous fistula

- First choice but not a panacea
- Upto 1/3 of AVF never mature, resulting in further procedure

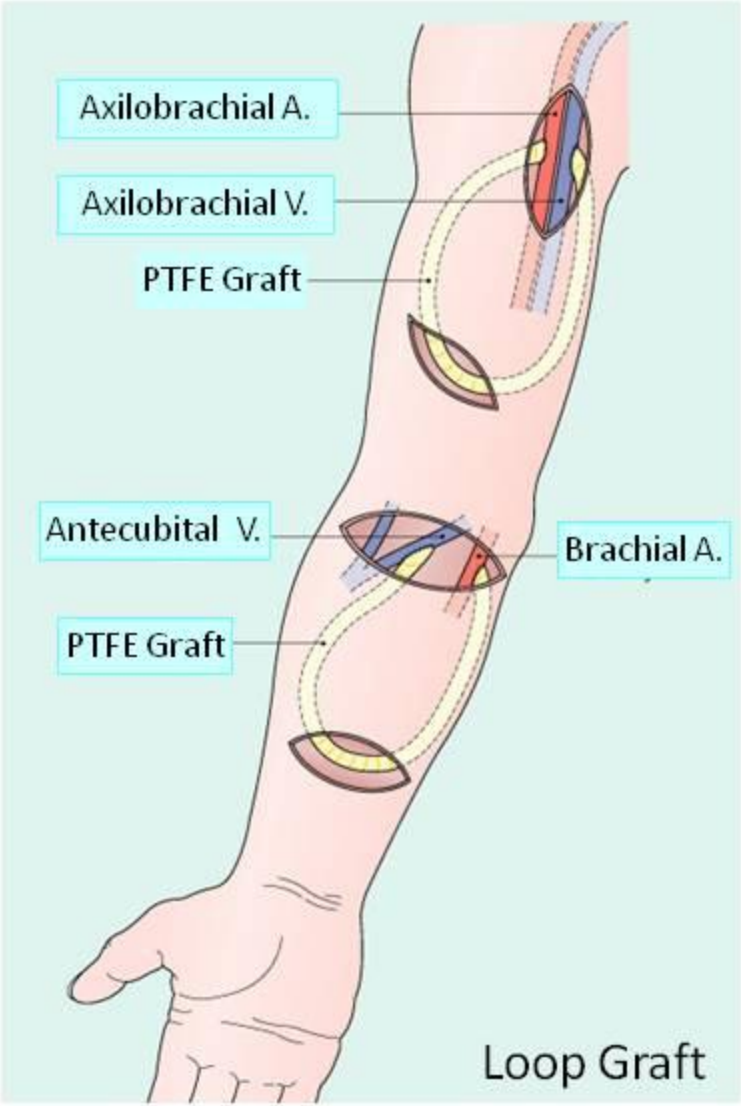
Advantages of arteriovenous Grafts

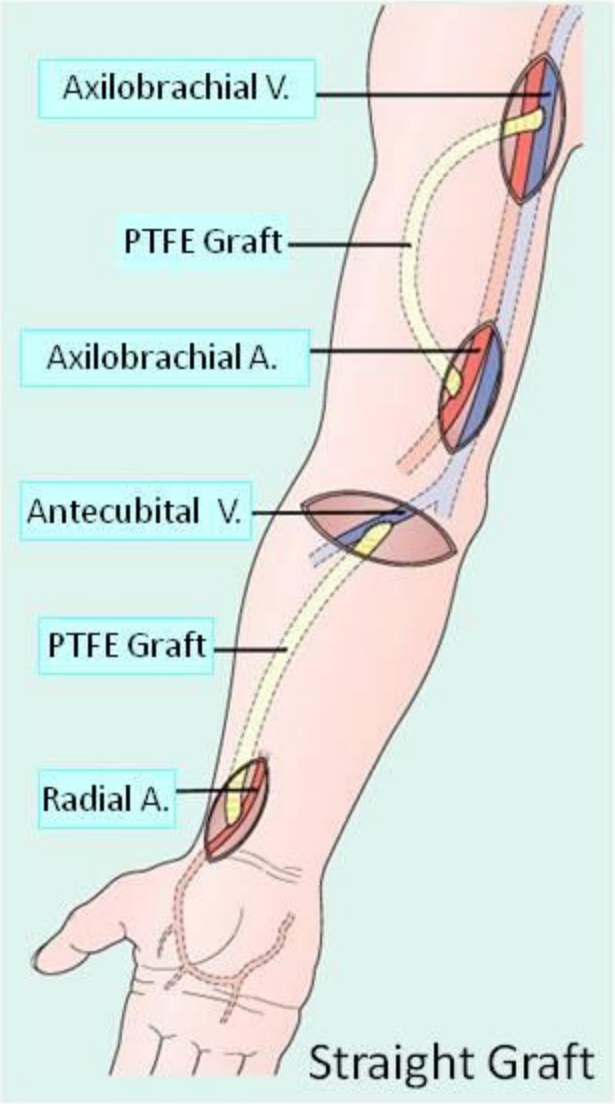
- Good length for cannulation
- Technically easy to cannulate
- Short lag-time from insertion to maturation (cannulate in 48 hr)
- Easy for the surgeon to handle, implant, and construct the vascular anastomoses

Disadvantage of arteriovenous Grafts

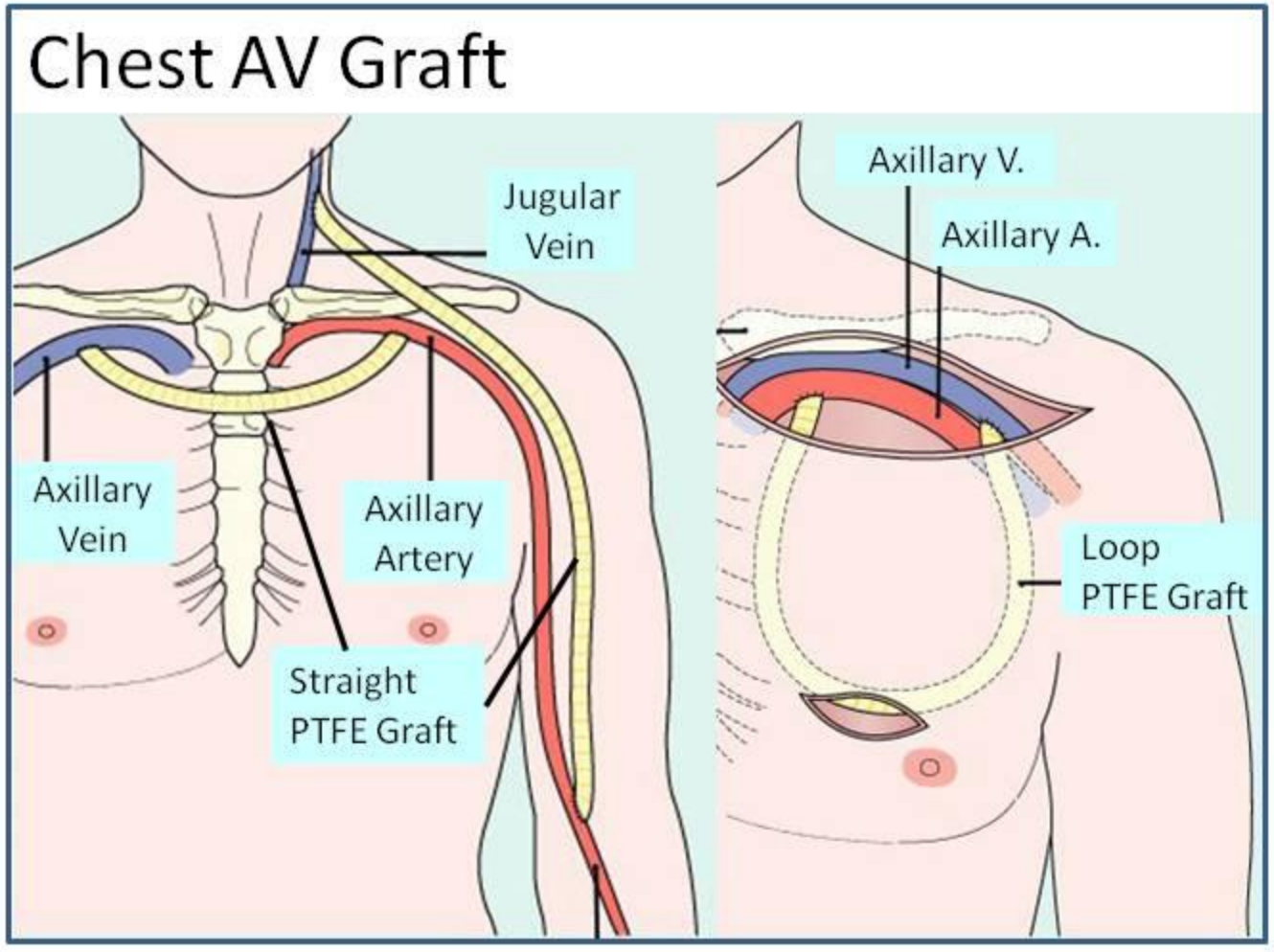
- Grafts have 8 time higher risk of complications and need for additional procedures than AVF

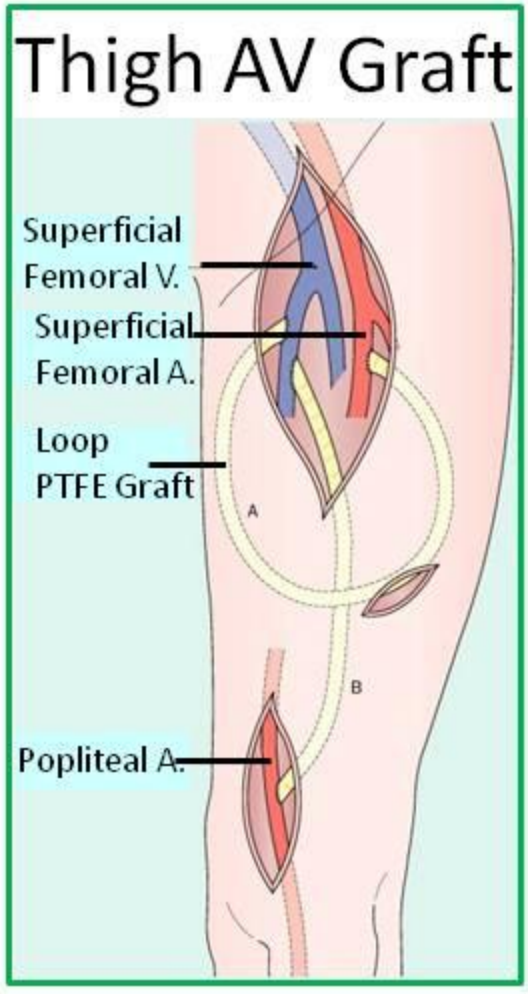
Upper arm AV Graft





AV Graft at other site





Complication AV Access

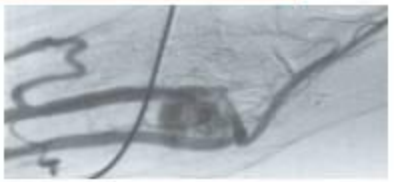
- Aneurysm
- Venous hypertension
- Steal
- Cardiac failure
- Infection
- Thrombosis

Aneurysm (localised dilatation)

AVF

1. AVF Vein aneurysm

2. AVF pseudoaneurysm



3. AVF anastomotic aneurysm

AVG

1. AVG pseudoaneurysm

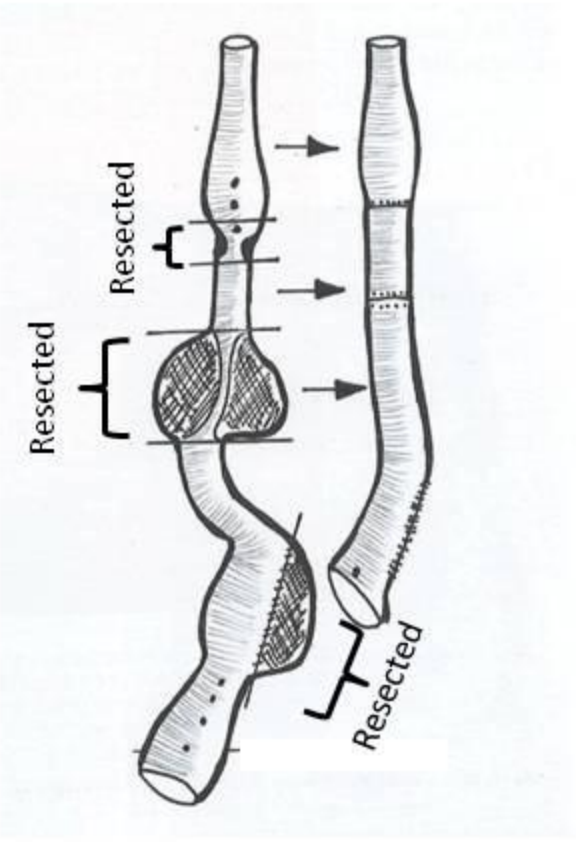
2. Infected Pseudoaneurysm

AVF Aneurysm:

1. Partial resection of aneurysm
2. Patch repair of the associated stenosis with the resected material

AVF Vein Aneurysm

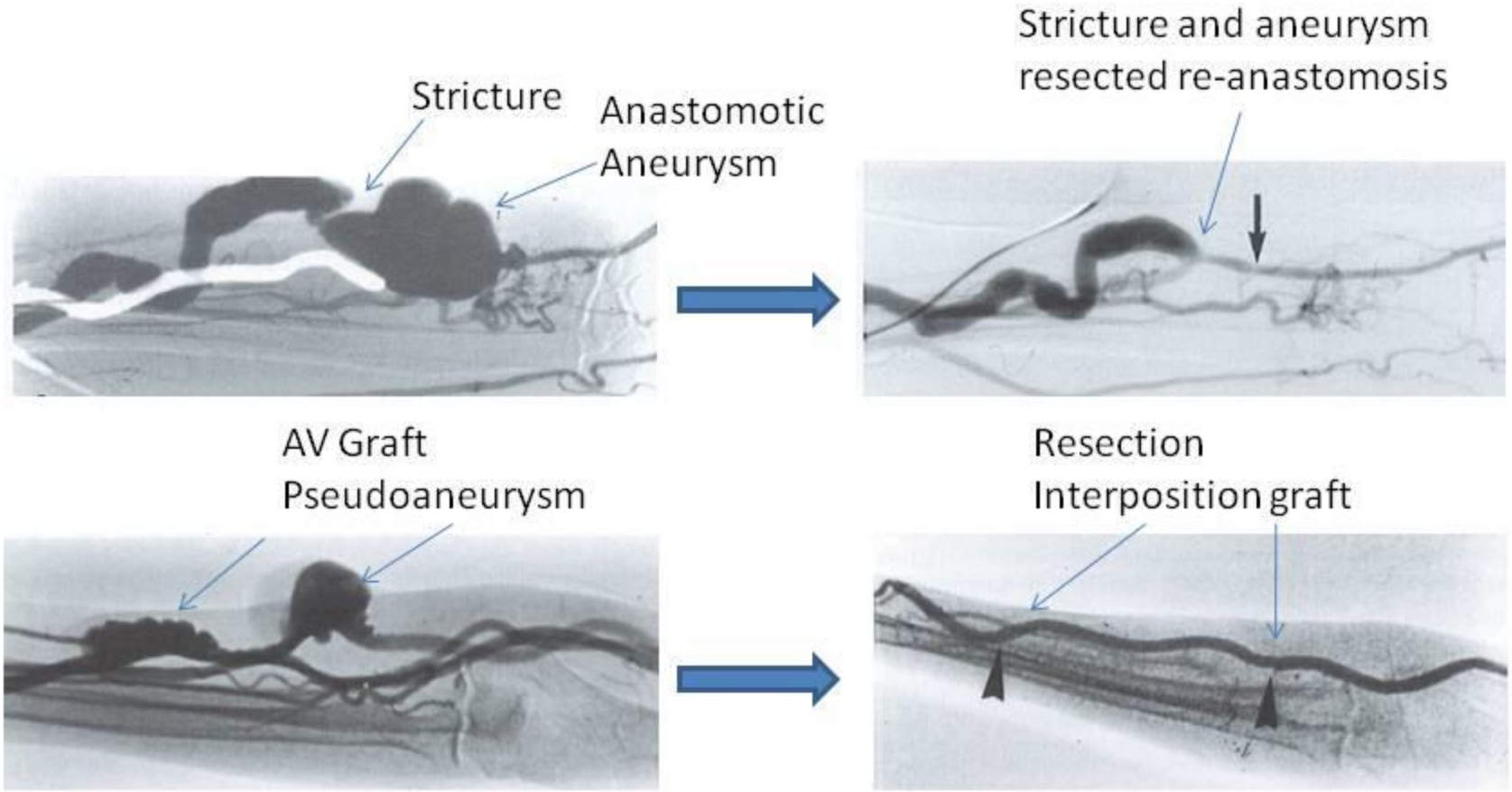
- Segmental resection of stenosed and dilated segments
- End to end anastomosis after stretching of the elongated remaining vein
- In multiple aneurysm, stage procedure to avoid the use of catheter.



AVF Vein aneurysm

Patch repair with adjacent vein

Repair of Aneurysm



Venous Hypertension

Causes

- Central Vein stenosis or occlusion — Jugular V for catheter placement
- Side to side AV anastomosis — End to side anastomosis
- Valvular incompetence in outflow vein

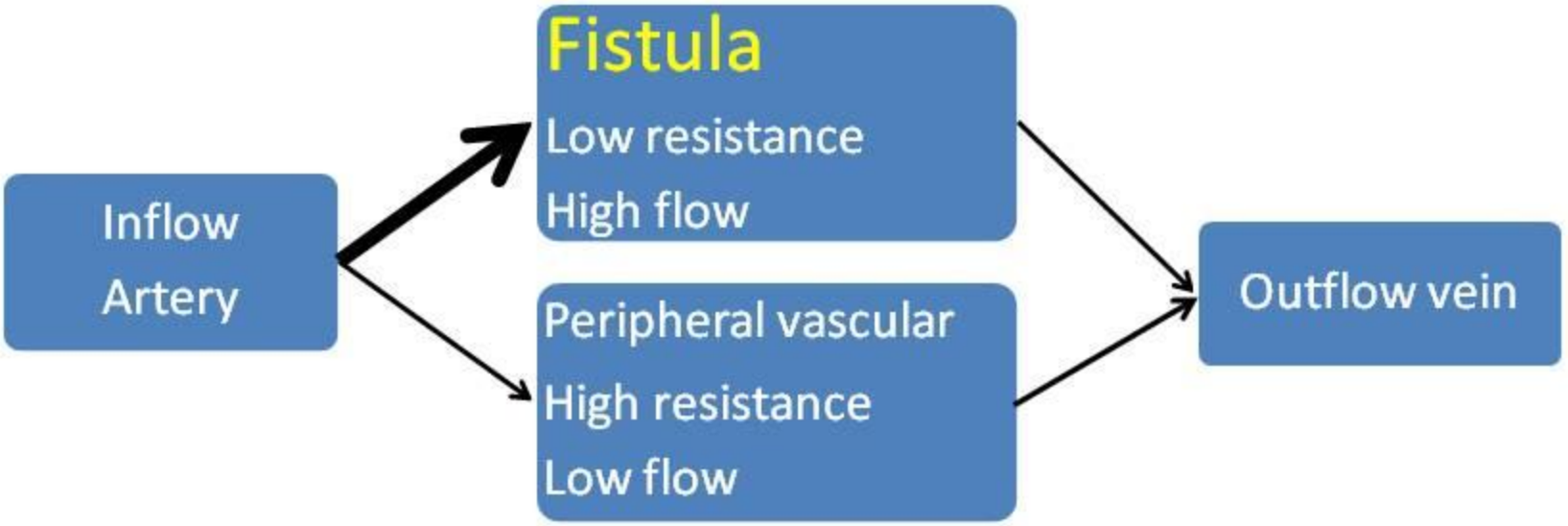
Sign and Symptom

- Distal swelling
- Discolouration of skin
- Ulceration

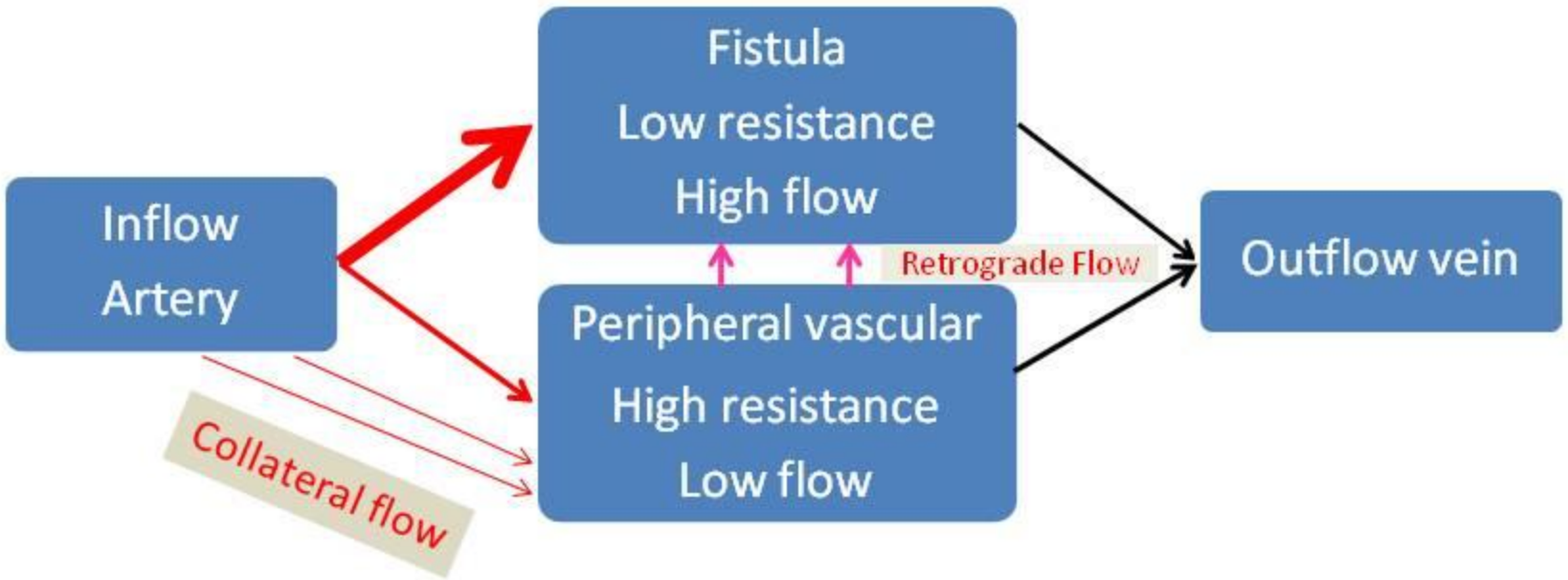
Treatment of obstruction

- Central venous Stenosis
  - Percutaneous angioplasty not durable; 25% at 6 months
  - Angioplasty + stenting 44% need access ligation during FU
  - Recurrent stenosis is the rule rather than the exception
- Occlusion: surgical bypass; axillary to jugular PTFE bypass
- Access ligation and replace at other limb
- Lower limb AV Graft

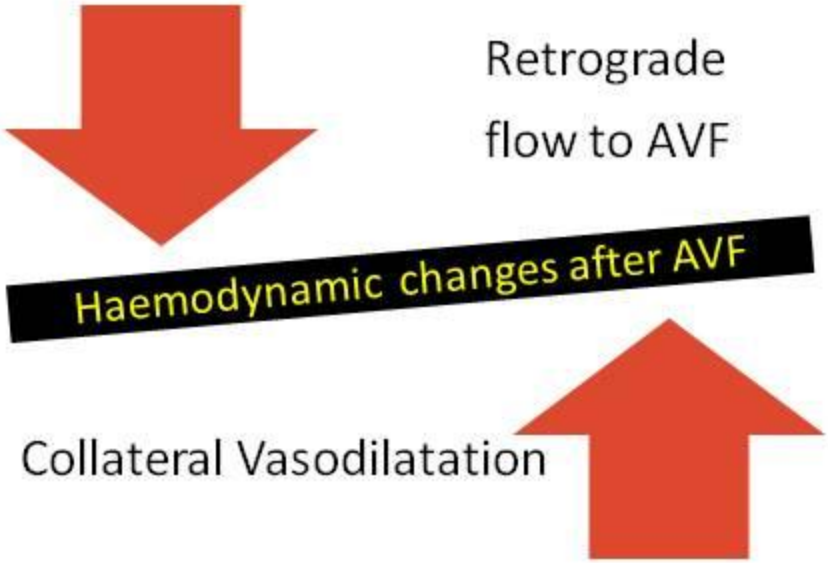
Flow associated with AV access creation

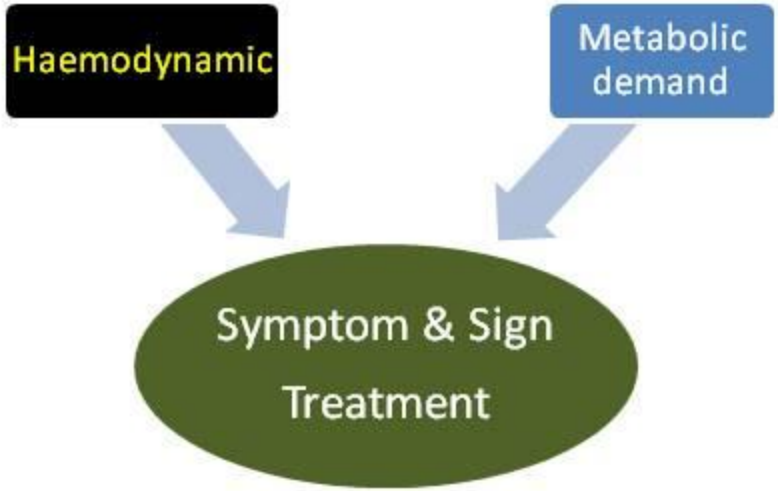


Haemodynamic changes after AV access creation



Changes after AVF creation





Vascular steal: Prevalence

- Physiologic steal
  - 75% of AVF 90% AV graft
- Symptomatic steal with pain or parasthesias
  - 10% to 20%
- Require intervention
  - 4% of AV Access
  - 1% of distal forearm AVF
  - 3% to 6% of AVF or AVG from Brachial artery
- Predicting steal remains difficult
- Risk:
  - Patients with diabetes
  - Arterial occlusive disease,
  - Multiple access procedures
  - Constructions based on proximal arteries are more

Vascular steal: Diagnosis

- Mild symptom
  - Hand coolness, Pallor
  - Mild Paresthesias
  - Paresthesias or Pain during HD
- Severe symptom
  - Rest pain
  - Cyanosis
  - Severe paresthesias
  - Hand weakness
  - Tissue necrosis, ulcer, gangrene
  - Parathesias during HD
- Sign
  - Delay capillary refill
  - Absence of radial pulse
  - Compression of the fistula; relief of symptom and return of radial pulse

Treatment for vascular steal

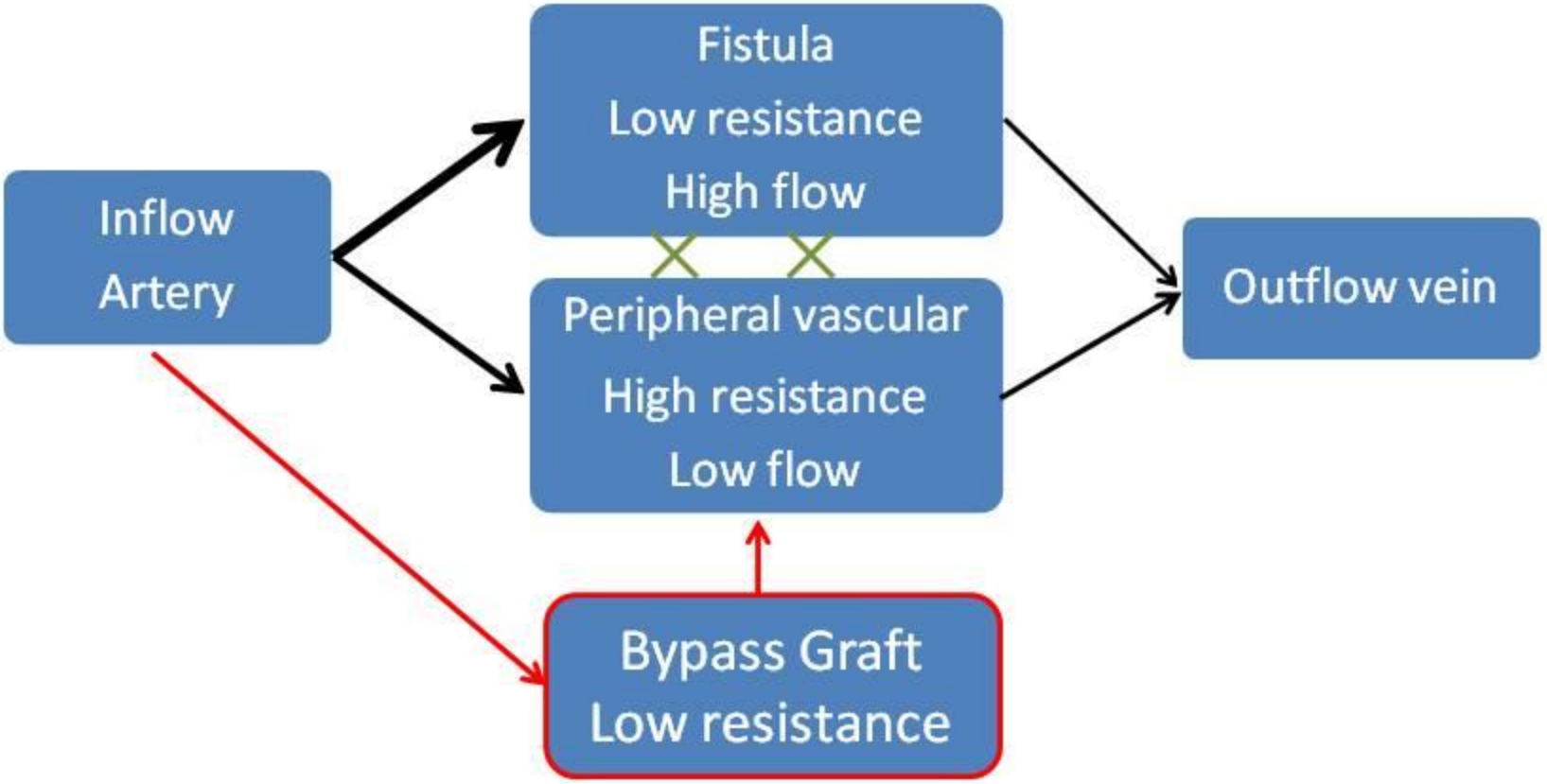
- Tests:
  - Duplex: retrograde flow to the access, antegrade with access compression
  - Augmentation of digital pressure and pulse volume with access compression
- Conservative: Mild symptom develop acutely after AV creation
  - Peripheral dilatation
  - Develop collateral
  - Resolve after several weeks
- Transient symptom during HD: Drop in systemic pressure, reduce perfusion
  - Withhold Anti-HT before HD
  - Limit rapidity of Vol removal
- Surgery
  - Severe symptom
  - Limb threatening complication
  - Most late developing steal

Treatment for vascular steal

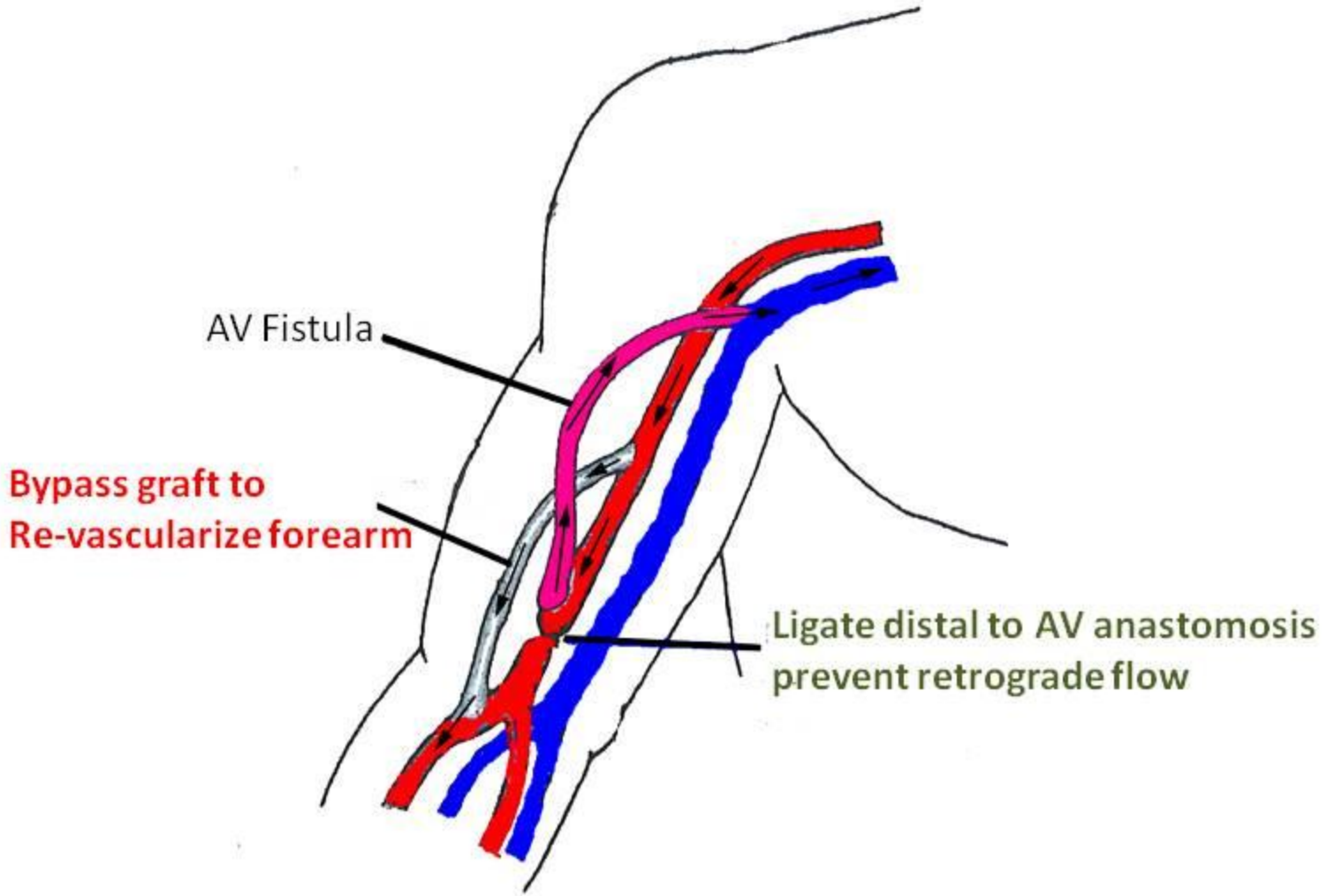
- Prevention:
  - Limit the size of the arteriotomy to < 4mm
  - Use of tapered graft
- Treatment:
  - Inflow artery occlusive disease, treated with angioplasty
  - Distal revascularization with interval ligation
  - Access ligation for limb threatening ischaemia

Distal Revascularization with Interval Ligation

1. Additional large collateral
2. Stop retrograde flow



DRIL: Distal Revascularization with Interval Ligation

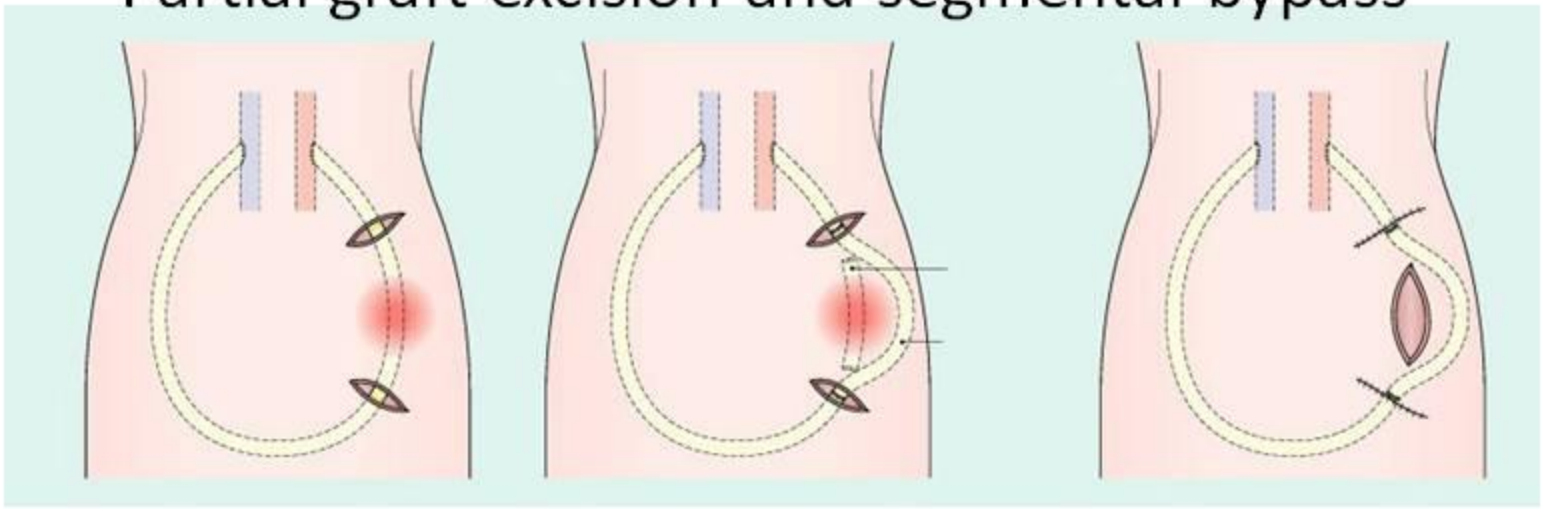


AV Graft infection

Infected AVG; skin erosion

Infected pseudoaneurysm; skin erosion

Partial graft excision and segmental bypass



AVG Thrombosis

- 85% of AVG failure due to thrombosis
- Prosthetic AV access thrombosis 0.5 to 0.8 episodes per year
- Early graft failure
  - Technical failure
  - Inadequate arterial inflow
  - Prolonged hypotension
  - Graft compression
- Late thrombosis most often due to venous anastomotic outflow obstruction
- Graft monitoring to prevent thrombosis

AV Graft Monitoring

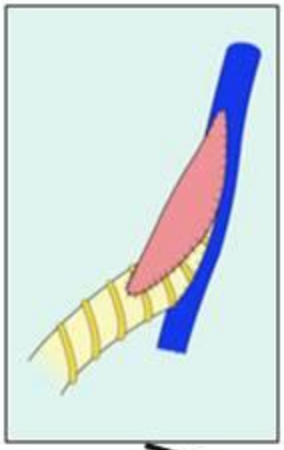
- Clinical
  - PE: absent of thrill, pulsation, distal edema
  - During dialysis: prolonged bleeding from needle puncture
  - Unexplained fall in the delivered Kt/V on a constant dialysis
- Surveillance
  - Static venous pressure: intragraft / systemic BP >0.6 suggest significant stenosis
  - Access blood flow: >25% decrease cf. baseline
  - Duplex scan: visualize stenosis, ratio of PSV > 2 across the stenosis

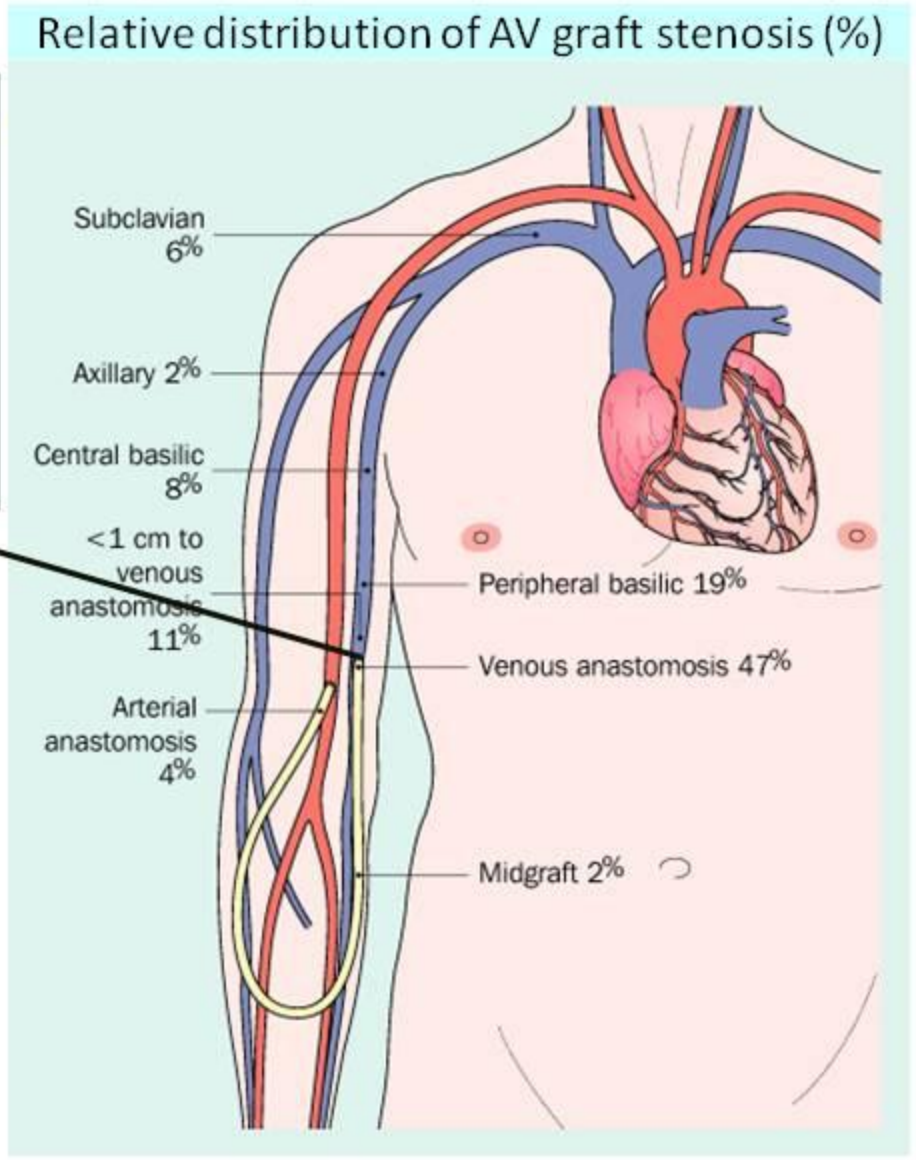
- Assumptions
  - Non-invasive test predict stenosis
  - Stenosis will lead to thrombosis in the near future
  - Angioplasty always work and is harmless
- Facts:

  Routine surveillance & Pre-emptive angioplasty not justify
  - Non-invasive test predict stenosis in about 70% - 80%
  - Cannot predict which stenosis will thrombose
    - 25% - 45% AVG with abn. Surveillance thrombose in 3 months
    - 30% of fistulogram documented stenosis (>50%) fail in 6 months
  - Angioplasty has complication and will accelerate neo-intimal hyperplasia
  - Increase flow is short-lived, 20% back to pre-angioplasty in 1 week, 40% in I month

AV Graft Thrombectomy

1. Large thrombus load; prefer surgical to endovascular thrombobectomy
2. Under LA; venous anastomosis exposed
3. Longitudinal incision in the graft, extending across the anastomosis onto the venous outflow
4. Thrombectomy using Fogarty balloon
5. Clot removed, patch angioplasty





Conclusion

- Early creation of access; allow time for maturation
- Pre-operative USG vein mapping in establishing access type & feasible site
- Be realistic and optimistic, cannot promise perfection but substantial chance of success
- Maturation and cannulation can be enhanced by secondary procedure
- Frank and close communication among the parties (Patient!) for secondary procedure if necessary
- Don’t give up ; in AVG failure conversion of AVG outflow vein to a AVF is often possible