DOPPLER IN UPPER LIMB AND LOWER LIMB ARTERIAL DISEASES

PRESENTED BY

DR.DIPTI PARMAR [1ST YEAR RESIDENT]

GUIDED BY

DR.TWINKLE VASAVA [3RD YEAR RESIDENT]

DR.BHAVISHA CHAUDHARY [SENIOR RESIDENT]

INDICATION FOR EXAMINATION

- Claudication and/or rest pain in the lower extremities to evaluate for arterial stenosis or occlusion.
- Patients with pain, discoloration or ulcer formation in the extremities (most commonly lower) ----ischemia or necrosis from arterial stenosis or occlusion.
- numbness or cold extremity.
- monitor progression of disease, determine success or failure after intervention, and identify acceptable vessels for bypass graft creation.
- To assess the vascular causes such as aneurysm or fistula.
- evaluation for thoracic outlet syndrome.

Continue……

- Patency of the palmar arch in surgical planning for bypass graft harvesting
- Assess the radial artery before and after vascular access.

TECHNIQUES

- **Gray-scale evaluation of the peripheral arteries :**

1. to determine the amount of atherosclerotic disease or thrombus present.

2. **high frequency transducer** allows good penetration and visualization, should be applied typically a **5- to 12 MHz linear array transducer**, used in areas where the arteries are more superficial.

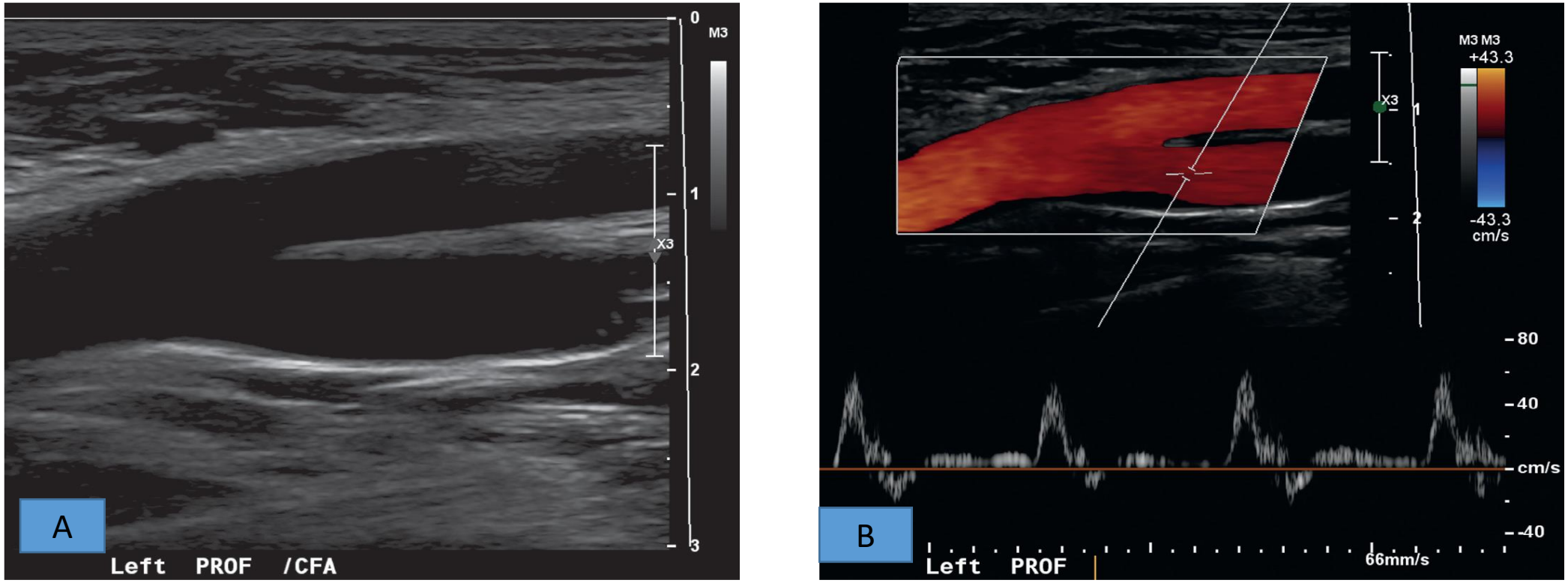
3. **3- to 5-MHz ,curved array probe** may be necessary in large patients or those with large amounts of edema.

- **Colour Doppler :**

    1. to evaluate residual lumen, with the gain adjusted

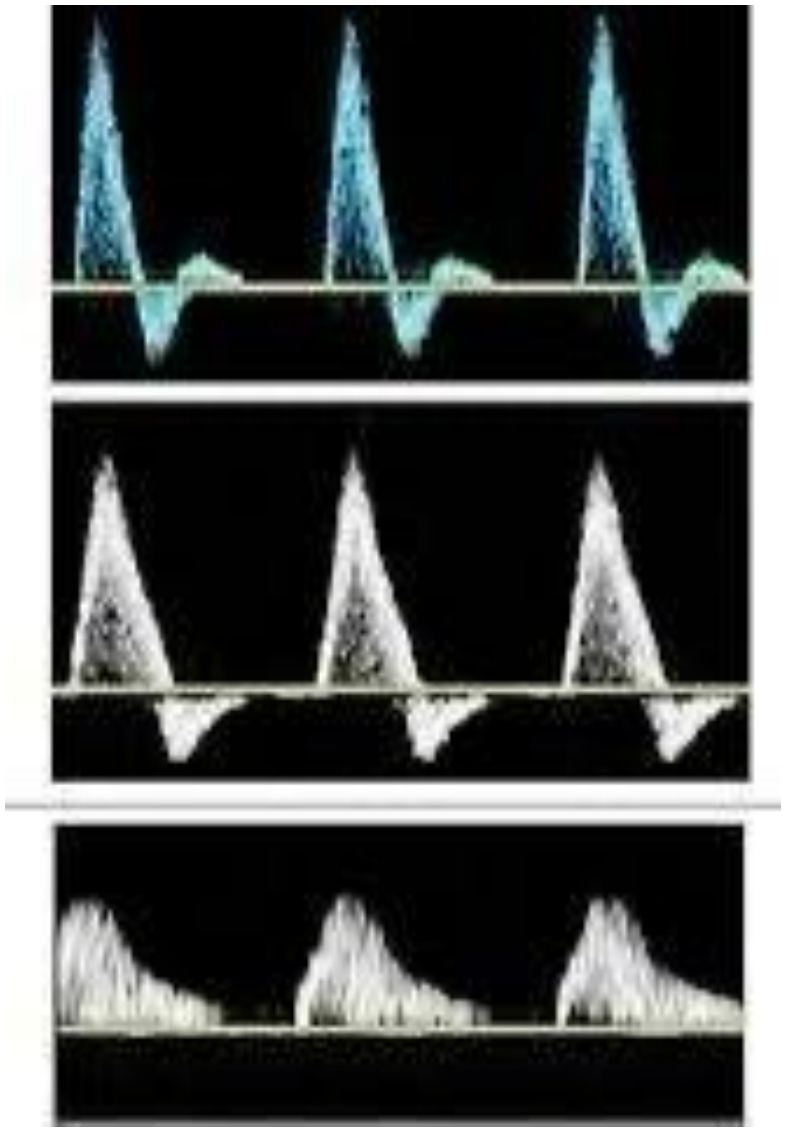
- **Spectral Doppler :**

    1. to evaluate normal waveforms

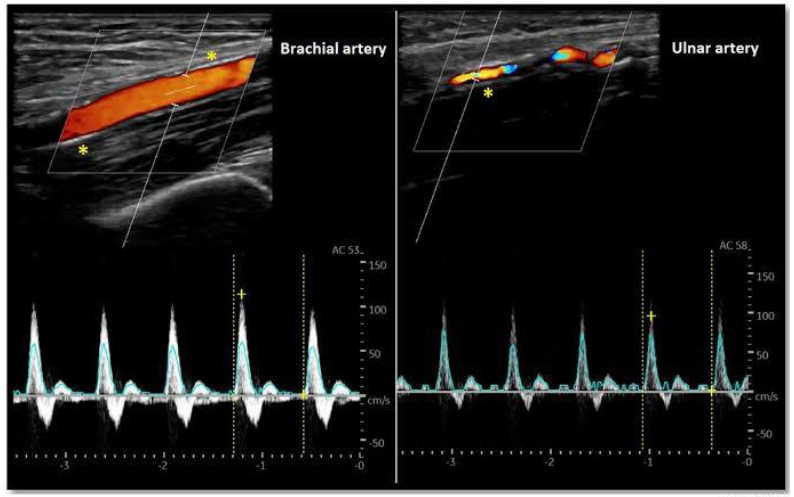


Normal Common Femoral Artery Bifurcation. (A) Gray-scale imaging shows the normal appearance of arterial wall with lack of plaque. **(B)** Color and spectral Doppler normal triphasic spectral waveform in the profunda femoris artery.

WAVEFORMS

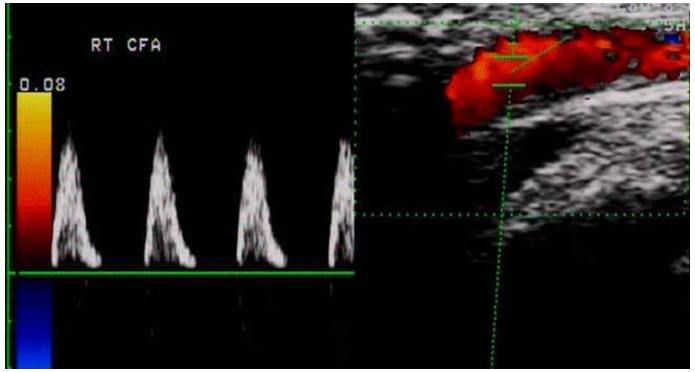


TRIPHASIC WAVEFORM

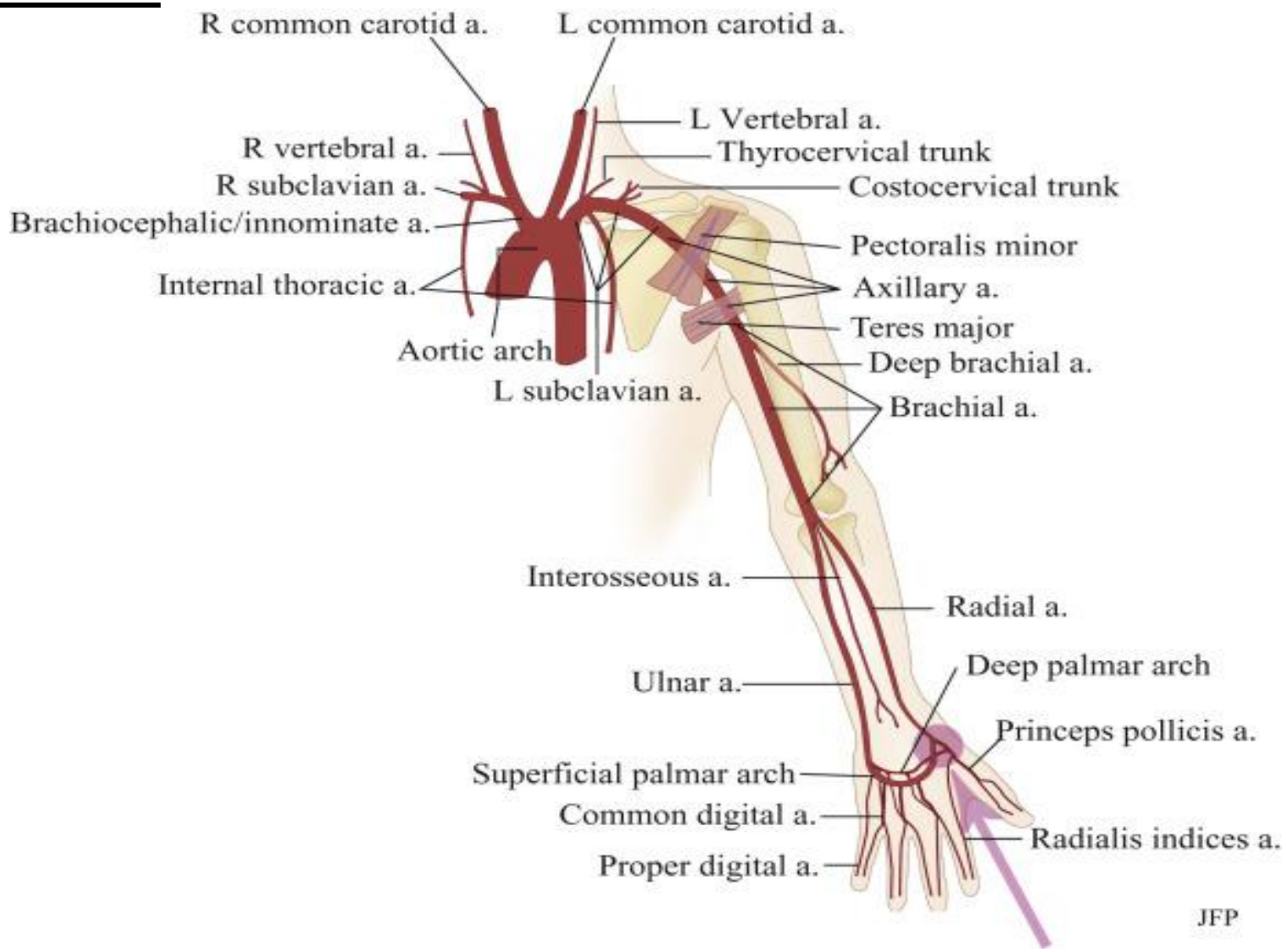


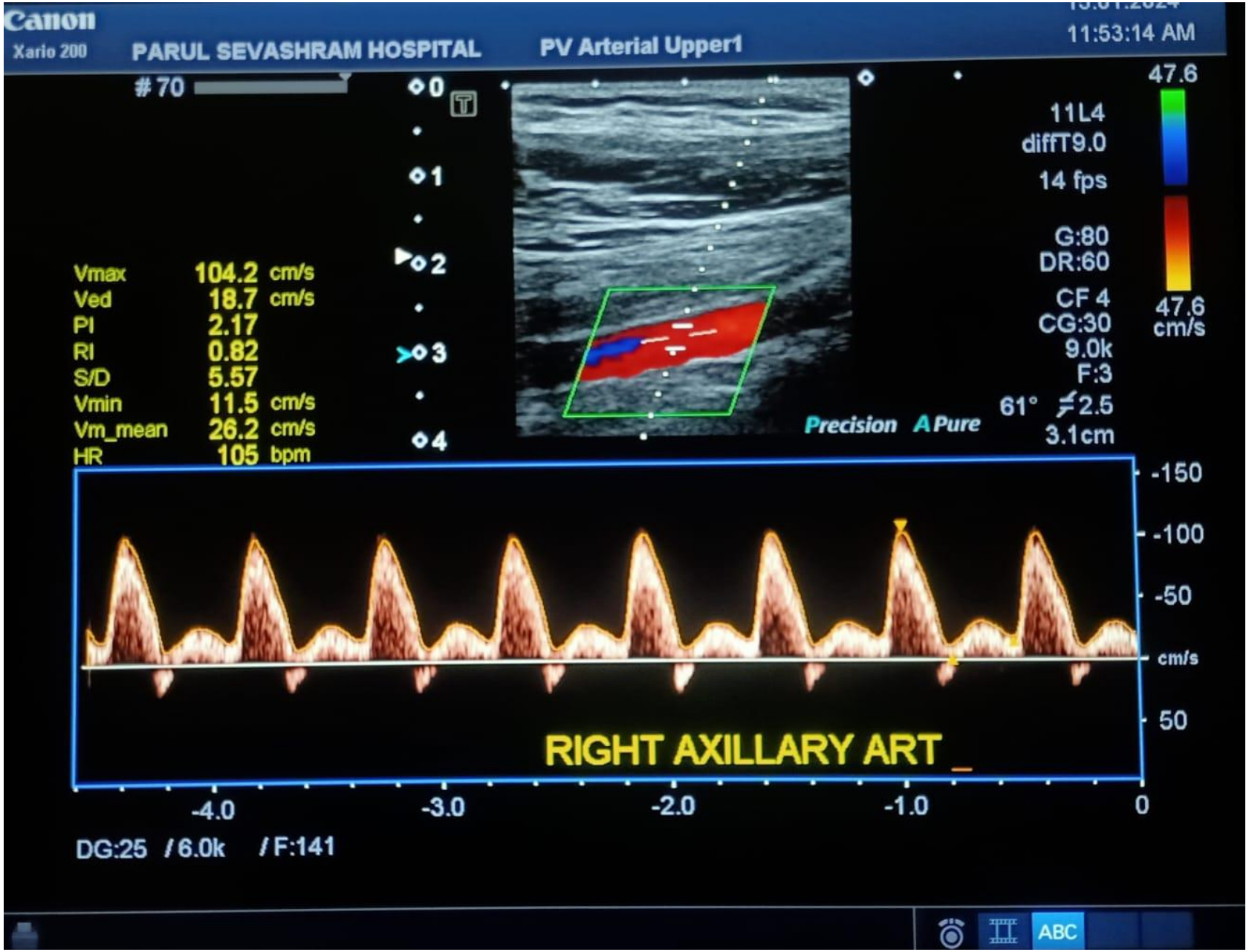
BIPHASIC WAVEFORM

MONOPHASIC WAVEFORM



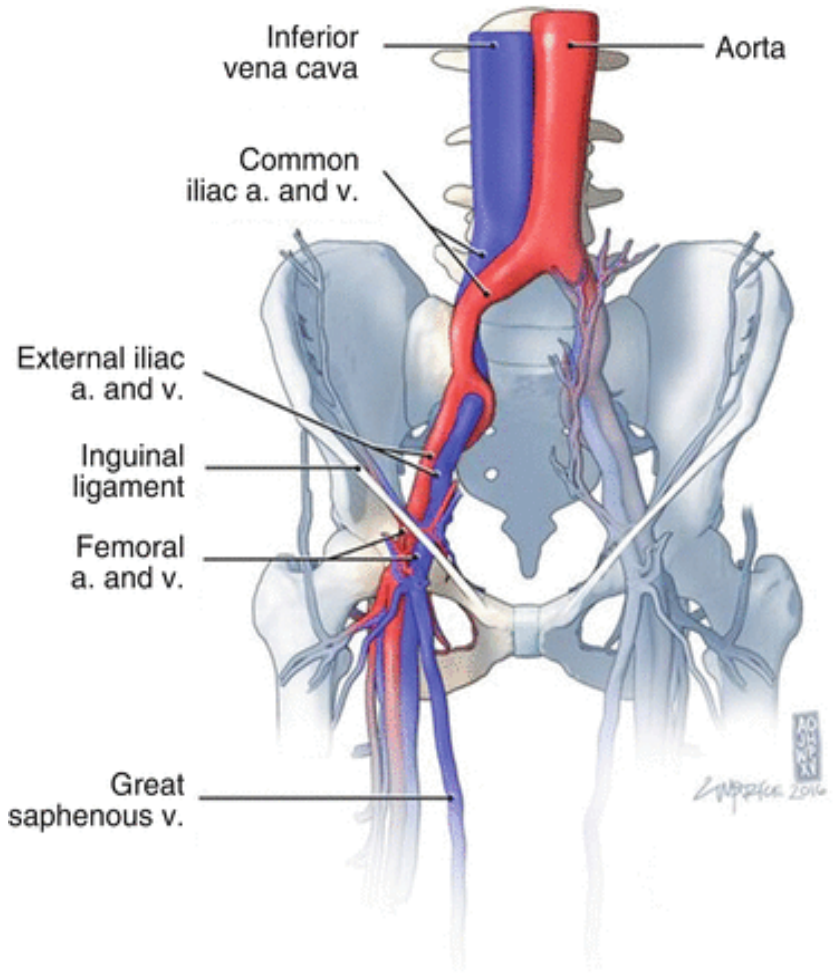
NORMAL ANATOMY OF UPPER LIMB ARTERIES



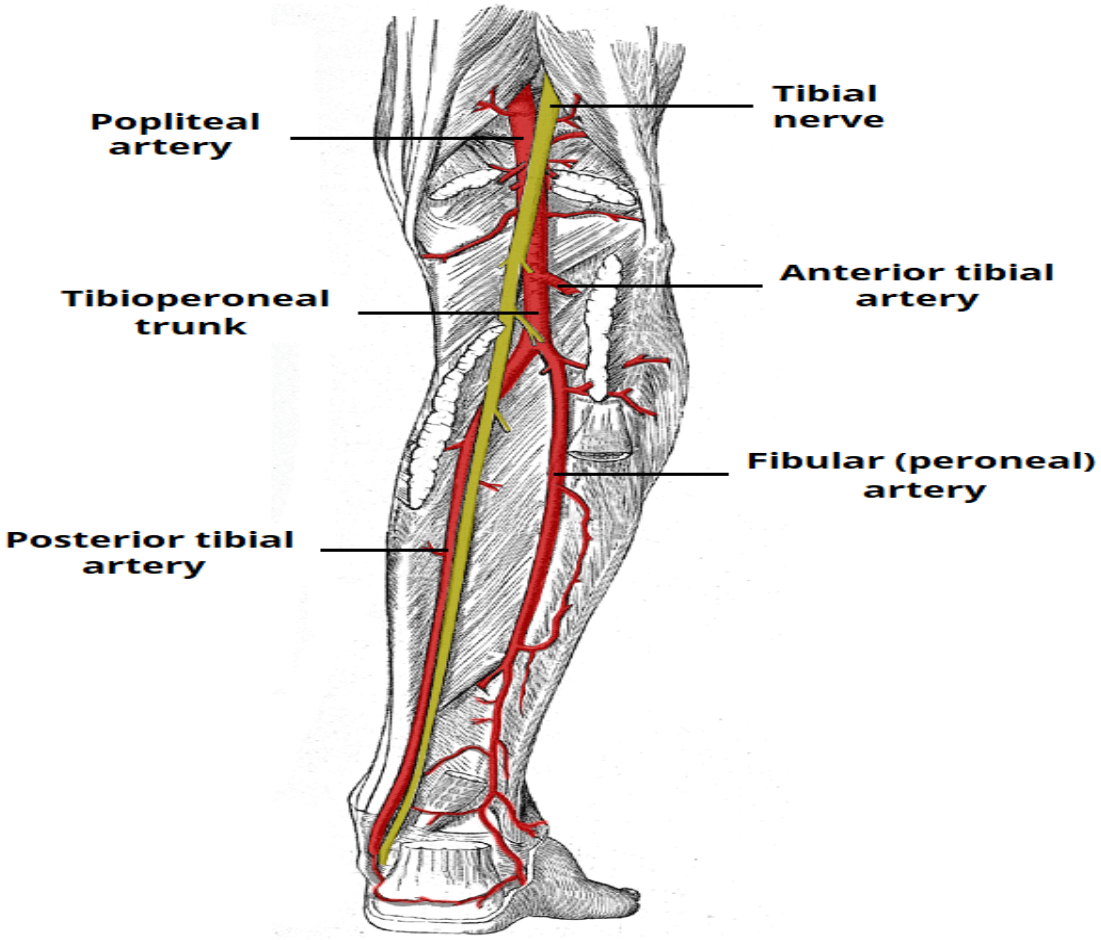

Canon
Xario 200
PARUL SEVASHRAM HOSPITAL
PV Arterial Upper1
11:53:14 AM
70
11L4
diffT9.0
14 fps
G:80
DR:60
CF 4
CG:30
9.0k
F:3
61°
2.5
3.1cm
47.6
47.6
cm/s
Precision
A Pure
Vmax 104.2 cm/s
Ved 18.7 cm/s
PI 2.17
RI 0.82
S/D 5.57
Vmin 11.5 cm/s
Vm_mean 26.2 cm/s
HR 105 bpm
-150
-100
-50
cm/s
50
RIGHT AXILLARY ART
-4.0
-3.0
-2.0
-1.0
0
DG:25 / 6.0k / F:141
ABC

NORMAL ANATOMY OF LOWER LIMB ARTERIES

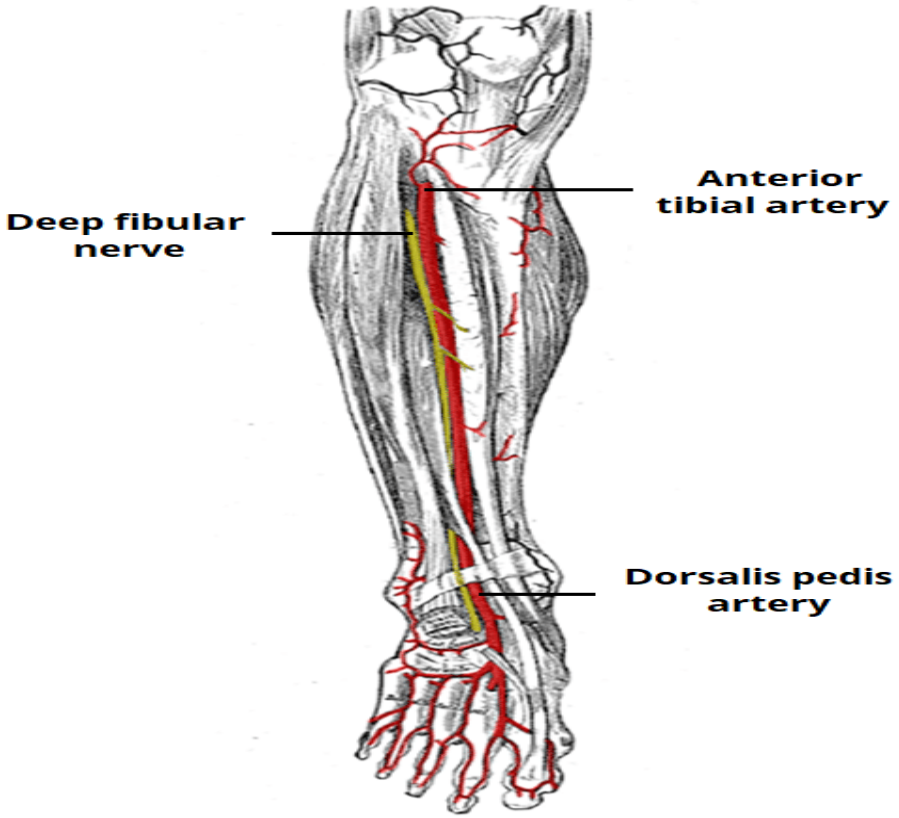
- The **common femoral artery,** which originates from the **external iliac artery** at the level of the inguinal ligament and extends caudally a few centimeters until it divides into the **superficial femoral artery** (SFA) and **profunda femoris artery.**



Continue…..



(i) Posterior Leg



(ii) Anterior Leg

Normal outer diameters :

- common femoral artery : 8.1 mm
- SFA : 6.1 mm
- popliteal artery : 6.0 mm
- posterior tibial artery : 2.1 mm
- anterior tibial artery : 2.0 mm

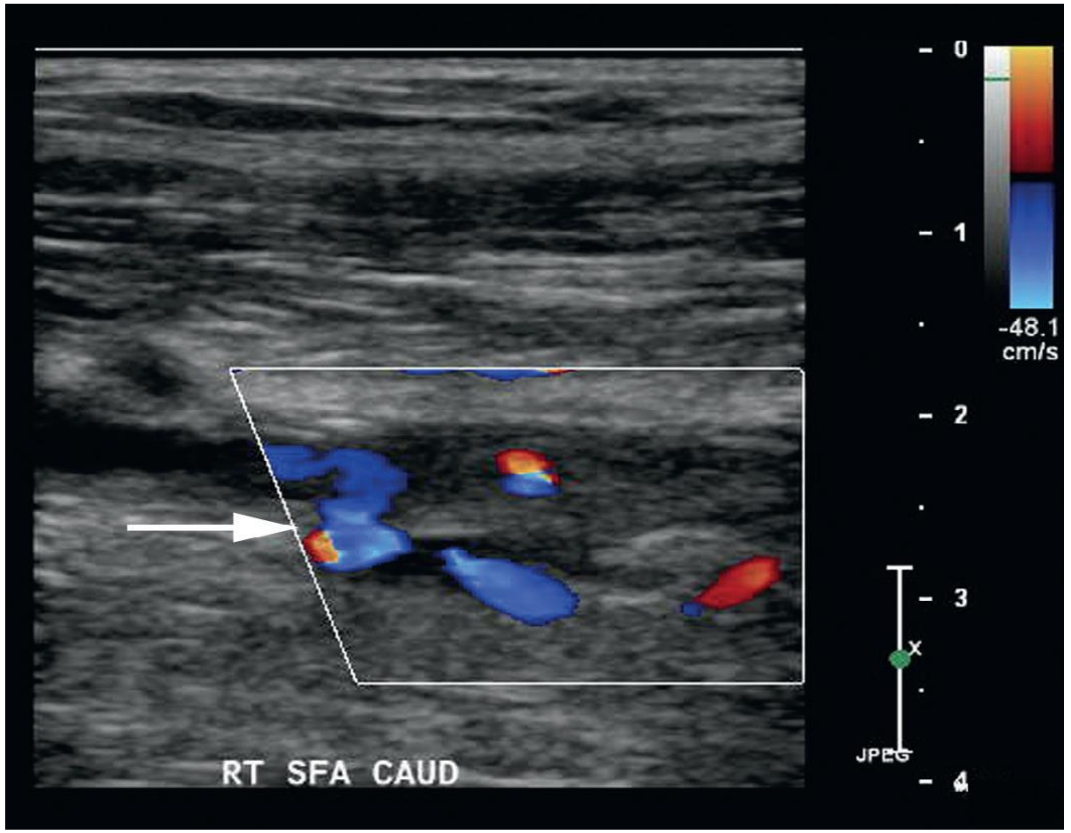
DISEASES:

PERIPHERAL ARTERIAL OCCLUSION :

CHRONIC OCCLUSION :

- Atherosclerosis is the most common cause of arterial occlusive disease.

- **Occlusion of the Superficial Femoral Artery With a Large Collateral Exiting Proximal to the Occlusion *(Arrow).***
- The presence of a collateral suggests chronic occlusion.

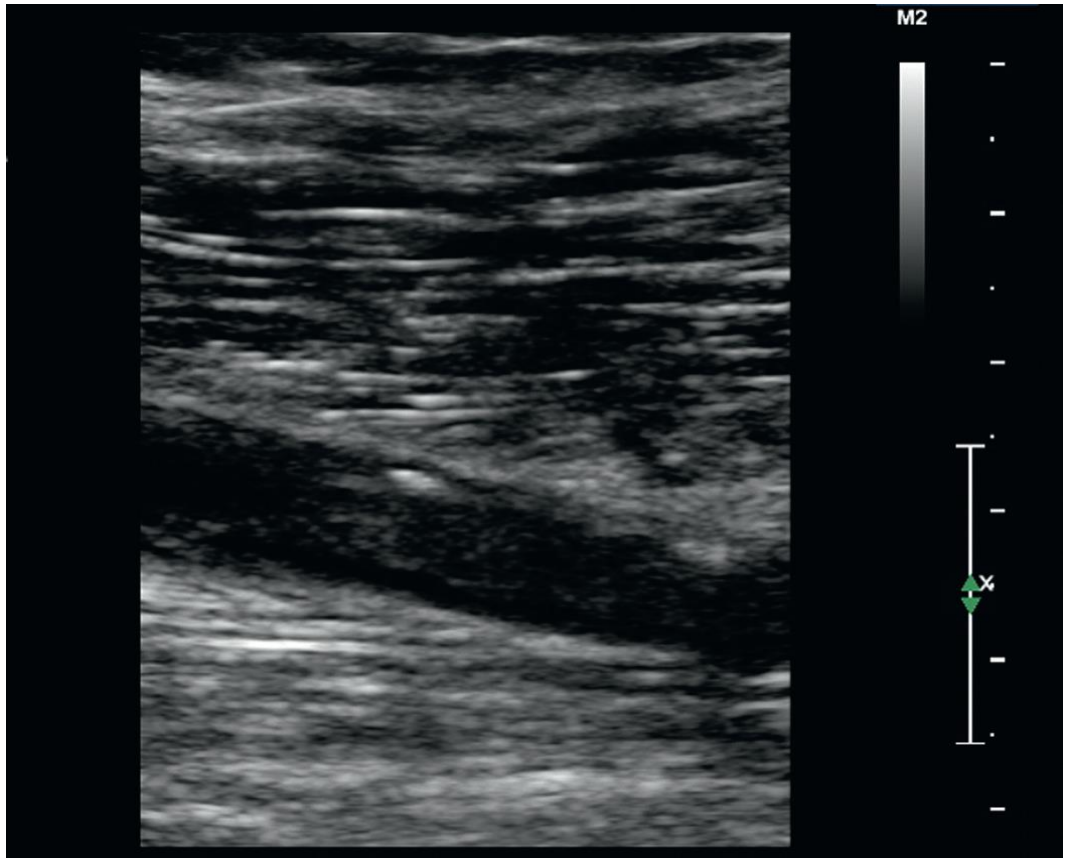


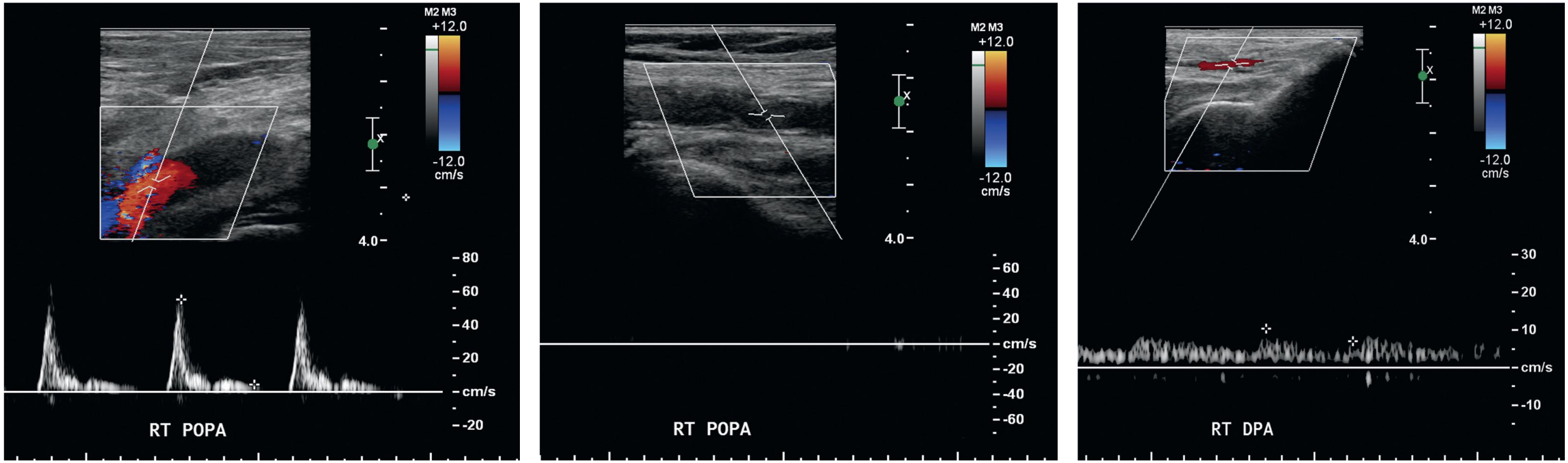
- # PERIPHERAL ARTERIAL OCCLUSION

ACUTE OCCLUSION :

- The most common cause of acute arterial occlusive disease is the arterial embolus.
- The embolus can consist of a piece of thrombus that formed in the arterial system or can be a piece of an atherosclerotic plaque.

- **Acute Thrombus in the Superficial Femoral Artery**
- On gray-scale imaging, the anechoic lumen is typically filled with medium-echogenicity thrombus.

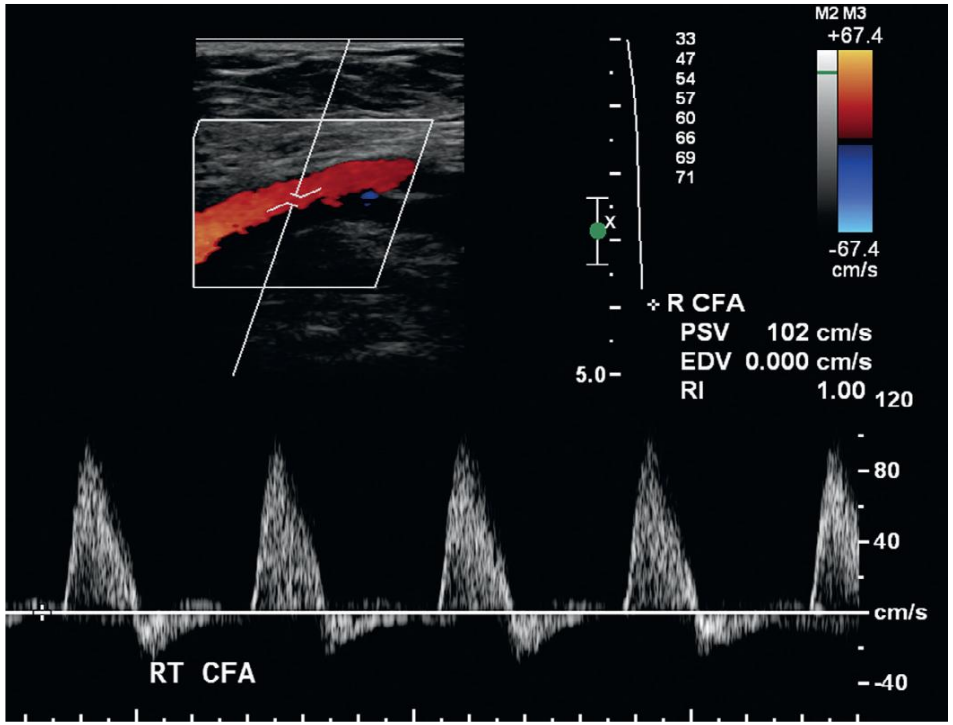




Occluded Popliteal Artery. (A) Spectral Doppler shows high-resistance flow pattern upstream to the occlusion. (B) Occluded portion of the popliteal artery without flow on spectral Doppler. (C) **Tardus parvus** pattern in the dorsalis pedis distal to the occluded popliteal artery indicates reconstitution of the artery by collaterals.

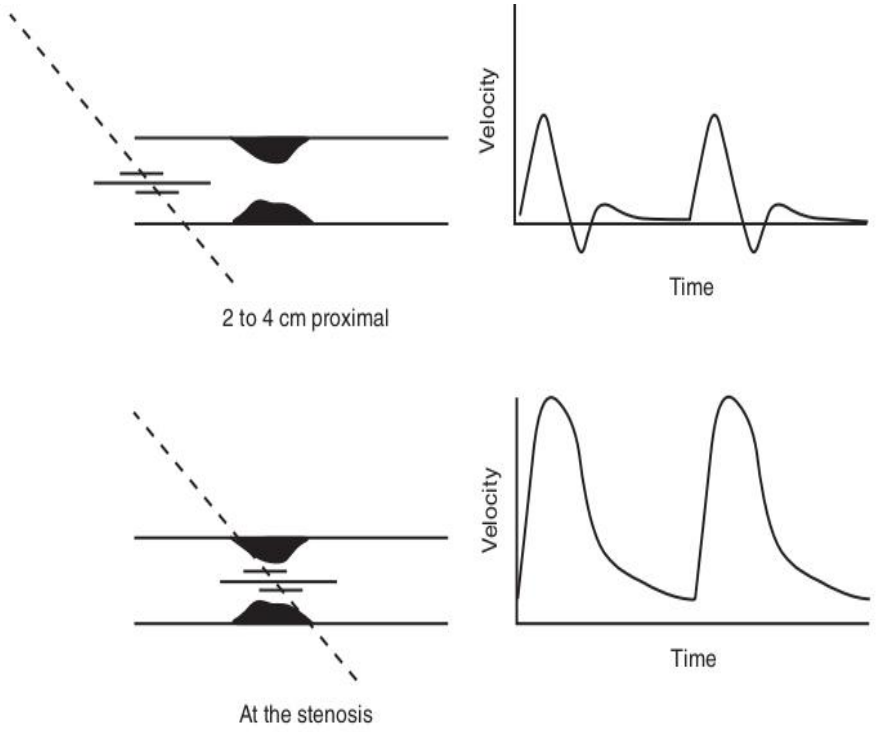
On color and spectral Doppler of an occluded artery, no flow signal should be detectable

Peripheral Arterial Stenosis

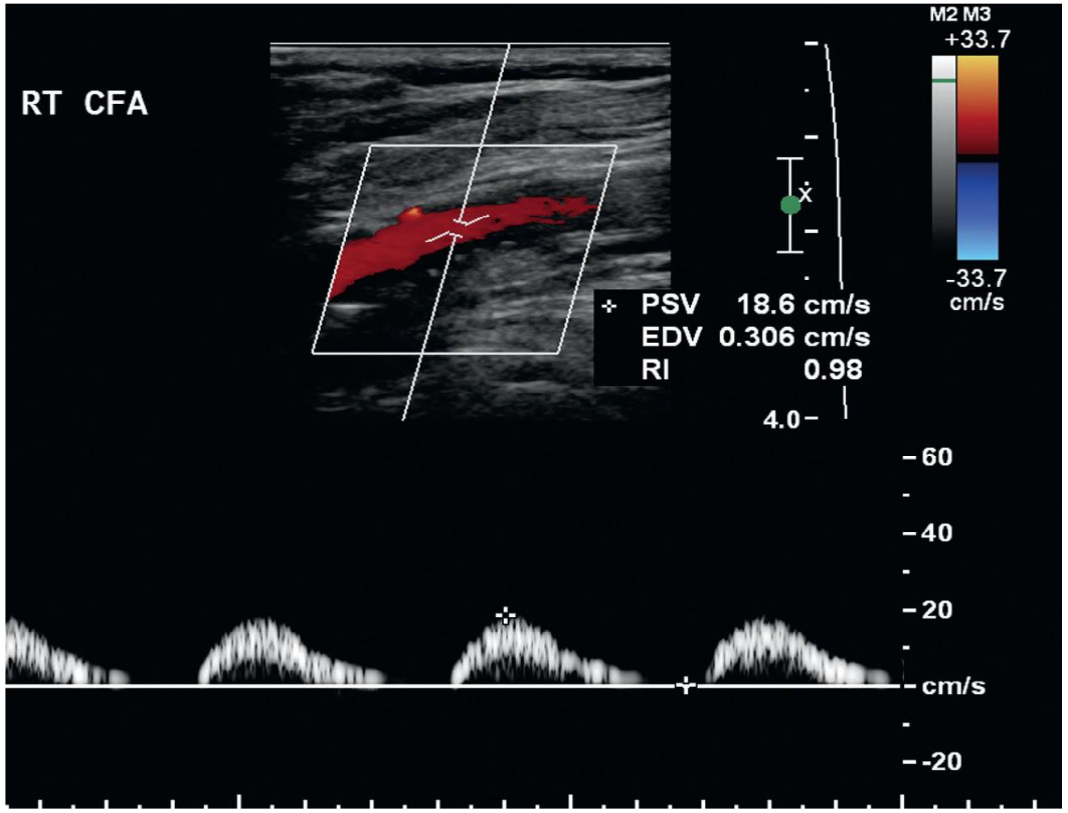


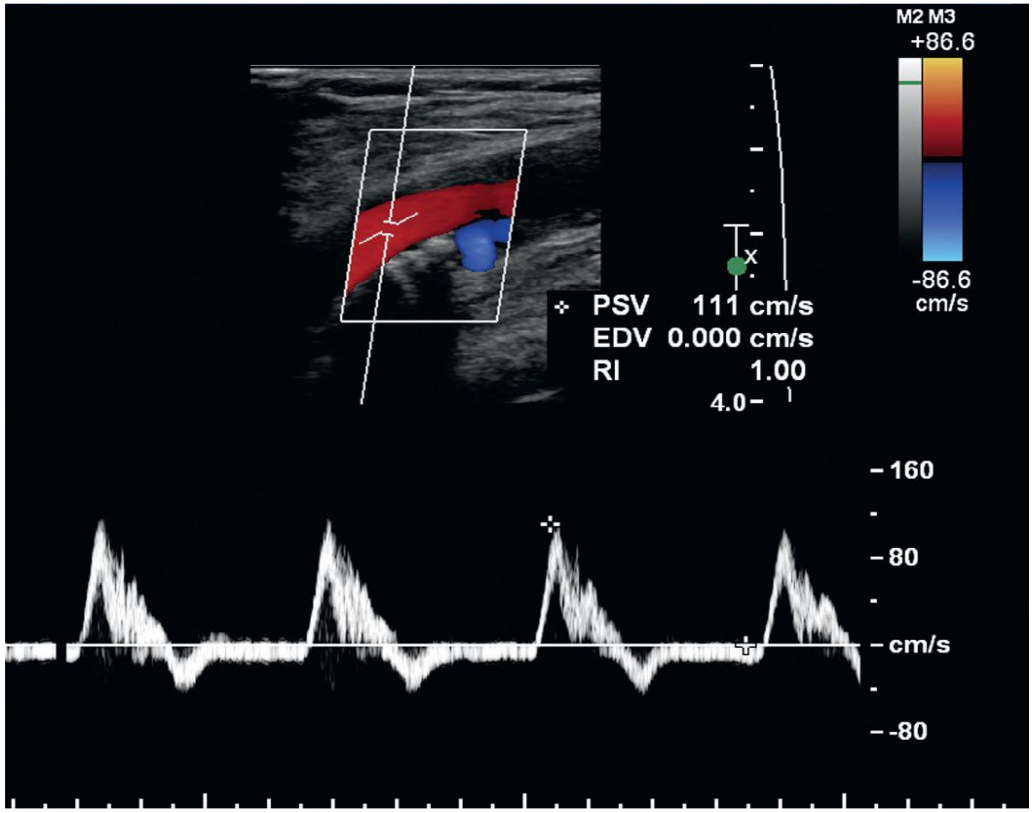
- Detection of **stenosis** in the setting of **atherosclerotic disease** is important owing to its role as a precursor to occlusion.
- Ultrasound is the primary screening tool for detection of stenosis, using a combination of gray-scale, color, and spectral Doppler.
- Spectral broadening can be seen in non flow-limiting stenosis less than 50%, with an otherwise normal waveform.

Continue....



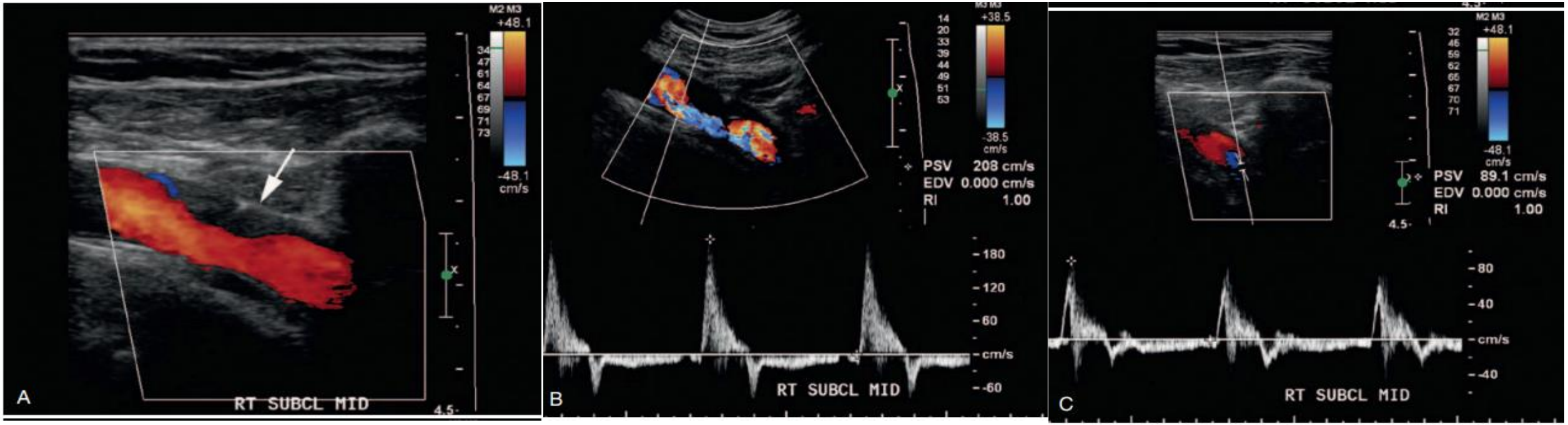
Blood Flow Velocity Alterations Occur With Stenosis of at Least 50%. Proximal to the lesion, the flow pattern is normal. At the stenosis, the peak systolic velocity increases in proportion to the degree of stenosis. Alterations in the diastolic portion of the Doppler waveform sampled at the lesion depend on the state of the distal arteries and the severity and geometry of the lesion; diastolic flow may increase dramatically or may be almost absent.





Iliac artery stenosis with monophasic waveform. (A) **monophasic waveform** in the right common femoral artery indicates severe upstream stenosis or occlusion.

(B) normal velocity biphasic waveform of the contralateral left common femoral artery indicates atherosclerotic Disease is in right common or external iliac artery, and not in the aorta (unilateral abnormal waveform).



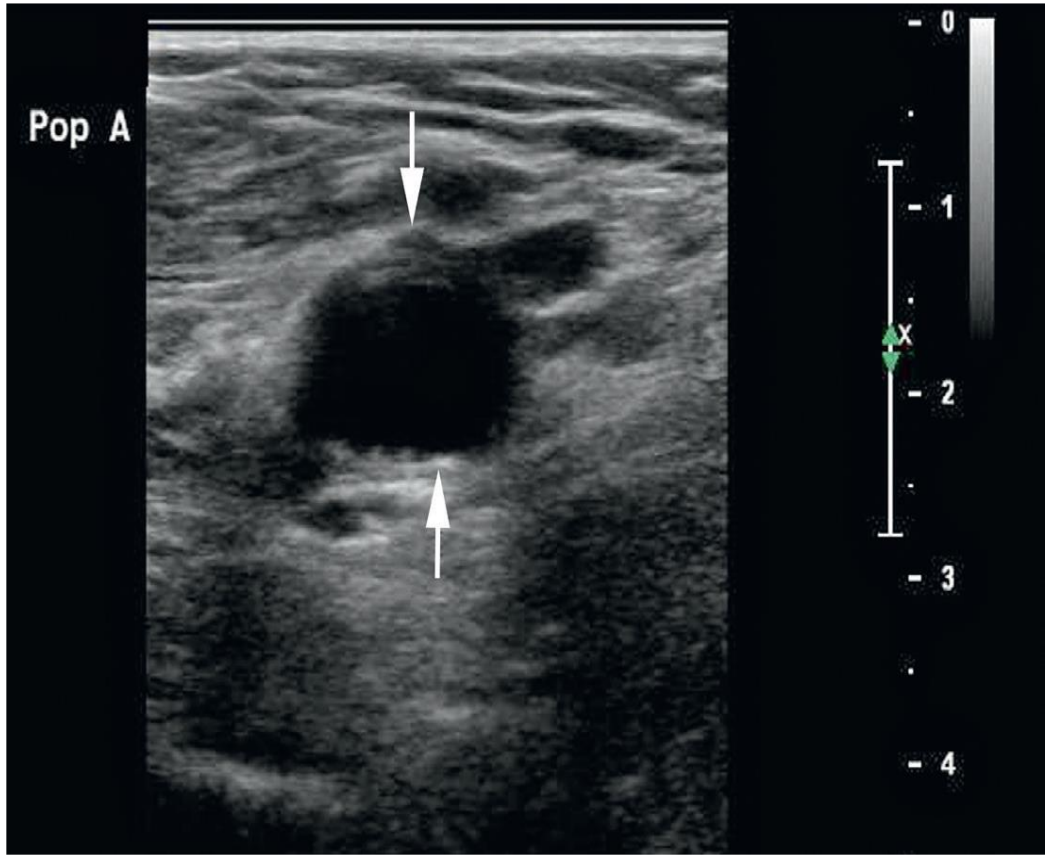
Subclavian Artery Stenosis Due to Atherosclerotic Disease. (A) Focal hypoechoic approximately 50% stenosis (arrow) in the proximal subclavian artery, outlined by color Doppler. (B) Peak systolic velocity (PSV) elevation at 208 cm/sec at stenosis. (C) PSV 2 cm upstream (proximal) to stenosis is 89.1 cm/sec for a PSV ratio of greater than 2 : 1.

ANEURYSM

- An **aneurysm** occurs when weakness of the arterial layers allows expansion of the arterial caliber beyond normal limits.
- Peripheral artery aneurysms may contain clot, which may result in distal emboli with or without soft tissue ischemia and infarction.
- The walls of an aneurysm may calcify, and the presence of calcifications may have some protective effects against rupture.

Continue……

- On gray-scale ultrasound, an aneurysm may appear as a fusiform anechoic or hypoechoic mass along the course of an artery



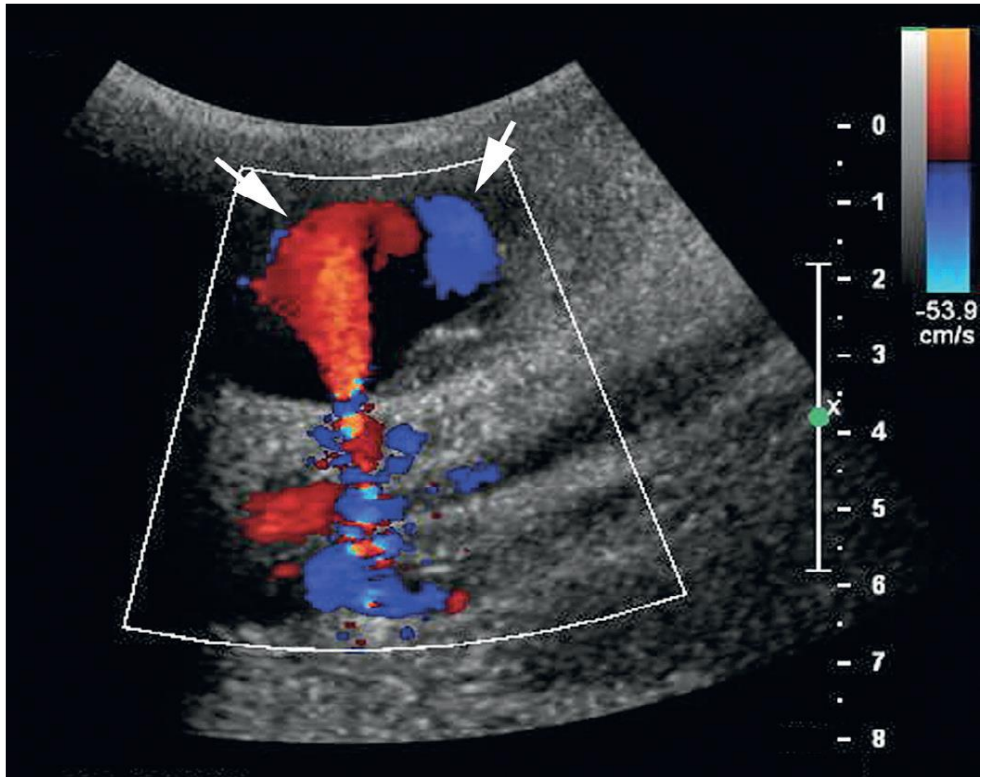
Continue……

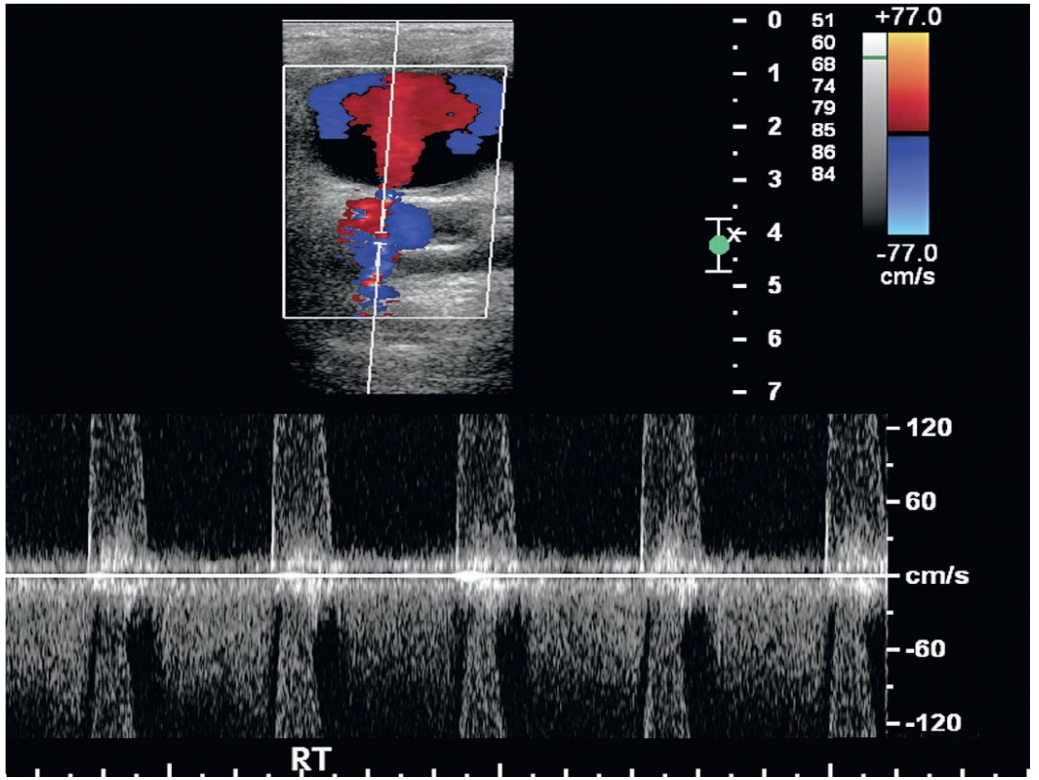
- A bulge or focal enlargement of 20% of the vessel diameter constitutes a simple functional definition of an aneurysm.
- 2-cm cutoff has been used to determine need for intervention.

Pseudo aneurysm

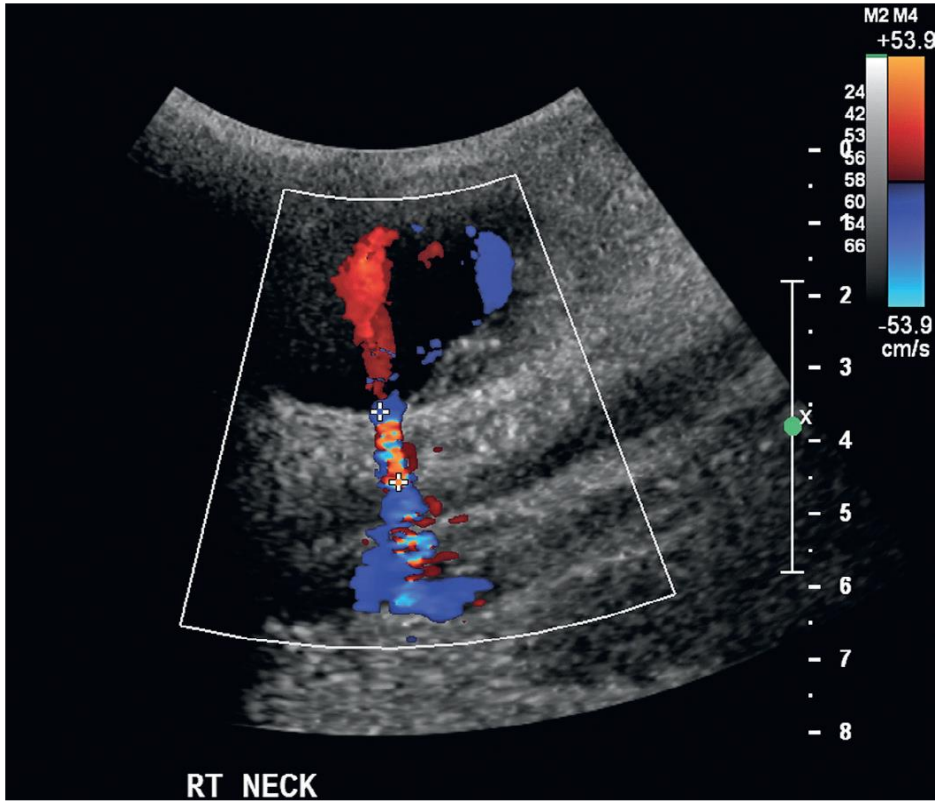
- Disruption of an artery with flow in a space beyond the vessel wall.
- It may arise from any arterial structure and may occur with direct trauma or tumor or inflammatory erosion.
- The mechanism of pseudo aneurysm formation---Pathologically, the arterial wall has been at least partially breached. A hematoma forms adjacent to the artery at the point of injury. Eventual lysis of the clot results in pseudo aneurysm.
- A pseudo aneurysm is different from an aneurysm in that at least one layer of wall is disrupted

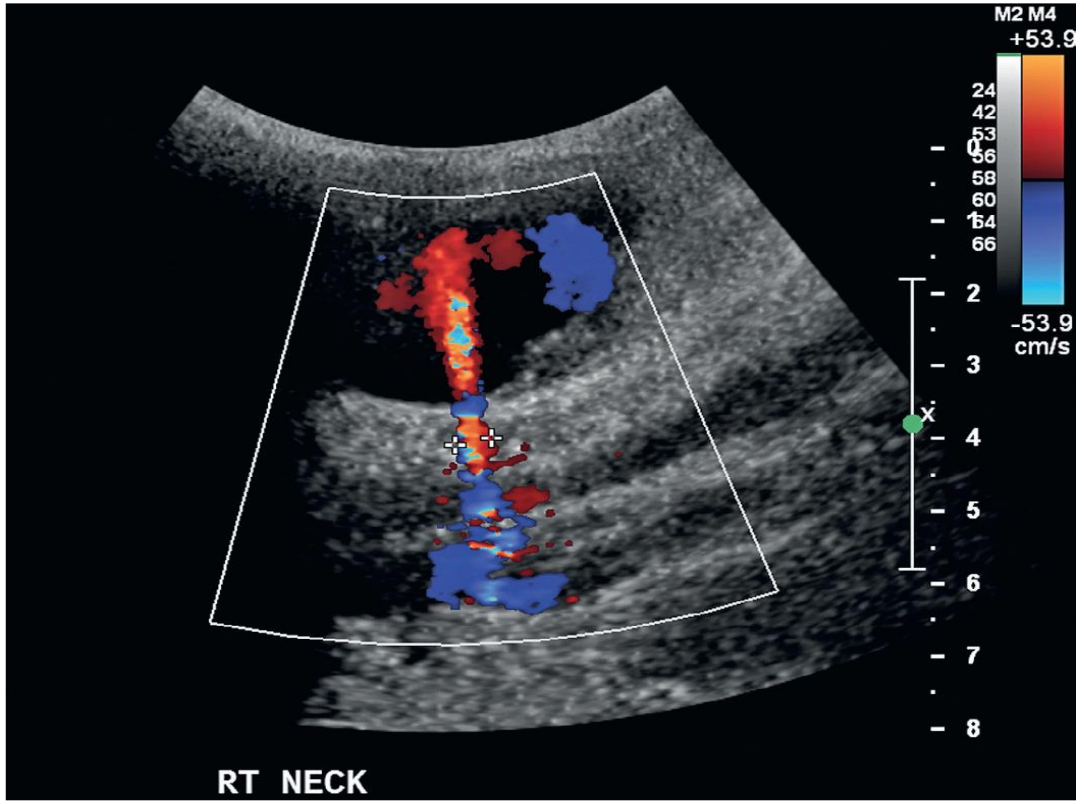
- The pseudo aneurysm can appear as a round or oval anechoic structure with or without associated thrombus.
- When present, thrombus appears isoechoic or hypoechoic; it may be located along the edge of the pseudo aneurysm lumen.
- Attention should be directed to these areas of extra luminal hematoma or any anechoic collections to determine if there are areas of flow with color Doppler.
- If flow is detected, spectral Doppler is next performed to characterize arterial versus venous flow and to exclude a superimposed AVF.





Common Femoral Artery Pseudo aneurysm. (A) Common femoral artery pseudo aneurysm with “yin-yang” colour flow pattern in the pseudo aneurysm *(arrows).* (B) Spectral Doppler of the pseudo aneurysm neck shows a high-velocity “to-and-fro” pattern.





Common Femoral Artery Pseudo aneurysm C) Measurement of the length of the neck from the common femoral artery to the pseudo aneurysm *(calipers).* (D) Measurement of the diameter of the neck *(calipers)* off of the common femoral artery indicates size of hole in artery; a “rent” in the artery

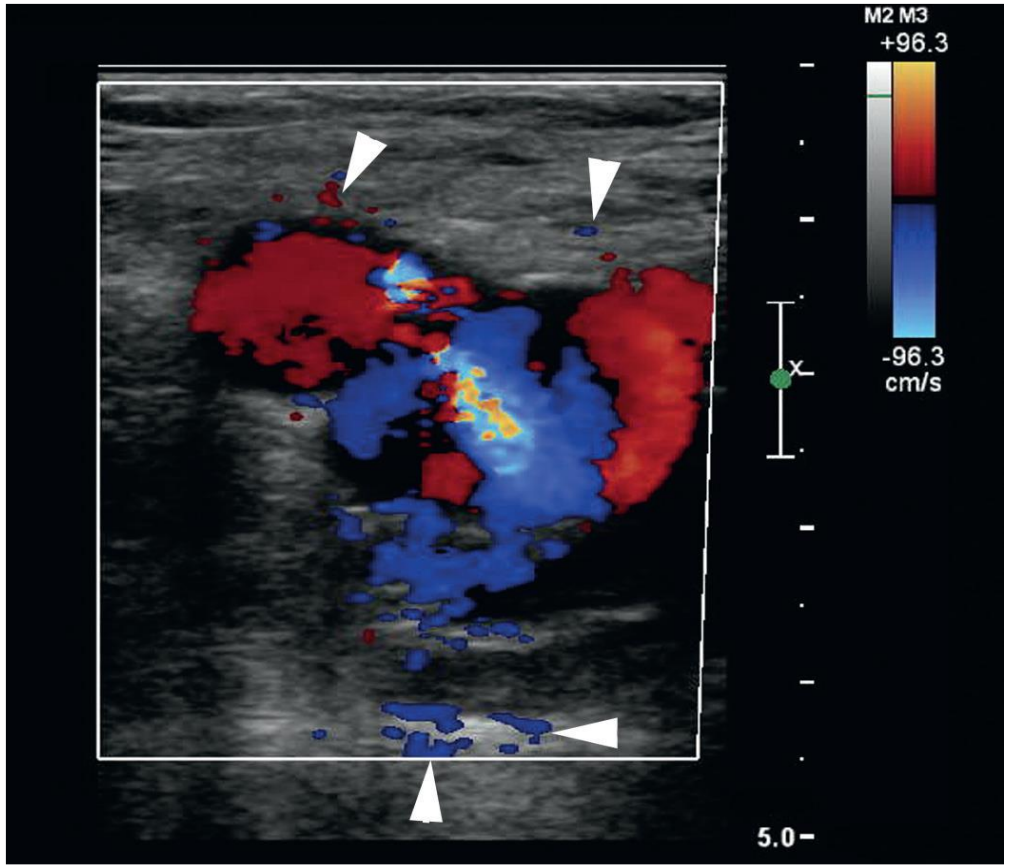
is less amenable to thrombin injection.

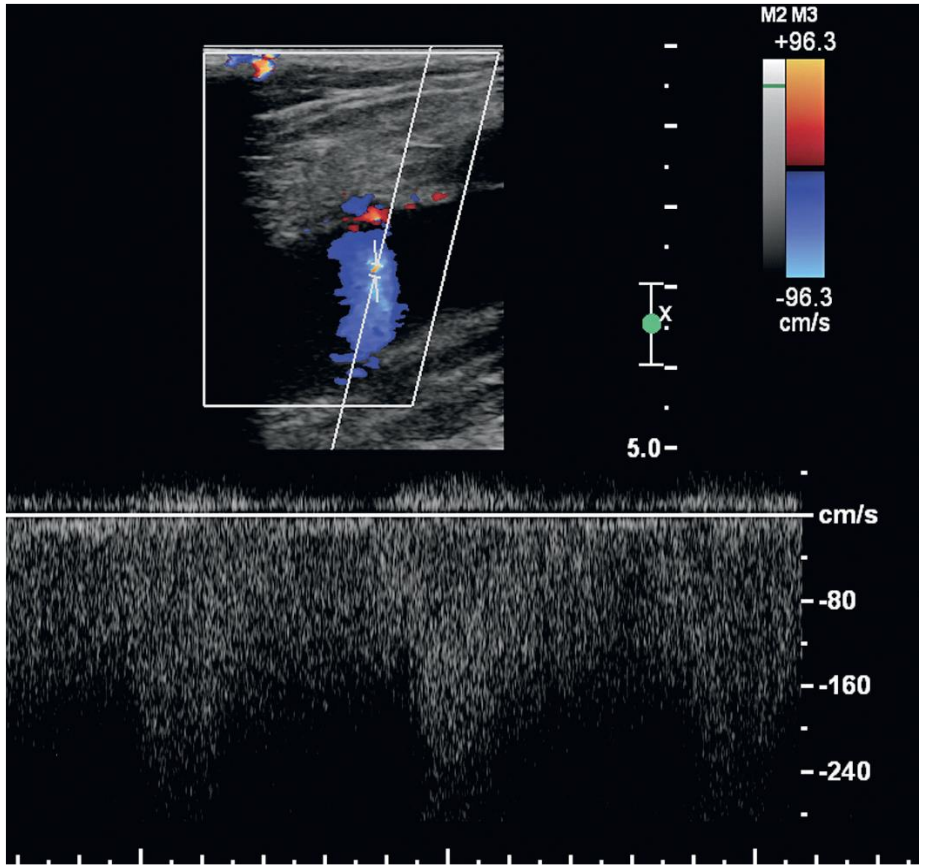
Arterio-venous fistula

- **fistula”** is an abnormal communication between the arterial and venous circulations.
- There is disruption through all layers of the arterial wall as well as a focal disruption of a nearby venous structure, allowing communication from high–arterial pressure to low-pressure veins.
- It can be congenital, acquired, or rarely spontaneous in nature.
- **A traumatic arteriovenous fistula** may course from normal artery to normal vein in the setting of trauma, but congenital arteriovenous malformations (AVMs) may occur with associated abnormal vascular structures.

CONTINUE…..

- Color Doppler ultrasound is the best noninvasive imaging modality to evaluate AVF or AVM and may **show a large cluster of tortuous vessels with abnormal hyperemic Flow.**
- Spectral Doppler waveforms of the inflow arteries feeding the AVF may show low-resistance Flow because they bypass the capillary bed.
- **Tissue vibration artifact**



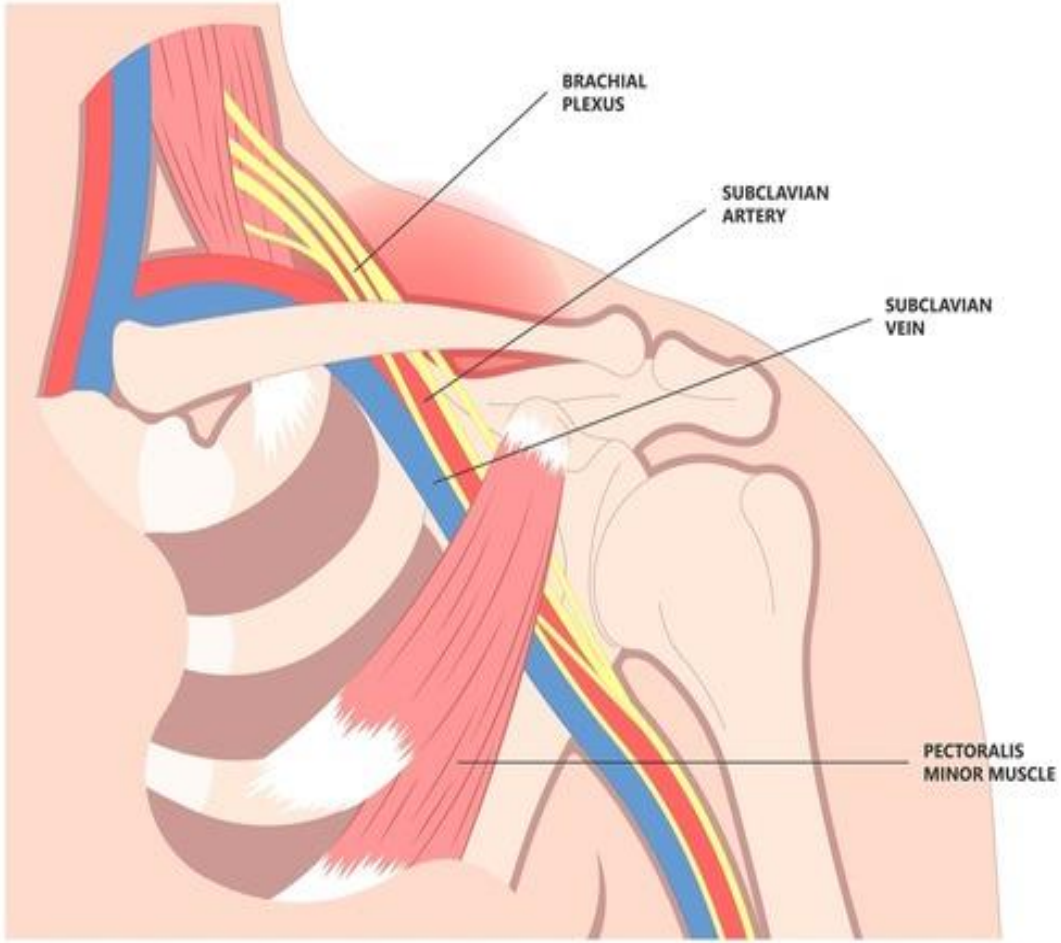


Common Femoral Artery to Common Femoral Vein Arteriovenous Fistula (AVF). (A)Color Doppler shows common femoral artery to common femoral vein AVF. Note the adjacent tissue vibration artifact *(arrowheads).* (B) Arterialized turbulent flow is seen within the vein just downstream to the AVF.

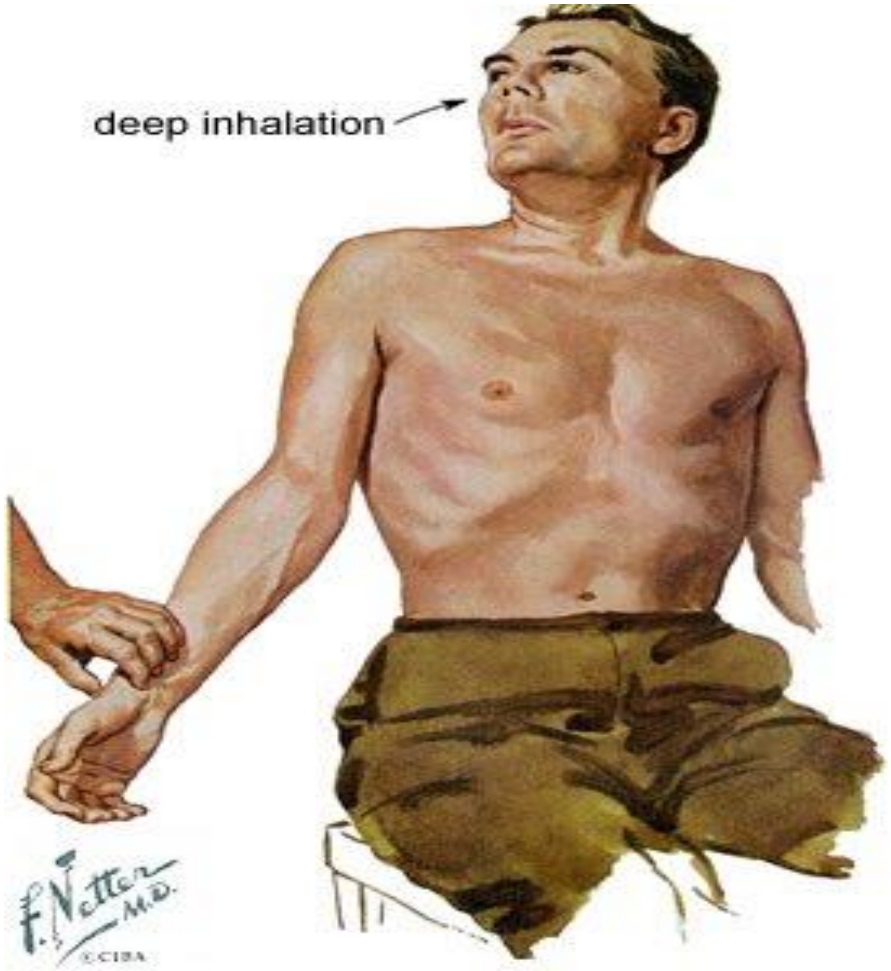
Thoracic Outlet Syndrome

- It occurs by external compression of the artery by adjacent muscles during abduction of the arm, and this narrowing can affect the waveform morphology of the downstream arteries.
- The velocities in the artery should be evaluated during adduction or neutral position then compared with velocities and waveforms in abduction.

- arm in neutral position for baseline waveform characterization. Waveforms are acquired from the forearm arteries with the patient sitting comfortably in an upright, seated position. Once the baseline morphology is clearly defined, the arm is moved into the inciting position, usually with abduction and elevation of the arm with external rotation.
- A combination of inspiration, breath holding, neck extension, and neck turn to the affected side, known as the **Adson maneuver**, may elicit a positive finding on Doppler.
- If positive, a diminished waveform should be apparent in the arteries of the forearm. Once this has been identified, it may be helpful to repeat the baseline and positive results to show reproducibility of the findings.



THORACIC OUTLET SYNDROME



Adson's test

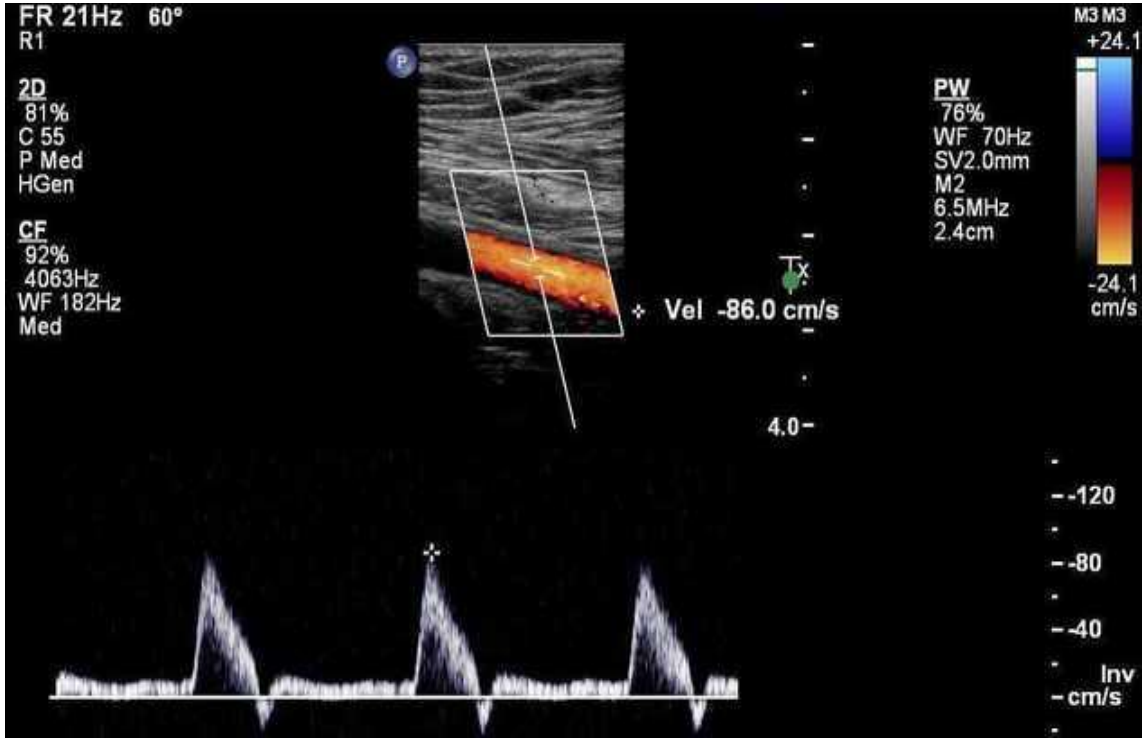


Image 1: left subclavian artery waveform with the arm adducted and at rest.

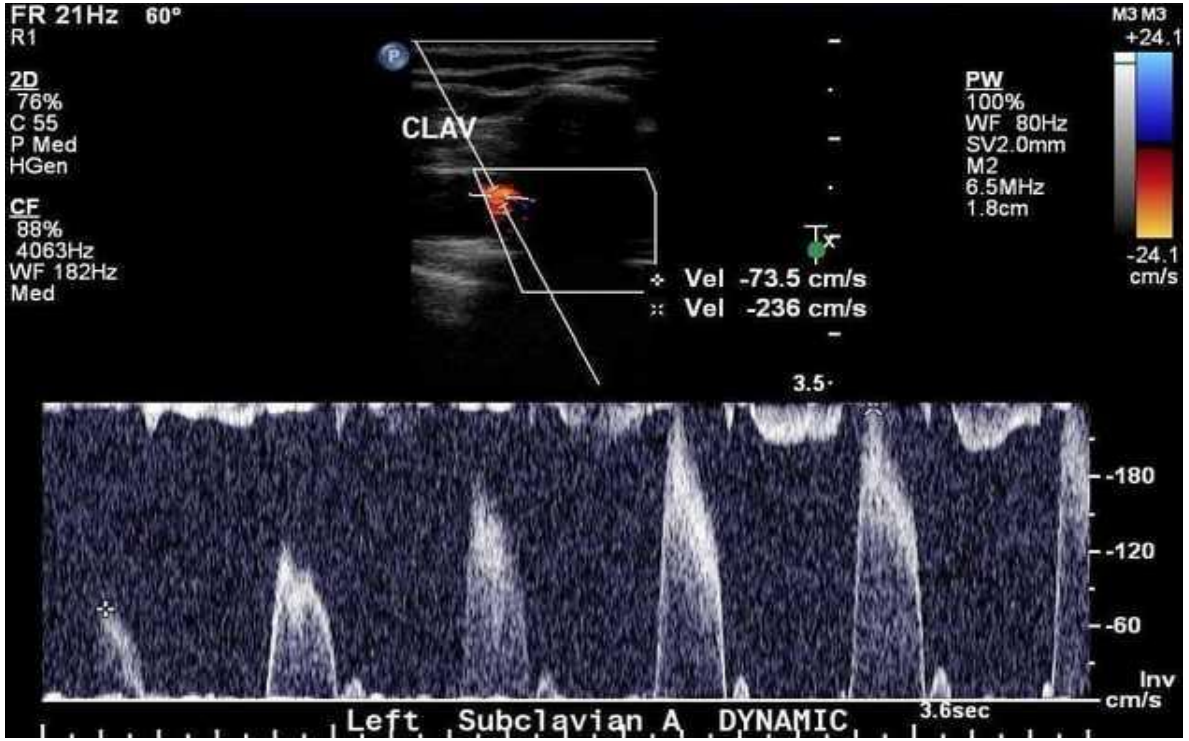


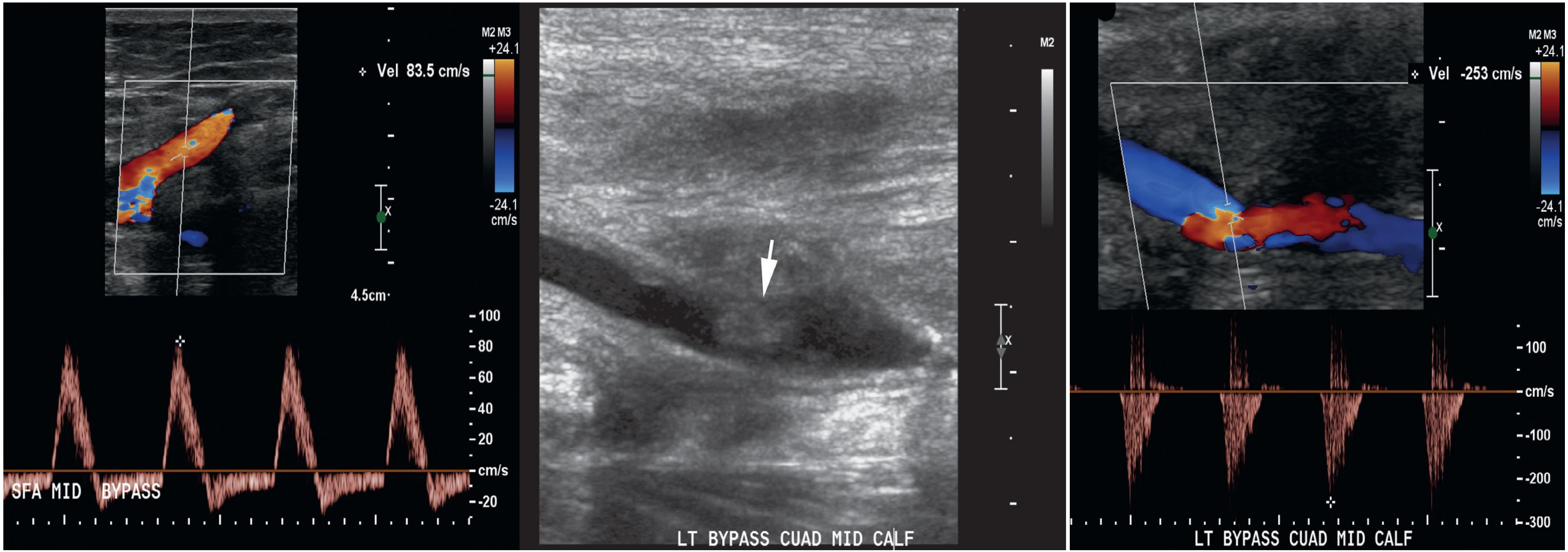
Image 2: with the arm in extreme abduction, the velocity within the left subclavian artery more than triples at the lateral edge of the clavicle, suggesting compression beneath the clavicle.

Image 3 : marked damping of the waveform in the lateral left subclavian artery with the arm in extreme abduction.

Lower Extremity Vein Bypass Grafts

- **Bypass grafts** may use arterial segments or veins for arterial revascularization.
- Ultrasound is a good technique to identify lesions that are likely to result in native vein bypass graft failure.
- Normal triphasic or biphasic waveforms in the ankle arteries distal to the bypass suggest patency of the bypass. Generalized reduced or monophasic flow velocities in a graft are concerning for disease.

- **Velocity ratio :** calculated by dividing the PSV at the stenotic site by peak velocity in the graft 2 cm upstream.
- PSV ratio of at least 2.0 corresponds to at least 50% diameter stenosis.
- Velocity criteria for severe stenosis used by Wixon and colleagues suggest that PSV above 300 cm/sec and PSV ratio above 3.5 should direct the patient to intervention of a vein graft stenosis.



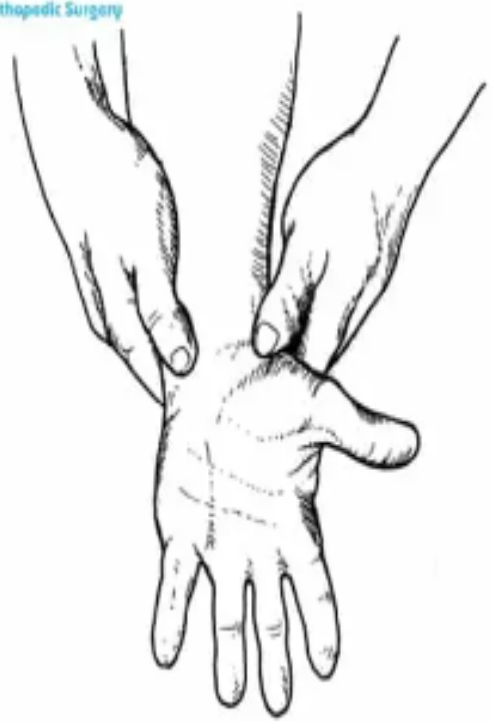
Superficial Femoral Artery Bypass Graft. (A) Color and spectral Doppler show normal biphasic flow in the proximal bypass graft, with a peak systolic velocity of 83.5 cm/sec. (B) Grayscale imaging in the midcalf shows a focal area of narrowing or thrombosis *(arrow).* (C) Spectral Doppler at the stenosis with aliasing and a peak velocity of 253 cm/sec, consistent with at least 50% stenosis.

Radial Artery Evaluation for Coronary Bypass Graft

- **to determine suitability of the radial artery for coronary artery grating**
- the ulnar artery supplies the superficial palmar arch, which is often incomplete.
- the radial artery supplies the deep palmar arch, which is more commonly complete, in communication with the ulnar artery.
- If the superficial palmar arch in the hand is patent, thus allowing flow to the entire hand through the ulnar artery, then the radial artery is harvested.

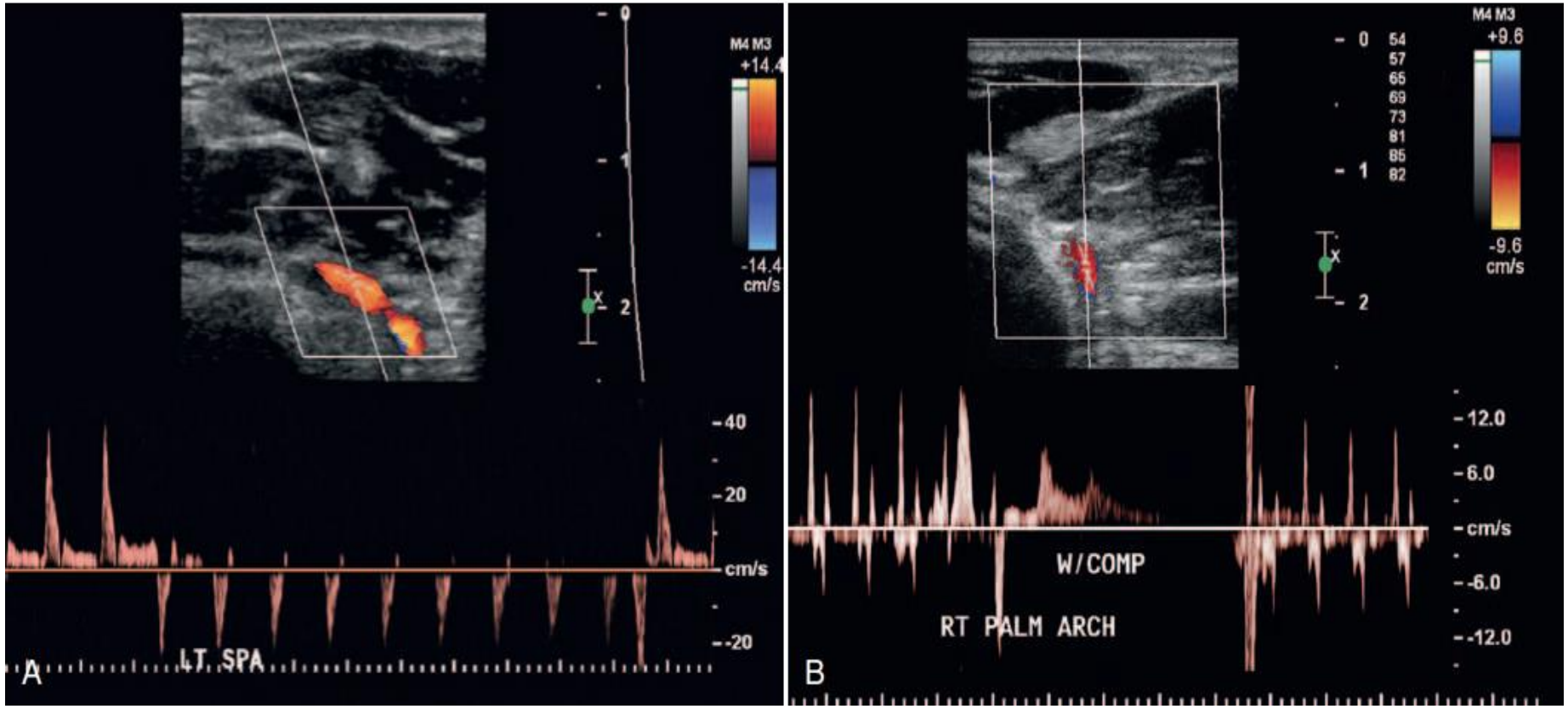
- With duplex Doppler, arterial low to the hand in the superficial palmar arch at the thenar eminence near the crease of the base of the thumb is characterized first with normal distal radial artery inflow. Subsequently, the radial artery is transiently occluded by direct compression of the radial artery at the wrist, and the resultant spectral Doppler waveform is evaluated.
- In patients with a patent superficial palmar arch, there should be reversed low of the radial artery in the hand, measured at the thenar eminence or in the region of the snuff box between the first metacarpal and second carpal bone.
- If there is no flow or absent reversed flow, then the radial artery of that upper extremity is not suitable for harvest owing to an incomplete arch.

OrthoFixar
Orthopedic Surgery



Allen Test

- The Allen test (or as it called Fist-Closure Test) is used to determine the patency of the vessels supplying the hand (the radial and ulnar arteries).
- Place your thumbs over the patient's radial and ulnar arteries and get him to clench his hand three times in quick succession.
- Compress the vessels and ask him to extend the fingers. The hand should be blanched.
- Now release the radial artery and note whether the return of skin color is delayed for more than 3 seconds.
- Repeat the test, this time releasing the ulnar artery.

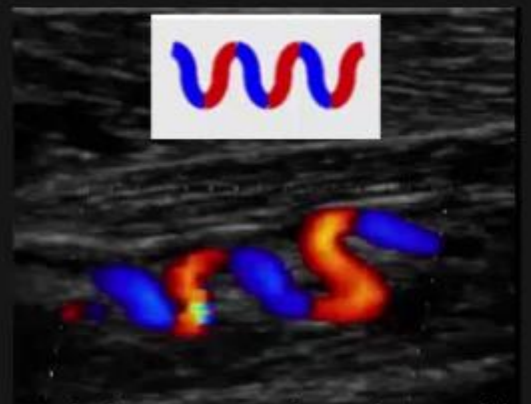


Radial Artery Evaluation for Coronary Bypass Graft. (A) Patent palmar arch, with reversal of flow in the superficial palmar arch on radial artery compression at the wrist. (B) Incomplete palmar arch, with lack of flow in the superficial palmar arch on radial artery compression at the wrist.

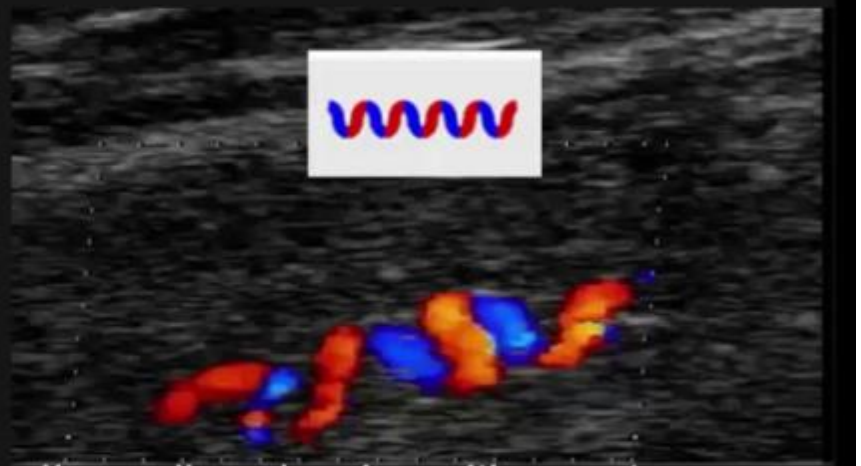
BURGER’S DISEASE

- Buerger's disease is a progressive, nonatherosclerotic, segmental inflammatory vasoocclusive disease of unknown etiolog, affecting the small and medium sized arteries, veins and nerves and is often bilateral-where inflammatory thrombi may affect both the arteries and veins

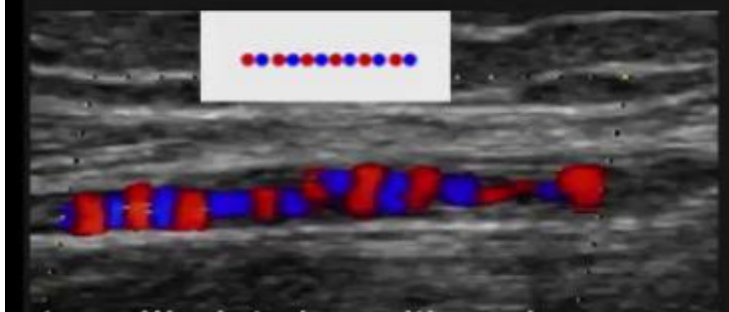
Multiple dilated **corkscrew** collaterals are noted bilaterally in **Buerger disease**



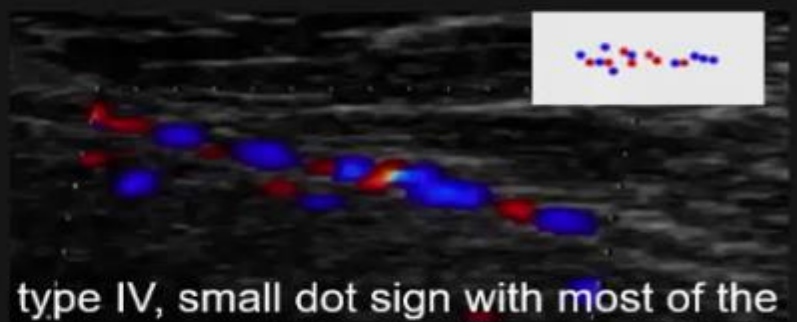
type I, large snake sign with an artery amplitude >5 mm being similar to or greater than amplitudes of original conduit arteries



type II, small snake sign with an artery amplitude >3 and ≤5 mm, most of the corkscrew collaterals with an amplitude of ≤3 mm being shown as dot signs



type III, dot sign with corkscrew collaterals with an amplitude >1 and ≤3 mm shown as a striped pattern of the side row



type IV, small dot sign with most of the corkscrew collaterals with an amplitude of ≤1 mm shown as random points but not a striped pattern of the side row

THANK YOU