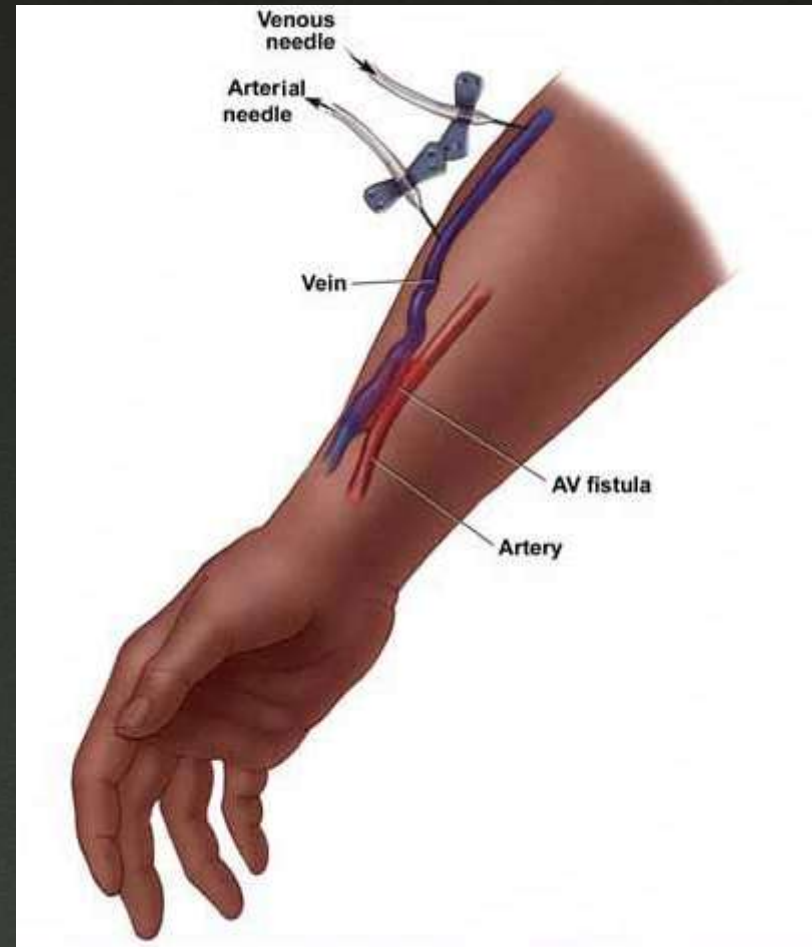


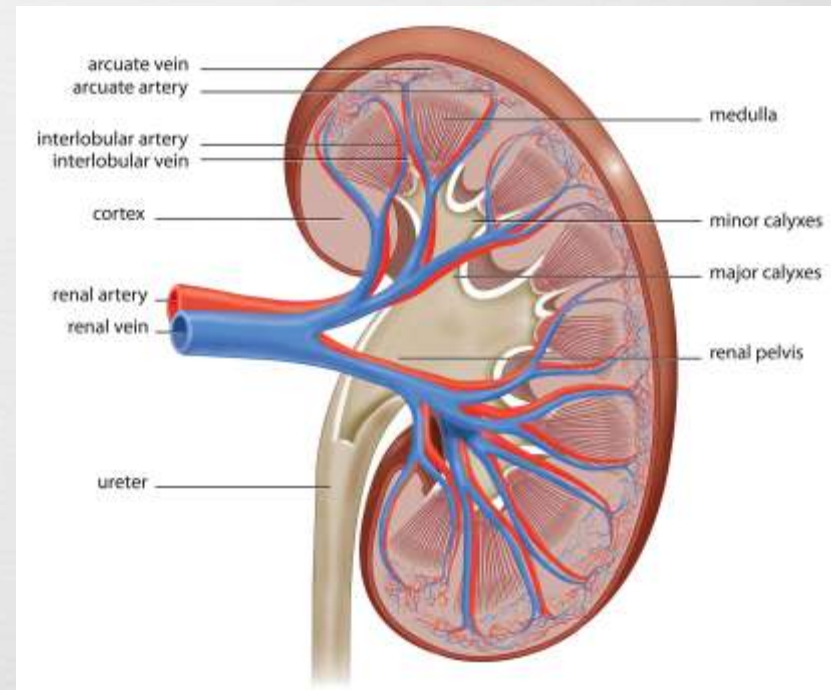
Arterio-venous fistula preparation



overview



- ❧ Natural history of AVF
- ❧ Understanding of cause of fistula failures
- ❧ Patient selection
- ❧ Duplex USG evaluation
- ❧ Site selection
- ❧ Algorithm
- ❧ conclusion



Natural history of AV fistula



- ❧ Following an iatrogenic creation of an arterio-venous anastomosis
 - ❧ the recipient vein will undergo certain 'predictable' changes which will make them
 - ❧ suitable for repeated puncture
 - ❧ withstand the stress of high volume flow
 - ❧ withstand high pressure flow
 - ❧ creates a high venous return (preload) to the heart

Natural history of AV fistula



- ❧ Changes that can be appreciated in the recipient vein
 - ❧ Increase in calibre
 - ❧ Increase in the thickness of the tunica media hence wall thickness
 - ❧ Both create a condition of 'Arterialisation of the vein'
 - ❧ Elongates in length
 - ❧ becoming more tortuous
 - ❧ Endothelial lining changes to withstand high flow/high pressure volume



Natural history of AV fistula



- ❧ Changes that can appreciated in the donor artery
 - ❧ Increase in calibre
 - ❧ In order to support the increase in arterial shunting over time
 - ❧ **No gross** increase in the thickness of the tunica media hence wall thickness
 - ❧ Reduces peripheral arterial resistance / capillary beds
 - ❧ in order to allow significant blood flow to reach the distal vascular beds

Natural history of AV fistula



- ❧ Changes that can be appreciated in the donor artery
 - ❧ Increase in flow
 - ❧ In order to support the increase in arterial shunting over time
 - ❧ eg: radial artery flow changes
 - ❧ Normal flow: 21-30 ml/min
 - ❧ Matured RCF: 650-800 ml/min
 - ❧ eg: brachial artery flow changes
 - ❧ Normal flow: 85-100 ml/min
 - ❧ Immediately after fistula creation: 400-500 ml/min
 - ❧ 6-8 weeks after fistula creation: 700-1000 ml/min
 - ❧ (10X increase in flow volume)

Natural history of AV fistula



- ❧ Changes that can be appreciated in the donor artery
 - ❧ Flow into the outflow veins not only will come from the inflow artery in antegrade manner **but also** a smaller percentage from retrograde manner from distal arterial segment

Why fistula fail?

- ❧ Poor vein maturation
- ❧ Non maturation
- ❧ Poor flow volume studies
- ❧ 'Too deep' to puncture
- ❧ 'Too tortuous'
 - ❧ Limited 'straight' segment for needling
- ❧ Venous hypertension in the limb
- ❧ High output cardiac failure
- ❧ Distal 'Steal syndrome'
- ❧ Infection
- ❧ Bleeding
 - ❧ requiring fistula ligation in order to save the life
- ❧ Thrombosis
 - ❧ Immediate...technical
 - ❧ late

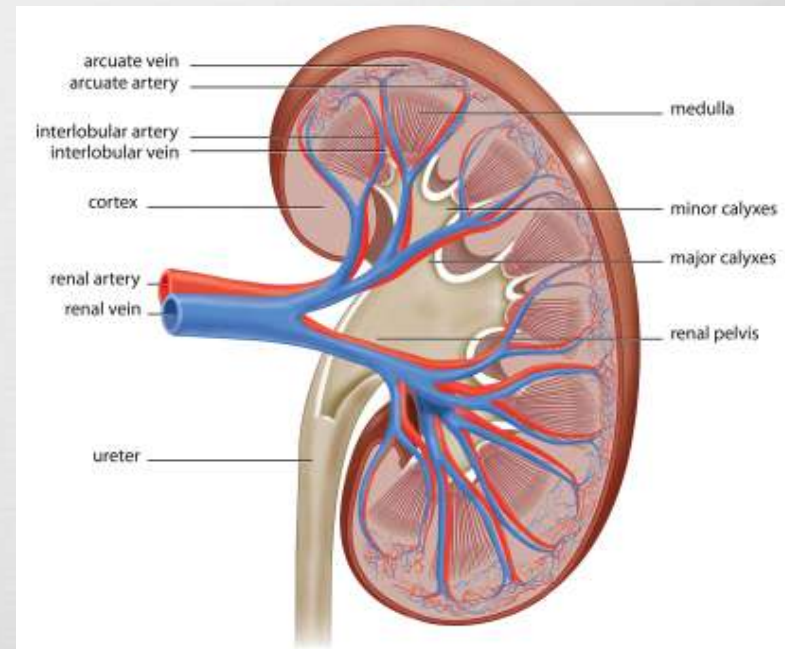


When fistula fail?



❧ Early failures

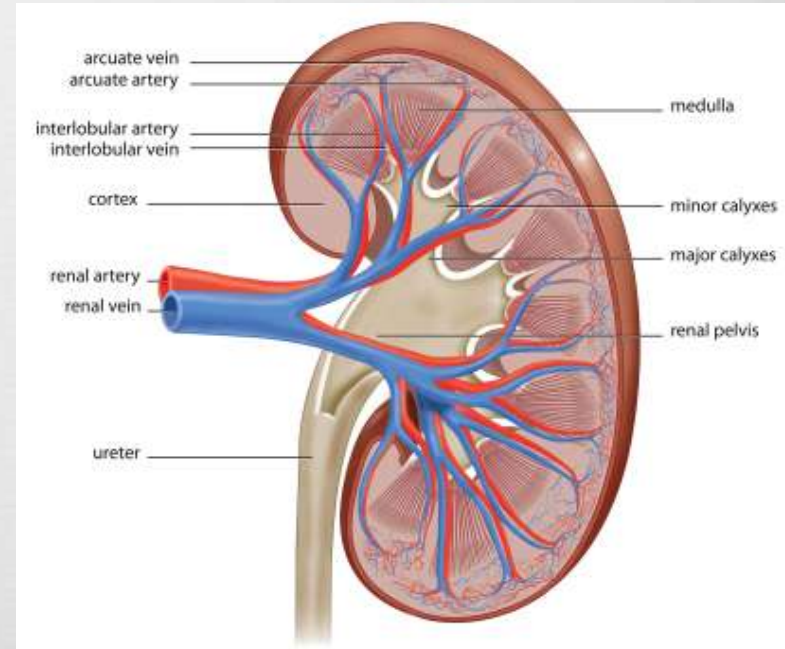
❧ Late failures



When fistula fail?



- ❧ Early failures
 - ❧ Inflow issues
 - ❧ Outflow issues



When fistula fail?

❧ Early failures



❧ Inflow issues

❧ **TECHNICAL**

❧ Pre-existing arterial problem

- ❧ Anatomically small donor artery selected

- ❧ Advance artherosclerosis in the donor artery selected

❧ Acquired arterial problem

- ❧ Arterial anastomotic stenosis

- ❧ Too small artery to start with

- ❧ Accidental / inadvertent suturing of the posterior wall at 'heel' and 'toe' areas of the anastomosis

- ❧ Juxta anastomotic stenosis

- ❧ Both are technical issues

When fistula fail?



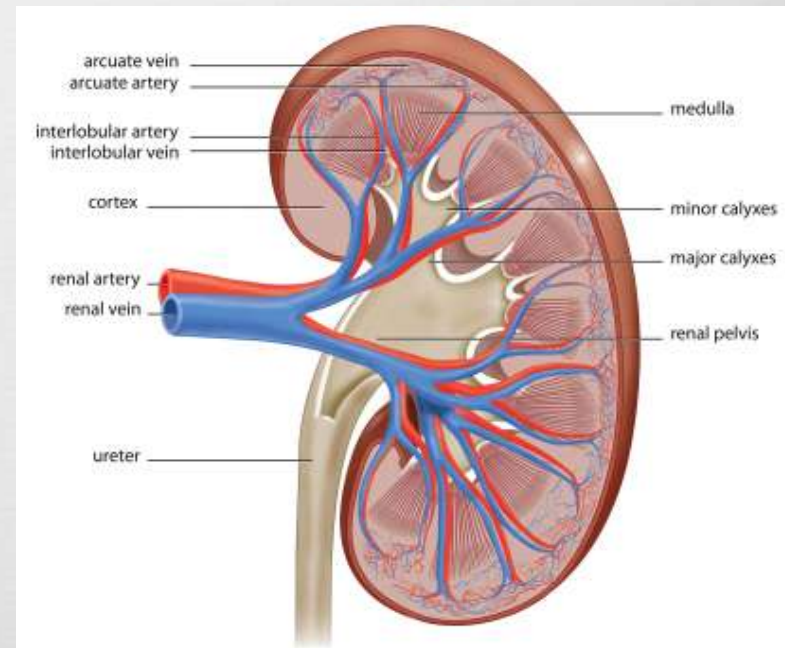
- ❧ Early failures
 - ❧ Outflow issues
 - ❧ Anatomically small recipient vein
 - ❧ mid 'segment' stenosis
 - ❧ Juxta anastomotic stenosis / proximal vein stenosis
 - ❧ Kink / anastomosis under tension / twisting/torque
 - ❧ Fibrotic vein
 - ❧ Accessory vein (parallel veins / side branches)
 - ❧ Anastomotic dehiscence
 - ❧ Pseudoaneurysm formation
 - ❧ technical
 - ❧ Central vein critical stenosis / occlusion

When fistula fail?



❧ Early failures

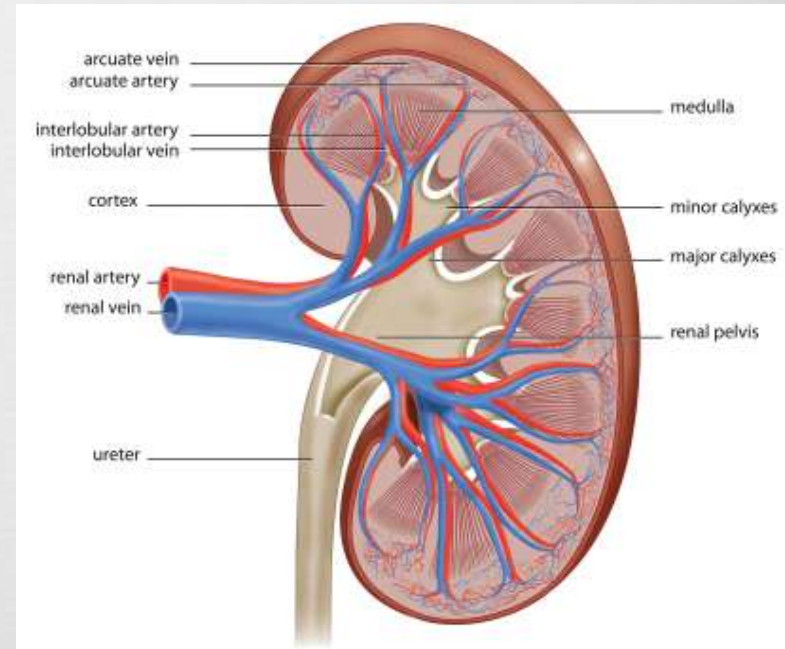
❧ Late failures



When fistula fail?



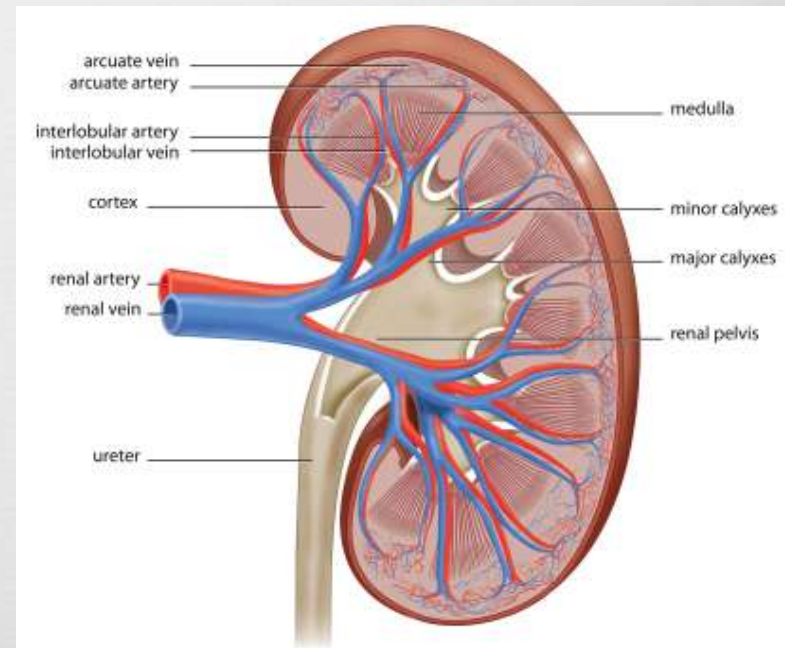
- ❧ Late failures
 - ❧ Venous stenosis
 - ❧ due to repeated puncture / wall damage
 - ❧ Thrombosis
 - ❧ Infection
 - ❧ Pseudoaneurysm formation
 - ❧ +/- haemorrhage
 - ❧ Acquired arterial lesion
 - ❧ Arteriosclerotic plaque causing luminal stenosis at inflow site
 - ❧ Excessive flow
 - ❧ 'giant fistula' –flow in excess of 3-4L/min
 - ❧ High output cardiac failure
 - ❧ Distal ischemia
 - ❧ Aneurysm formation



What to assess prior to AVF creation?



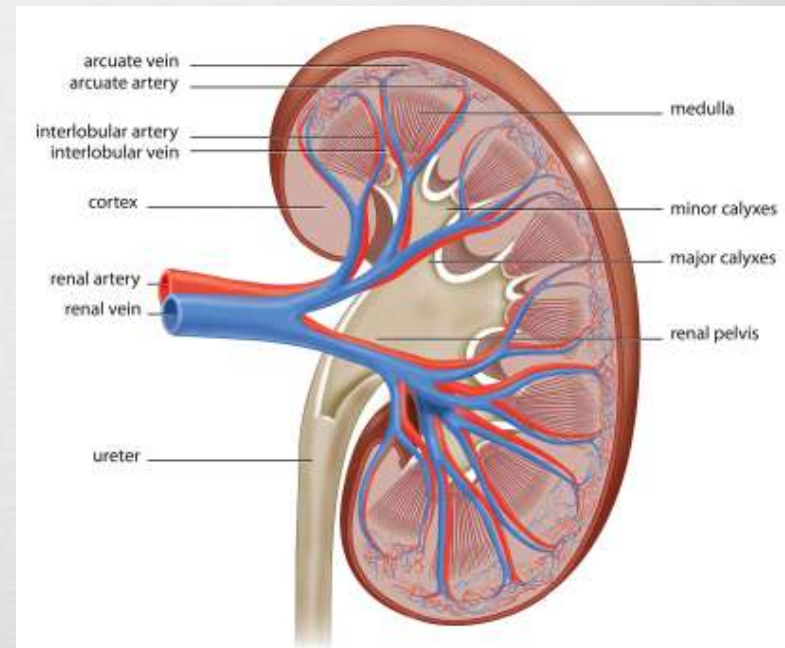
- ❧ History
- ❧ Physical examination
- ❧ Duplex USG
- ❧ +/- venography



Patient selection



- ❧ GFR < 15-29 ml/min/1.73m² (CKD stage 4)
- ❧ 5 stages of CKD..stage 5 is ESRF stage
- ❧ Age
- ❧ Premorbid conditions
- ❧ Dominant limb



History

Factors	The issue'
DM	Vascular damage, multiple admissions for uncontrolled DM
Central vein catheterisation	Iatrogenic central vein stenosis
Previous arterial or venous catheterisation	Conduit damage
Previous vascular access	Need to know why previous fistula fails (recurring cause ?), location will affect future fistula placement
History of congestive cardiomyopathy	Poor fistula maturation, altered haemodynamics may trigger high output cardiac failure
History of cardiac valves procedure / prosthesis	May need to be considered to avoid prosthesis infection. AVF preferred over catheter / AVG
History of pacemaker use	Central vein stenosis

History

Factors	The issue'
Prev. trauma, surgery over the ipsilateral arm/neck/chest	Think of vein stenosis, consider other side if possible
Neck / chest irradiation	Think of vein stenosis, consider other side if possible
Use of anticoagulants / antiplatelets use / haemophiliacs	Self explanatory. Aspirin...non issue
h/o cancer, advance coronary disease, disease with limited life expectancy	Why not catheters?
Anticipating kidney transplant in near future	Why not catheters?
SLE / RA / connective tissue diseases	Small, easily thrombosed vessels, refer to tertiary center with better technical skills so as not to damage possible AVF option

Examination



	What to look for?		issue
Arterial tree	Peripheral pulses	Pulse volume	Do not attempt if no palpable distal pulse or feeble pulse
		State of arterial wall	'rock' hard arteries- poor candidate as inflow arteries
		Allen test	Poor collateralization result-> do not attempt distal fistula
	Bilateral arm BP		Use the higher of the 2 if BP difference > 20 mm Hg

Non palpable pulse in thick forearm / swollen limb -> supplement with handheld doppler evaluation for systolic pressure evaluation

Examination

	What to look for?		issue
Venous system	Visible vein	Straight vs tortuous	Tortuous vein not suitable for puncture
	(with or without tourniquet)	'Missing segment'	If on-tourniquet...missing segment of dilated veins noted..choose other outflow vein
	Limb oedema		Limb not suitable for vascular access creation
	Arm size		Larger arm (if not dominant arm) may denote underlying venous congestion
	Collateral veins	Multiple visible cutaneous veins	Possibility of central vein obstruction / stenosis

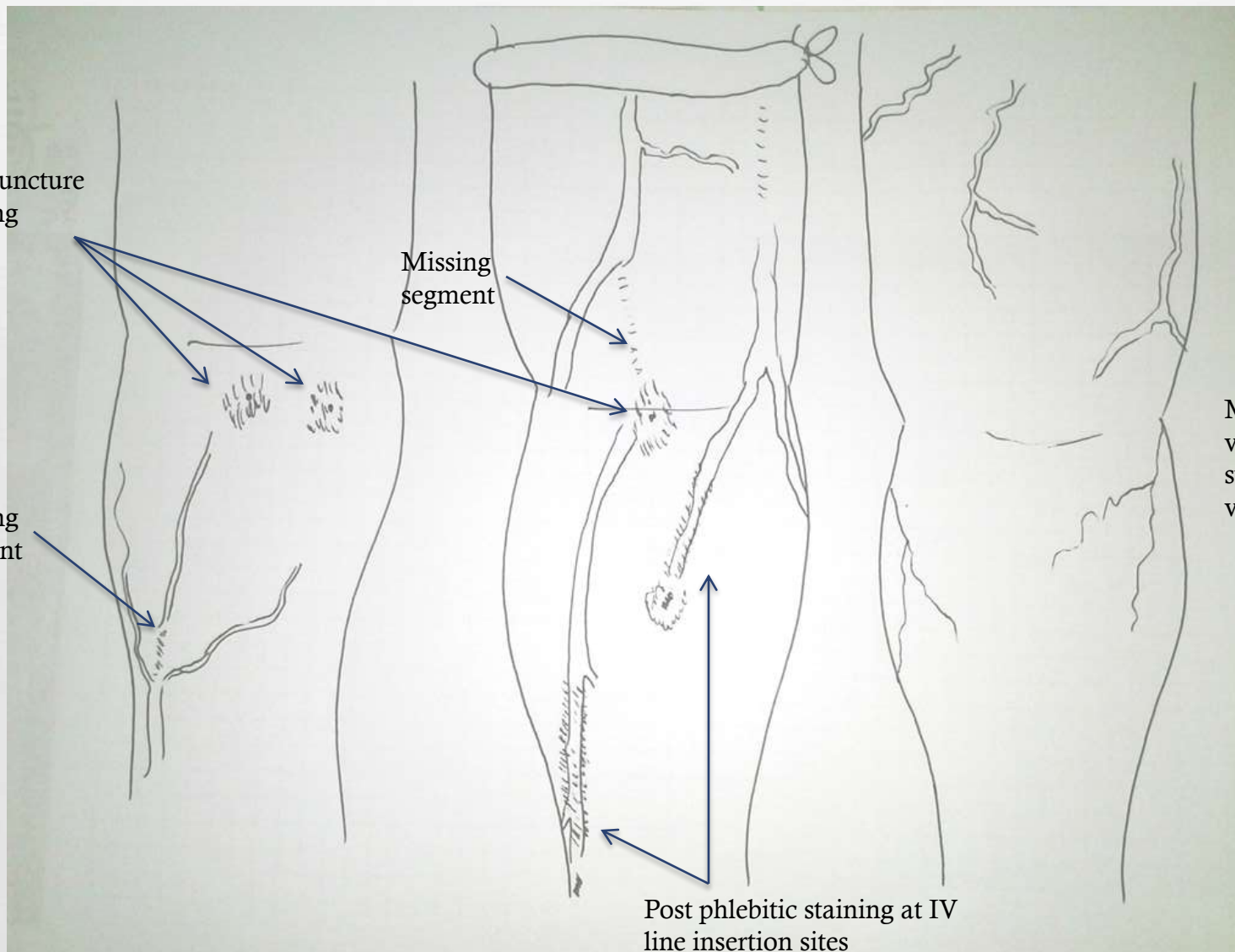
Post puncture staining

Missing segment

Missing segment

Multiple visible superficial veins

Post phlebitic staining at IV line insertion sites



Examination



	What to look for?		issue
Neck	Puncture site scar	Single / multiple	Suspect central vein stenosis / occlusion
	Collateral veins	Multiple visible cutaneous veins	Possibility of central vein obstruction / stenosis
	operative scar neck, upper chest		Possibility of vein damage
	Indurated skin of previous irradiation		Possibility of vein damage
	Marks of trauma / bony fractures	Clavicular #	Possibility of vein damage



Examination



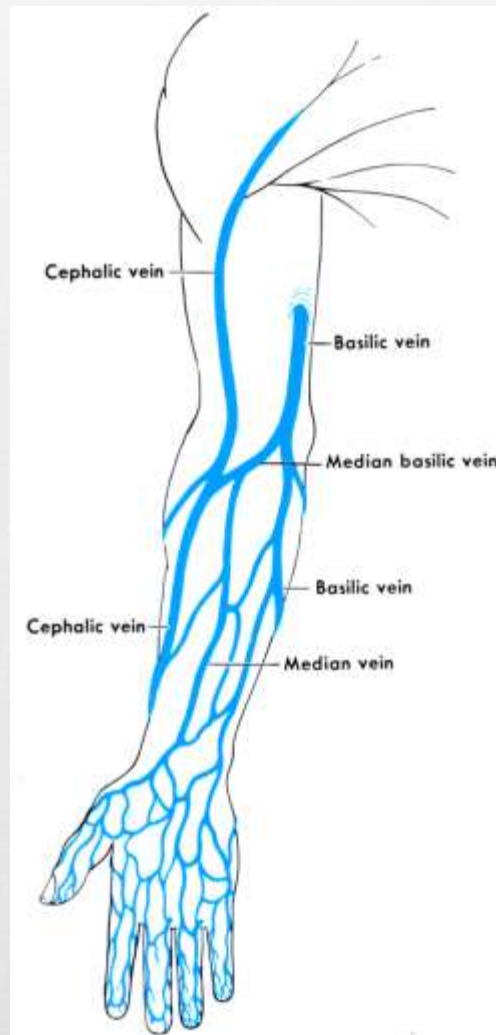
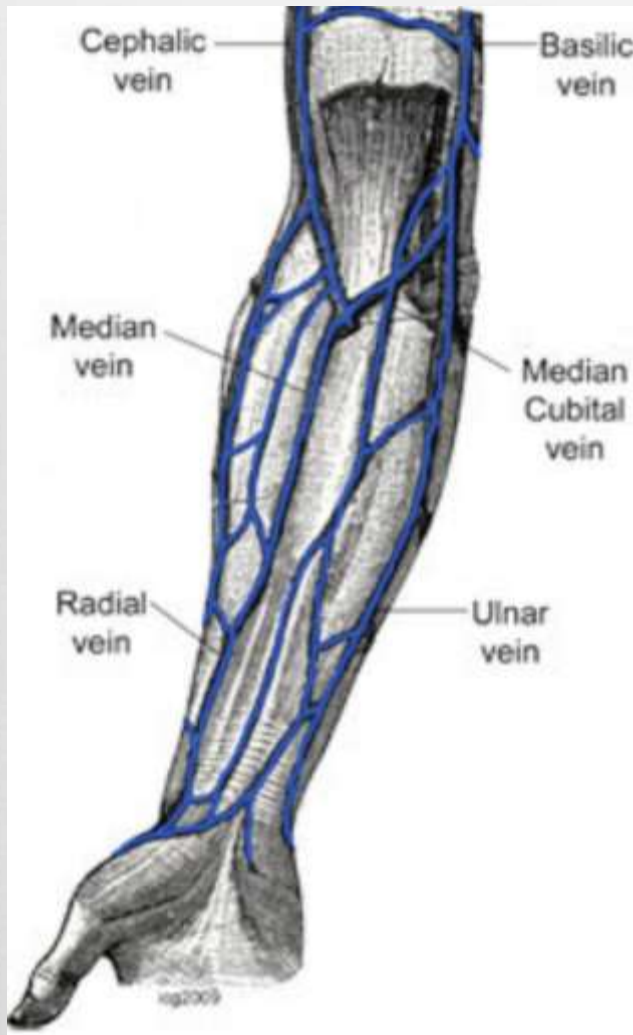
	What to look for?	issue
Limb	Paralysed / post stroke limb	Consider contralateral limb
	Marks of trauma / eschar / fracture	Underlying vein already damage
	Post phlebotic staining along vein length	Consider other outflow veins
Cardiovascular system	Raised JVP	Possible valvular damage or CCF
	Other signs of cardiac failure	May not be suitable for AVF / AVG...consider catheter

Duplex ultrasound evaluation

- ☞ Show real time state of arterial and venous wall
- ☞ Few criterias need to be considered
- ☞ Formal training in ultrasound?
- ☞ Especially important in 're-do' cases



Duplex ultrasound evaluation

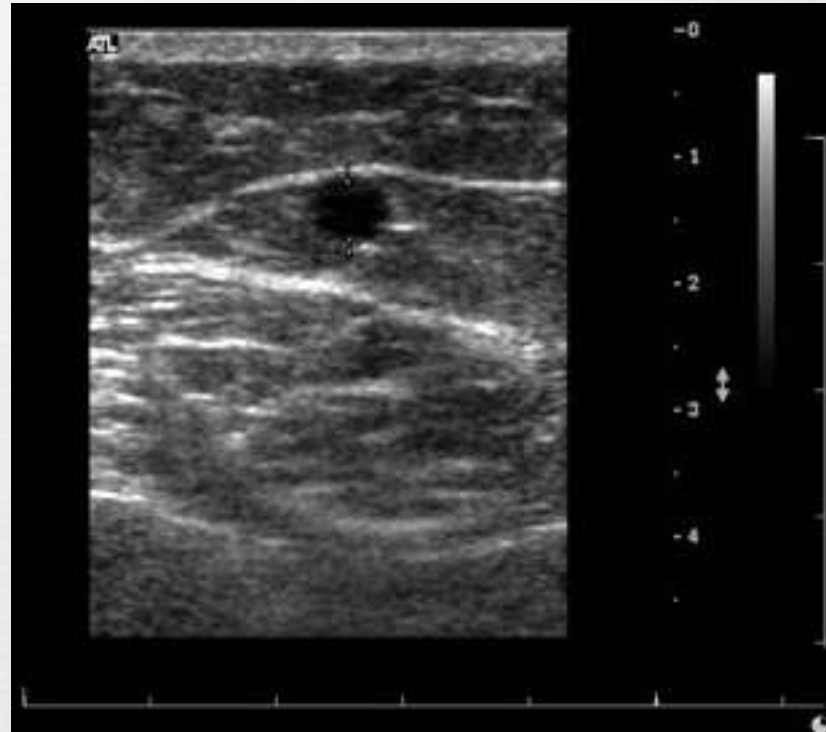


be familiar with a normal superficial venous anatomy

Duplex ultrasound evaluation



- ❧ Venous duplex
 - ❧ Vein size
 - ❧ 2.0-2.5 mm at a minimum
 - ❧ Vein continuity
 - ❧ Should have adequate length for puncture once matured



Duplex ultrasound evaluation

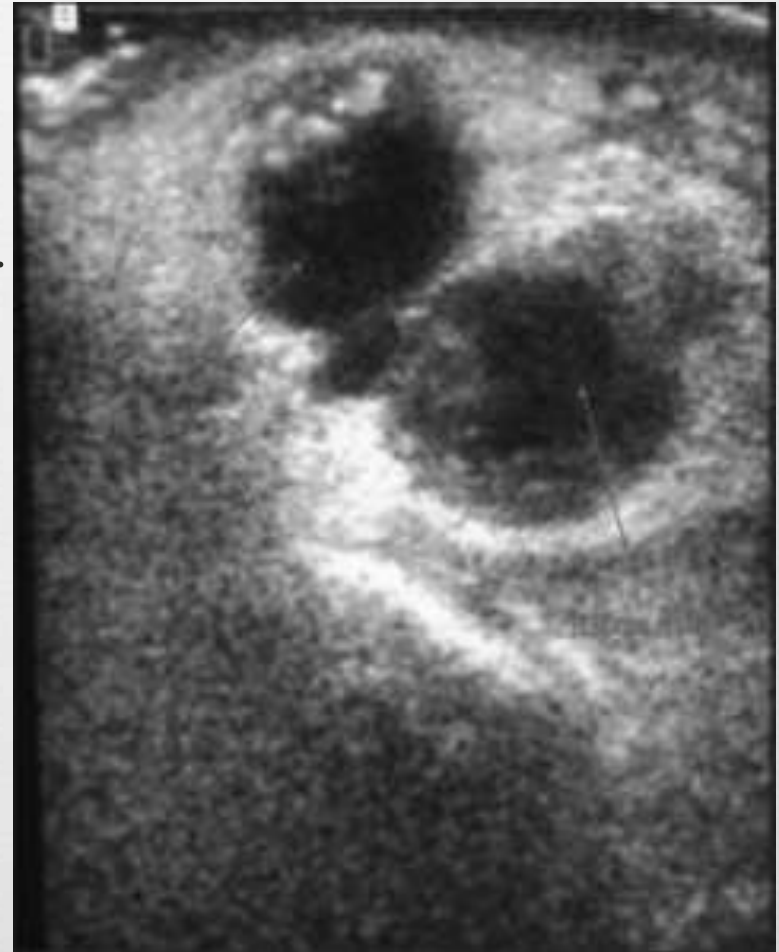
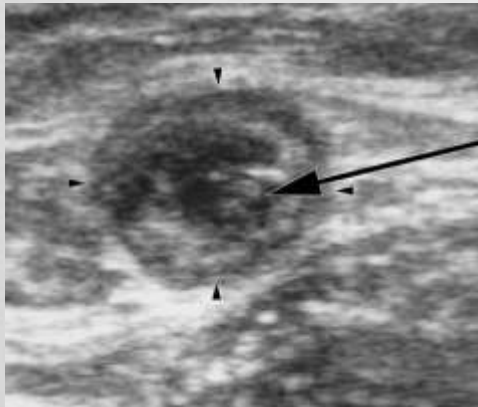


- ❧ Venous duplex
 - ❧ Vein stenotic segment
 - ❧ May require arm tourniquet to see the segment if not obvious
 - ❧ Pay special attention to segments where regular sites of venepuncture / blood taking and IV line locations

Duplex ultrasound evaluation



- ❧ Venous duplex
 - ❧ Thickened segment
 - ❧ Intraluminal echogenicity
 - ❧ Recanalised thrombosed vein... good



Duplex ultrasound evaluation



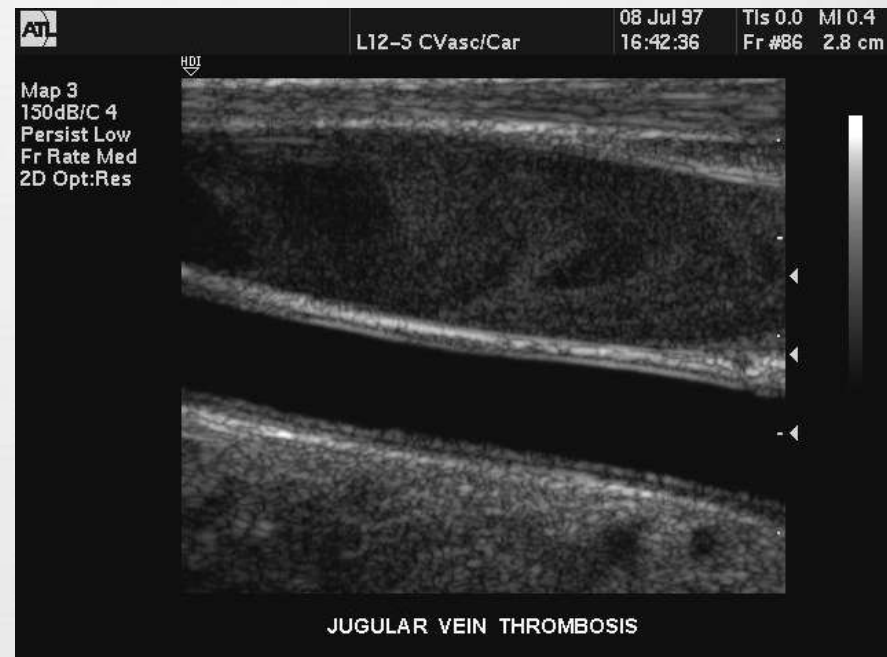
- ❧ Venous duplex
 - ❧ Depth of vein
 - ❧ > 6mm depth or thick SC fat, be prepared for secondary 'lift' procedure
 - ❧ Distance to possible arterial inflow
 - ❧ > 2 cm apart, careful during mobilization to avoid kink/twist/sharp angulation causing juxta anastomotic stenosis and non maturation

Duplex ultrasound evaluation



☞ Venous duplex

- ☞ Multiple chest vein visible on B-mode USG
- ☞ Neck vein
 - ☞ Especially multiple puncture neck,
 - ☞ scarred neck looking for possible IJV thrombosis/occlusion as marker of ipsilateral central vein stenosis/occlusion



Duplex ultrasound evaluation



- ❧ Arterial duplex
 - ❧ Artery size
 - ❧ Nothing less than 1.6 mm artery (espc RCF)
 - ❧ Arterial wall expansile pulsation
 - ❧ B-mode USG
 - ❧ Wall echogenicity
 - ❧ Bits of posterior acoustic shadowing vs whole length shadowing

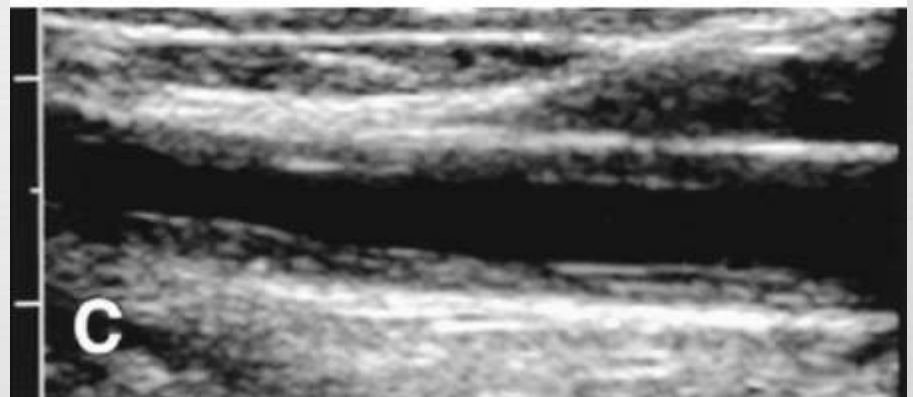
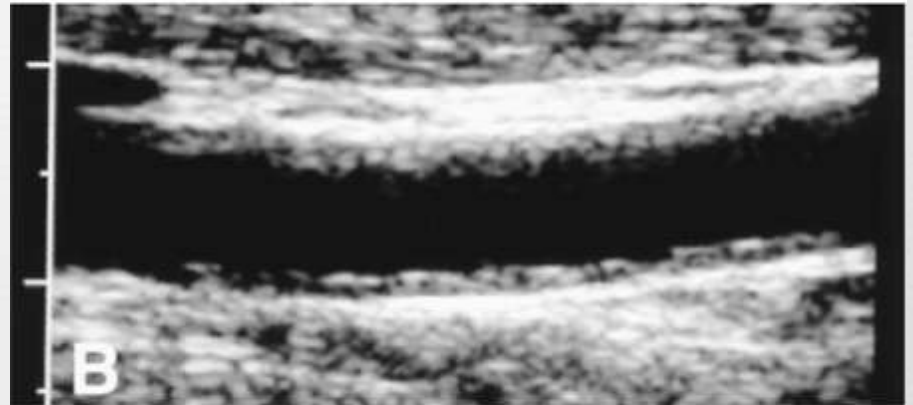
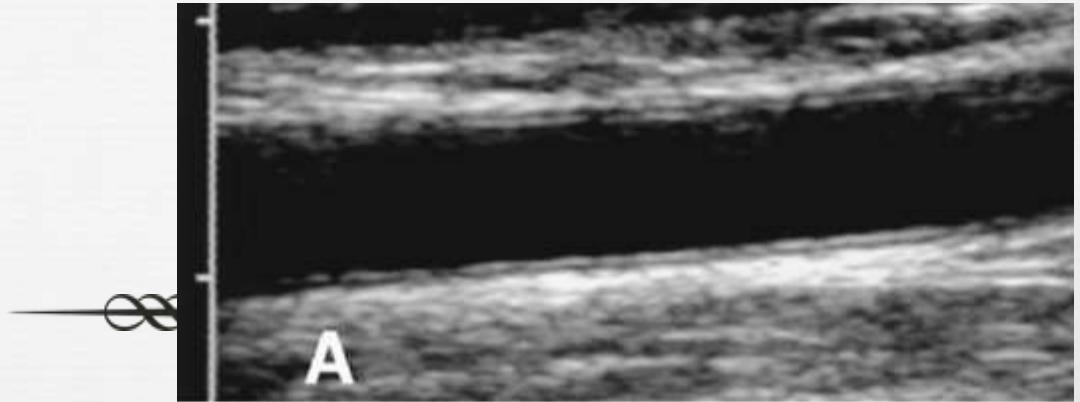
Duplex ultrasound evaluation

∞ Arterial duplex

∞ A- fairly normal

∞ B- echogenic wall

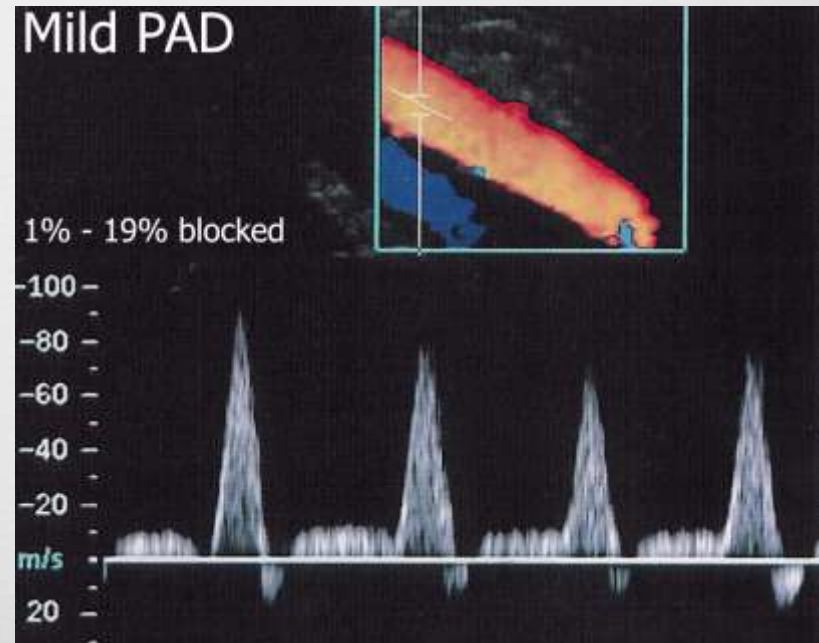
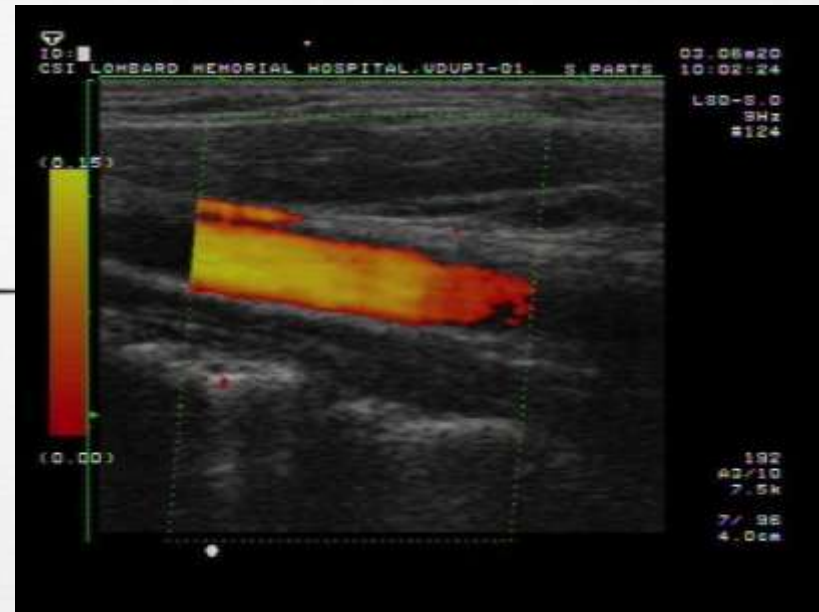
∞ C- stenotic artery



Duplex ultrasound evaluation



- Arterial duplex
 - Posterior acoustic shadowing
 - Doppler signal of the arterial flow
 - Triphasic...nothing less
 - 'If possible'...duplex of whole length of donor artery till location of anastomosis looking for stenosis / turbulence flow / occlusive segment



Venography

∞ Indications

- ∞ 'Re-dos'
- ∞ Multiple failed AVF
- ∞ Visible chest / shoulder veins
- ∞ h/o 'non puncturable' neck veins
- ∞ Venous hypertension changes in UL



a.



b.

“AVF commandments”

I/ Distal over proximal

II/ Non dominant over dominant UL

III/ Superficial over deep (outflow) vein

IV/ Native vein over graft

V/ Upper Limb over lower limb

“In the end”



- ❧ Reconfirm the indication for vascular access
- ❧ Clinical history
- ❧ Perform physical examination
 - ❧ By which time should have an idea
 - ❧ on possible limb and site/arterial inflow location
 - ❧ whether to avoid AVF/AVG placement....catheter instead
- ❧ Duplex USG evaluation
 - ❧ Confirm previous evaluations
- ❧ +/- venography +/- venoplasty/stenting
- ❧ Follow the AVF commandments
- ❧ DECIDE on best fistula placement for the individual



Thank you for your attention