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CLINICAL APPROACH TO VASCULAR ULTRASOUND AND REGISTERED PHYSICIAN IN VASCULAR INTERPRETATION (RPVI) PREP COURSE

Subclavian and Vertebral Ultrasonography

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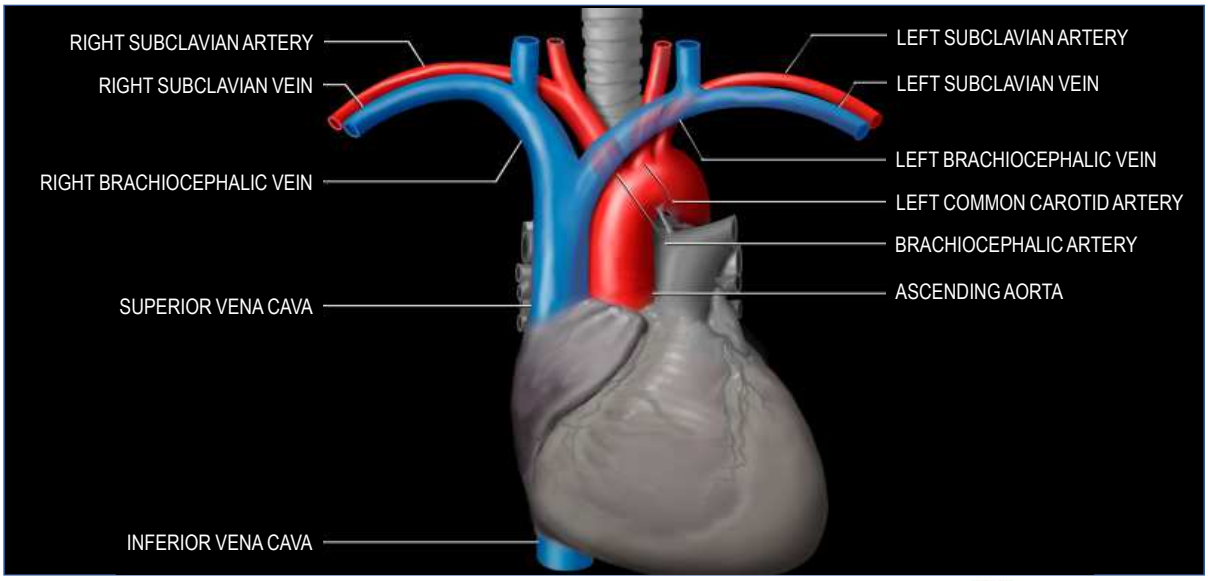
SUBCLAVIAN VESSELS ANATOMY



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SUBCLAVIAN VESSELS ULTRASOUND IMAGING

- ✓ Subclavian artery (SCA) and vein (SCV) evaluation is usually part of duplex imaging of the upper extremity
- ✓ The same principles and basic techniques of imaging of other vascular districts, such as the lower extremity, also apply to the subclavian vessels
- ✓ There are anatomical features and pathological processes affecting the subclavian vessels that require specific evaluation and provocative maneuvers

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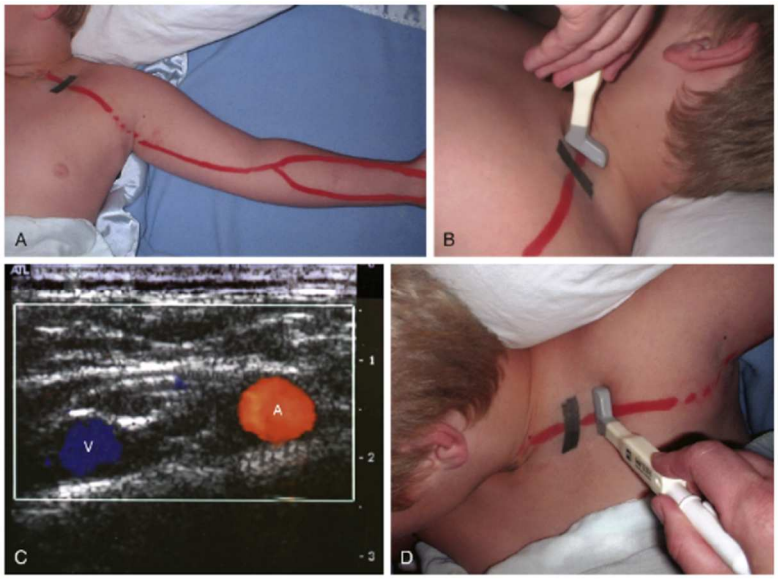
SUBCLAVIAN VESSELS ULTRASOUND IMAGING



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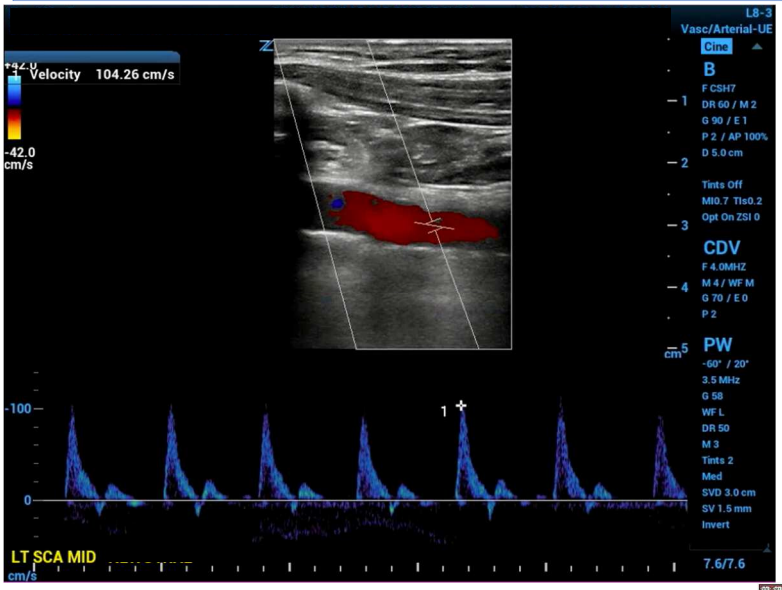
SUBCLAVIAN ARTERY ULTRASOUND IMAGING



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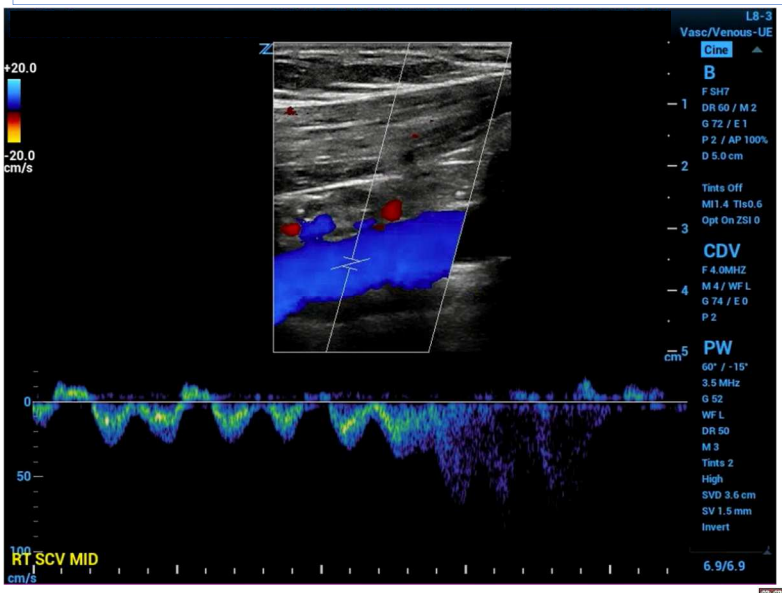
SUBCLAVIAN VEIN ULTRASOUND IMAGING



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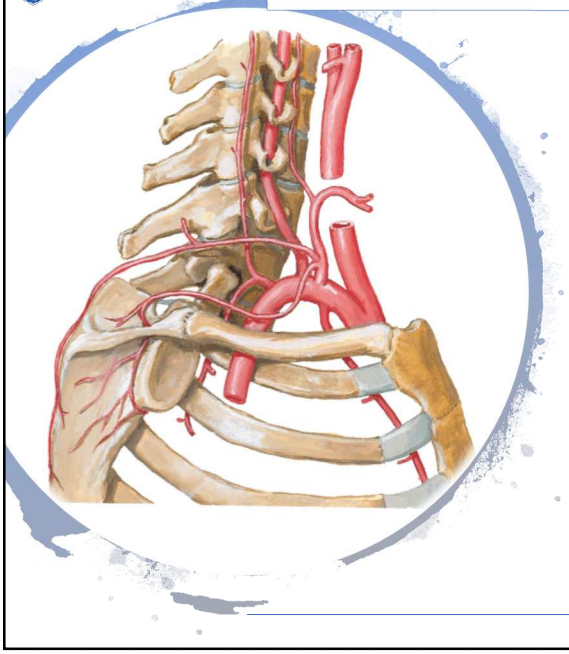
SUBCLAVIAN VESSELS PATHOLOGY



- ✓ Atherosclerosis
- ✓ Thoracic outlet syndrome
- ✓ Stenting
- ✓ Thrombosis & Embolism
- ✓ Vasculitis
- ✓ Dissection
- ✓ Aneurysm

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SUBCLAVIAN ARTERY ATHEROSCLEROSIS

- ✓ SCA atherosclerosis is often diagnosed incidentally when different blood pressures are noted between the upper extremities
- ✓ The left SCA is four times more likely to be affected than the right SCA
- ✓ Even when asymptomatic, atherosclerotic SCA stenosis is associated with increased risk of coronary artery disease and cerebrovascular events

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SUBCLAVIAN ARTERY ATHEROSCLEROSIS

- ✓ Manifestations of atherosclerotic SCA stenosis include arm claudication, rest pain, distal embolization with finger ischemia, and steal phenomena
- ✓ Neurologic symptoms from vertebrobasilar hypoperfusion include vertigo, syncope, ataxia, visual disturbances, dysarthria and facial sensory deficits
- ✓ In patients with internal mammary artery coronary bypass grafts, steal may cause anginal symptoms

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SUBCLAVIAN ARTERY ATHEROSCLEROSIS

- ✓ Stenosis of 50% or greater are hemodynamically significant and can be identified by increased peak systolic velocity (PSV), post-stenotic turbulence, and abnormal distal waveforms (monophasic, delayed time to peak, broad systolic peak, continuous diastolic flow)
- ✓ A post-stenotic PSV that is double the pre-stenotic PSV is considered hemodynamically significant (≥50%)

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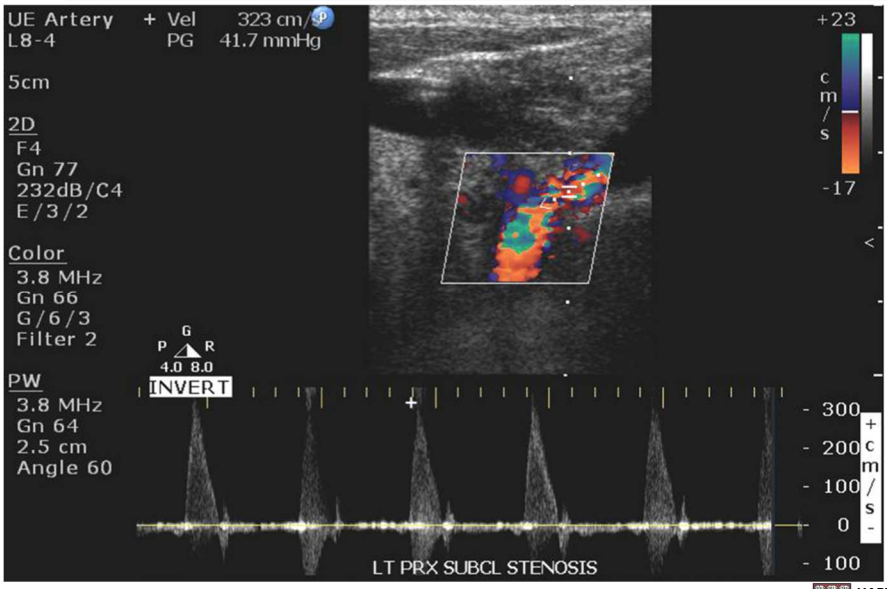
SUBCLAVIAN ARTERY ATHEROSCLEROSIS



(Pellerito JS, Polak JF. Introduction to Vascular Ultrasonography 6th Ed. 2012)

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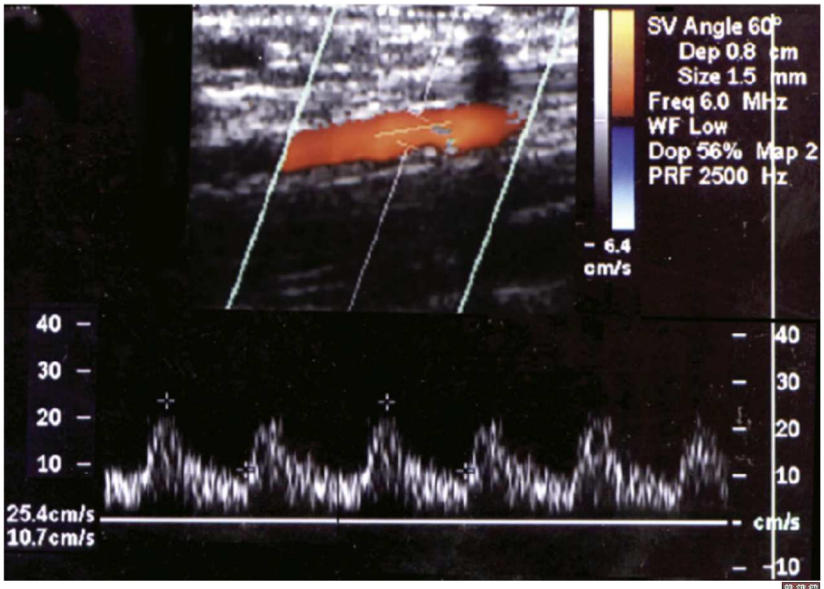
SUBCLAVIAN ARTERY ATHEROSCLEROSIS



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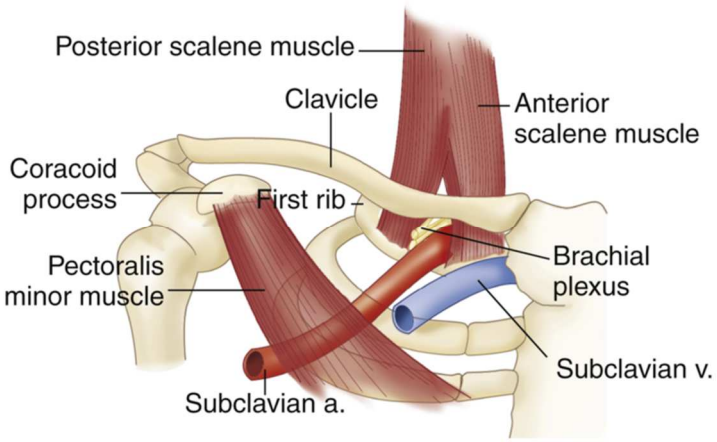
SUBCLAVIAN THORACIC OUTLET SYNDROME



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SUBCLAVIAN THORACIC OUTLET SYNDROME

- ✓ The thoracic outlet is bounded by the clavicle, first rib and scalene muscles
- ✓ The subclavian vessels and brachial plexus may become compressed within this confined space with certain arm positions
- ✓ The repeated mechanical stress may injury the artery or the vein leading to intimal damage or thrombus formation

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SUBCLAVIAN THORACIC OUTLET SYNDROME

- ✓ To diagnose the presence of arterial or venous thoracic outlet syndrome (TOS), the subclavian vessels are imaged in the neutral position and during provocative maneuvers
- ✓ Pulsed Doppler signal is monitored for dampening or total loss during performance of the provocative maneuvers

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SUBCLAVIAN THORACIC OUTLET SYNDROME

Test	Maneuver	Result
ADSON TEST	Affected arm is abducted 30° at the shoulder while maximally extended. While extending the neck and turning head towards ipsilateral shoulder, patient inhales deeply	Decrease or absence of ipsilateral radial pulse
Elevated Arm Stress Test (EAST) or ROOS	Arms are placed in the surrender position with shoulders abducted to 90° and in external rotation, with elbows flexed to 90°. Patient slowly opens and closes hand for 3 min	Precipitates pain, paresthesias, heaviness or weakness
Upper Limb Tension Test (ULTT) or ELVEY	Position 1: arms abducted to 90° with elbows flexed Position 2: active dorsiflexion of both wrists Position 3: head is tilted ear to shoulder, in both directions	Positions 1 and 2 elicit symptoms on the ipsilateral side, while position 3 years elicits symptoms on the contralateral side

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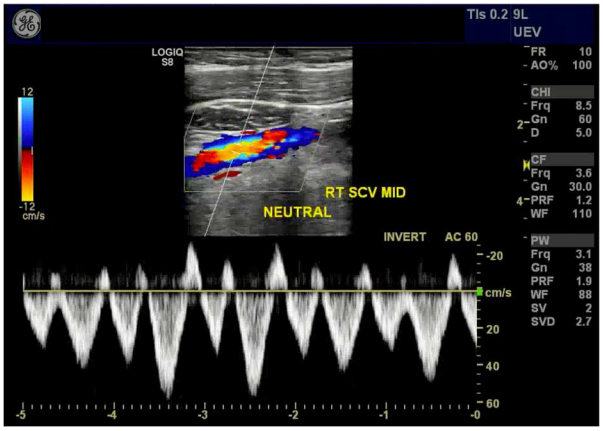
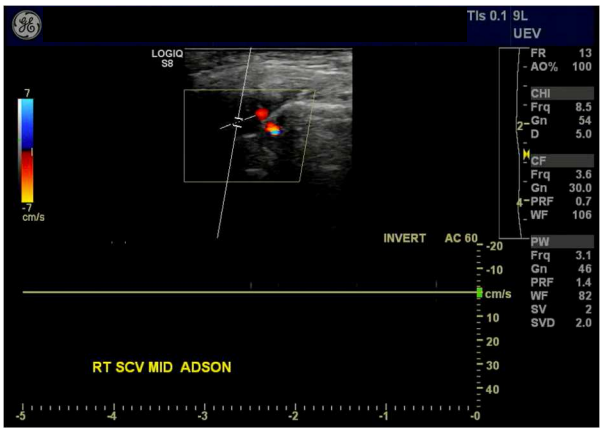
SUBCLAVIAN THORACIC OUTLET SYNDROME

VENOUS TOS





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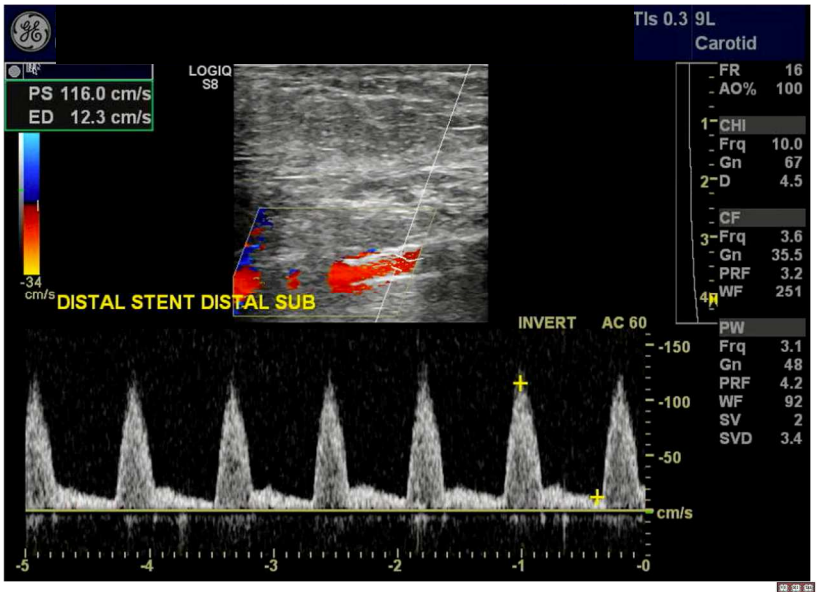
SUBCLAVIAN ARTERY STENTING



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SUBCLAVIAN VENOUS THROMBOSIS

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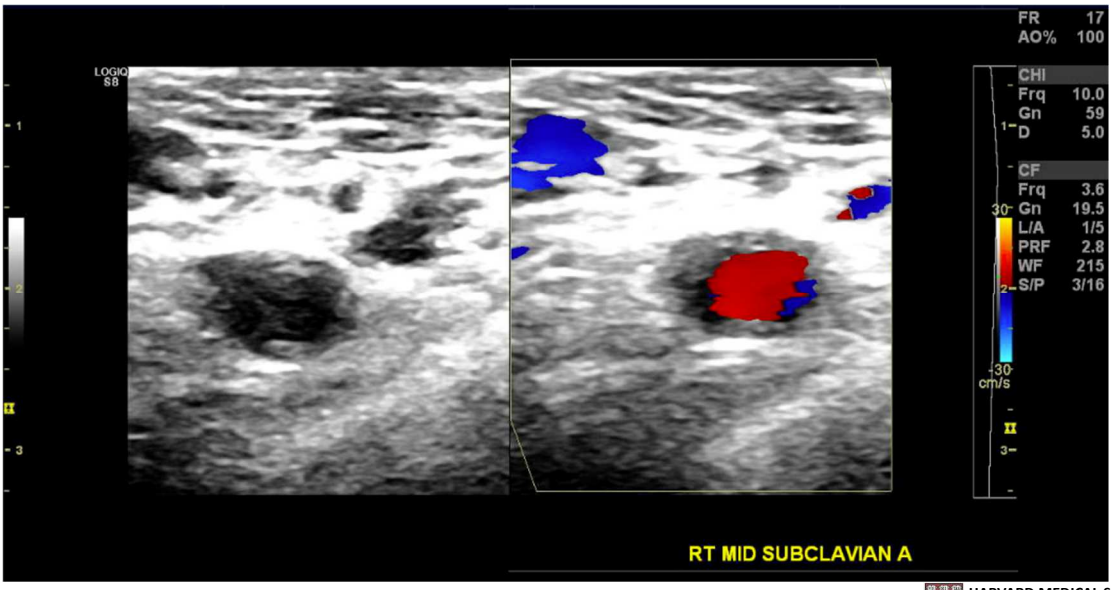
SUBCLAVIAN ARTERY VASCULITIS



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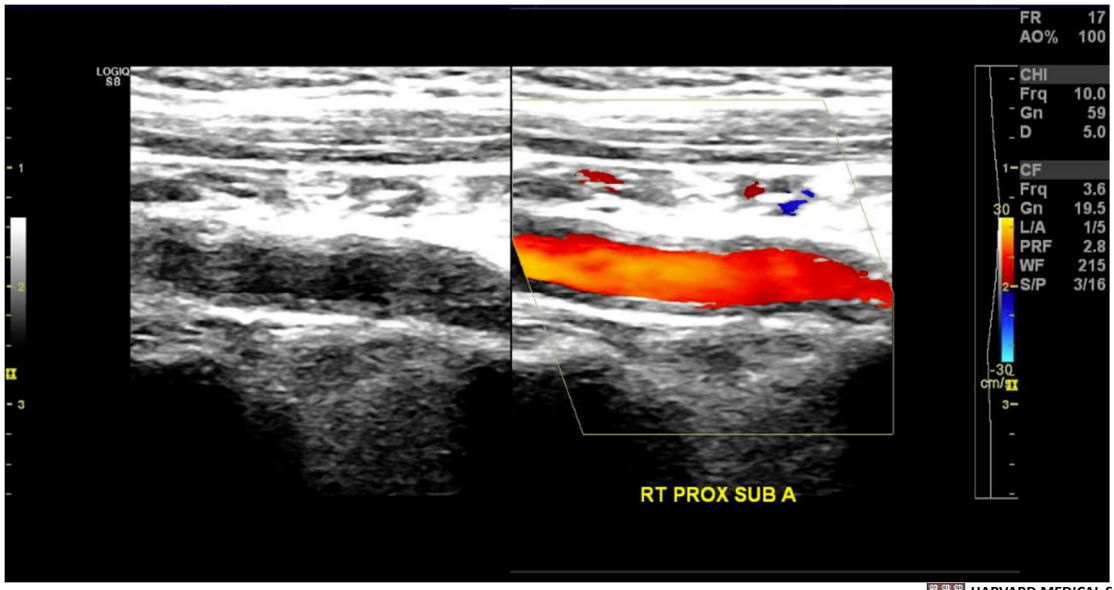
SUBCLAVIAN ARTERY VASCULITIS



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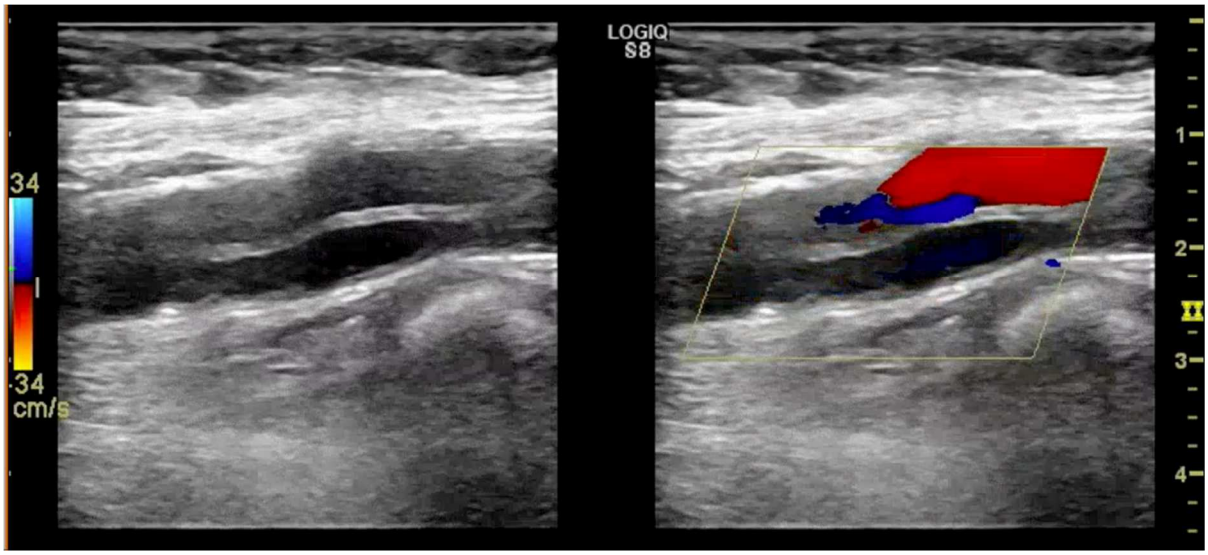
SUBCLAVIAN ARTERY DISSECTION



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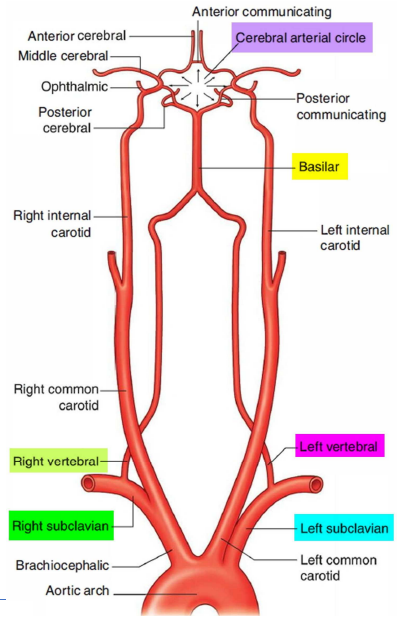
VERTEBRO-BASILAR SYSTEM ANATOMY



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VERTEBRAL ARTERY ULTRASOUND IMAGING

- ✓ Vertebral artery (VA) evaluation is part of duplex imaging of the extracranial arterial system
- ✓ Interpretation of the ultrasound findings of the VA requires knowledge of the anatomical and physiological relationships with the contralateral VA and ipsilateral SCA

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VERTEBRAL ARTERY ULTRASOUND IMAGING

- ✓ The normal spectral Doppler velocity waveform in the VA directly reflects the low vascular resistance of the intracranial vascular system
- ✓ The waveform should have a well-defined systolic peak with sustained flow throughout diastole
- ✓ There is wide variability in the absolute peak systolic velocity in normal patients, with a range of 20 cm/sec to 60 cm/sec or higher

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VERTEBRAL ARTERY ULTRASOUND IMAGING

- ✓ Up to three-quarters of all patients have a dominant VA, which demonstrates larger size and higher flows than the contralateral side, most often occurring on the left side
- ✓ Physiologic VA flow is antegrade (i.e. towards the brain) in both systole and diastole. The transient or complete flow reversal in a VA indicates the presence of a steal phenomenon

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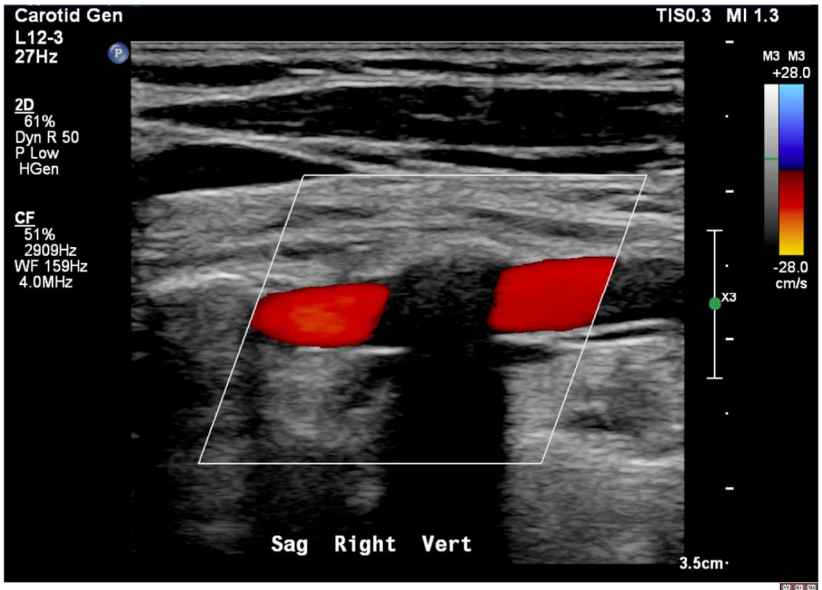
VERTEBRAL ARTERY ULTRASOUND IMAGING



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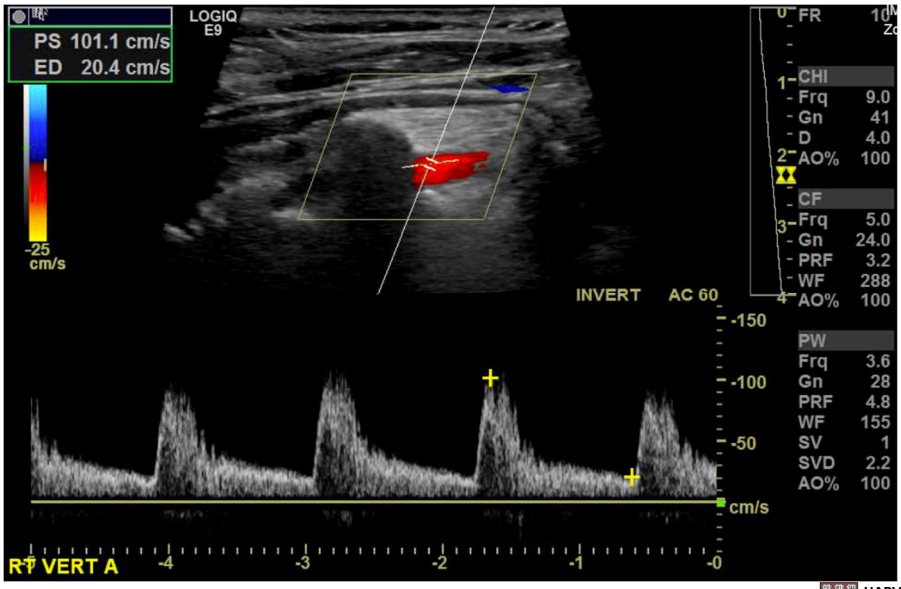
VERTEBRAL ARTERY ULTRASOUND IMAGING



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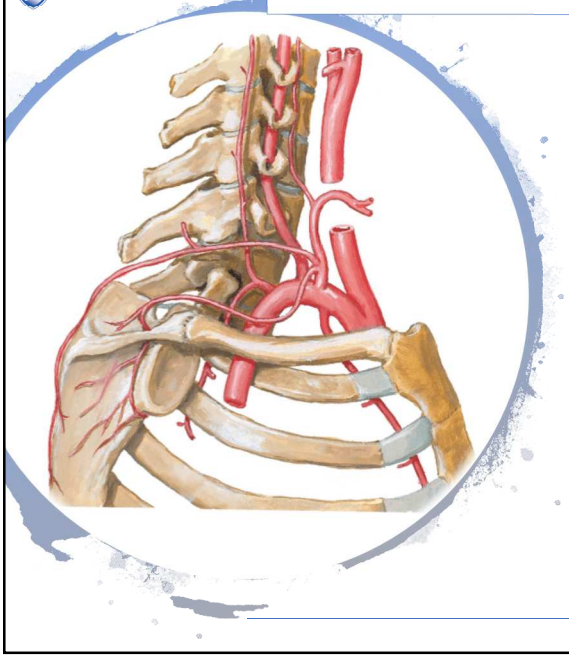
VERTEBRAL ARTERY PATHOLOGY



- ✓ Atherosclerosis
- ✓ Congenital
- ✓ Vasculitis
- ✓ Dissection
- ✓ Subclavian steal

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VERTEBRAL ARTERY ATHEROSCLEROSIS

- ✓ Atherosclerosis represents the main cause of VA stenosis and the majority of the atherosclerotic lesions occur at the origin
- ✓ No velocity criteria are available to define the severity of VA stenoses; however, a focal doubling of velocity implies a greater than 50% diameter reduction
- ✓ It is not always possible to discriminate between vertebral hypoplasia and acquired stenosis

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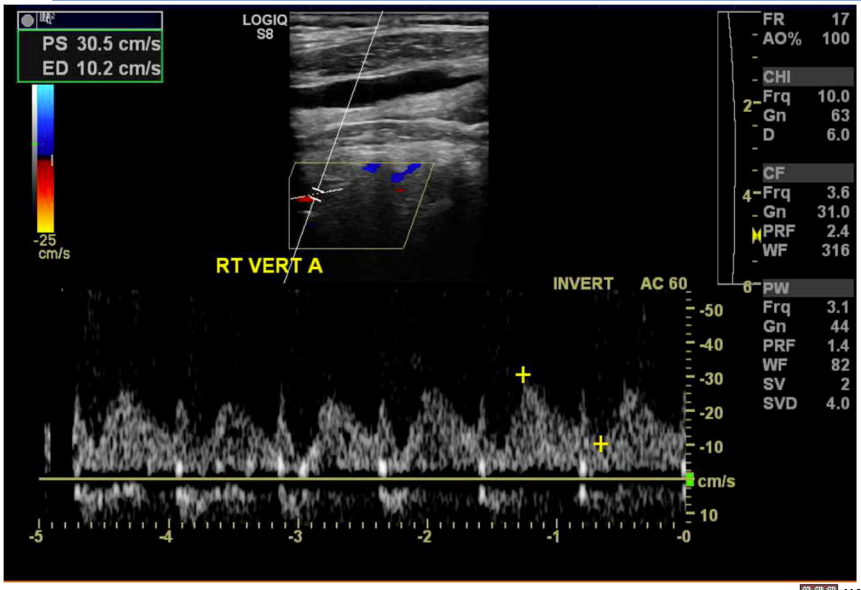
VERTEBRAL ARTERY ATHEROSCLEROSIS



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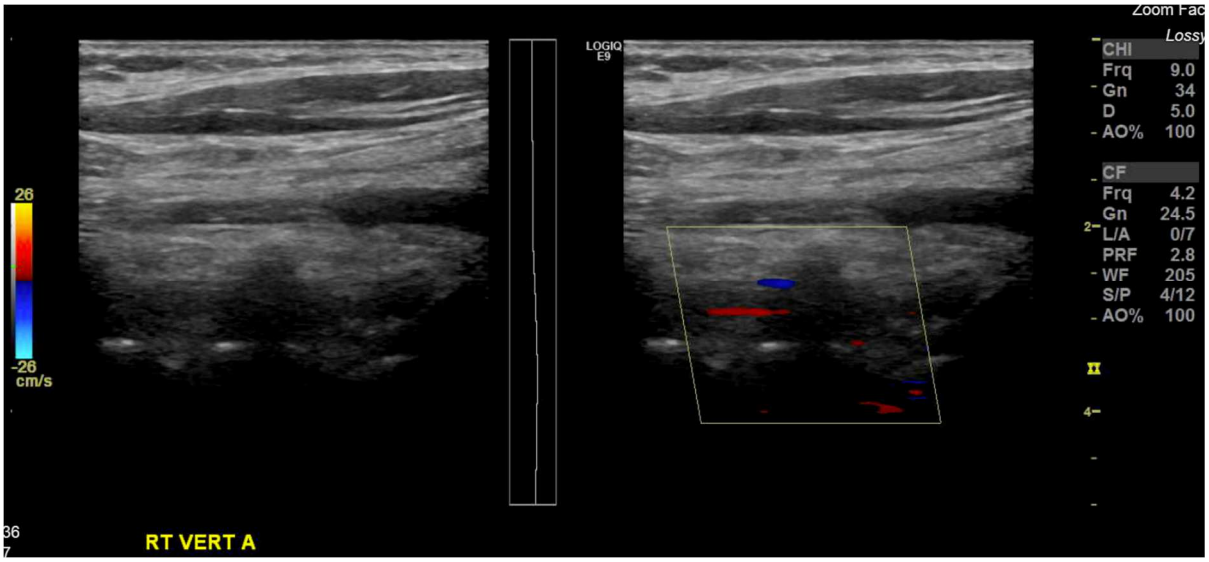
VERTEBRAL ARTERY VASCULITIS



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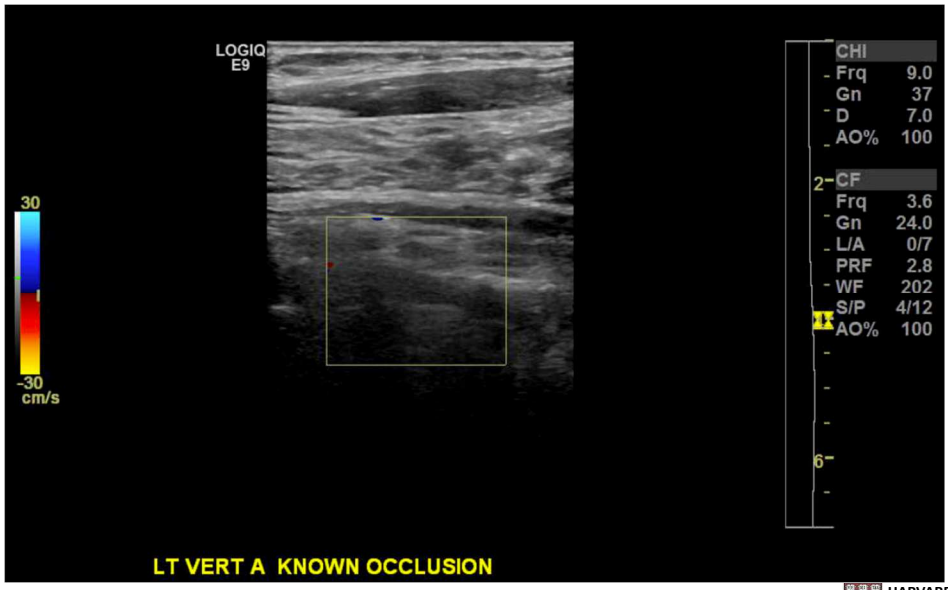

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SUBCLAVIAN STEAL

- ✓ A relatively frequent incidental finding on duplex interrogation of the VA is the presence of flow reversal in of the VA, a phenomenon known as subclavian steal
- ✓ Flow reversal is caused by the pressure gradient between a patent vertebrobasilar circulation and a subclavian or brachiocephalic artery with severe proximal obstruction

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SUBCLAVIAN STEAL

- ✓ When vertebral flow reversal is seen on the right side, it is important to determine whether the source of the steal is the SCA, which affects only VA flow, or the innominate artery, which has a significant effect on both the right common carotid and VA
- ✓ Typically, patients with subclavian steal also have a systolic pressure difference greater than 15 to 20 mm Hg between the normal and affected arms

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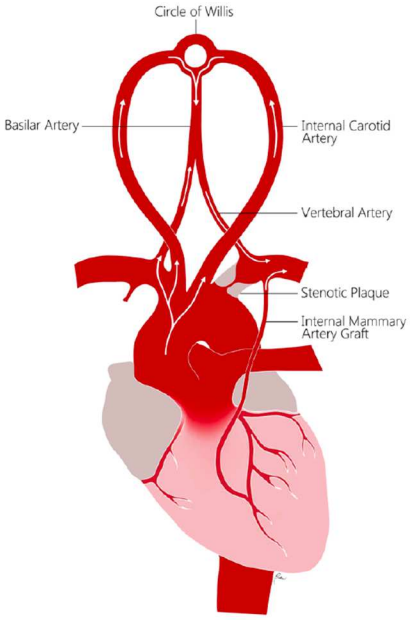
SUBCLAVIAN STEAL



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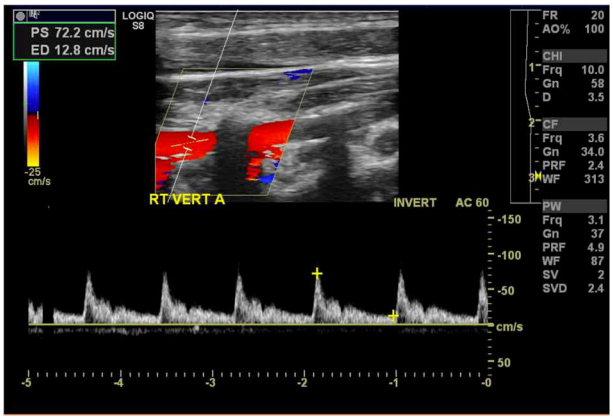
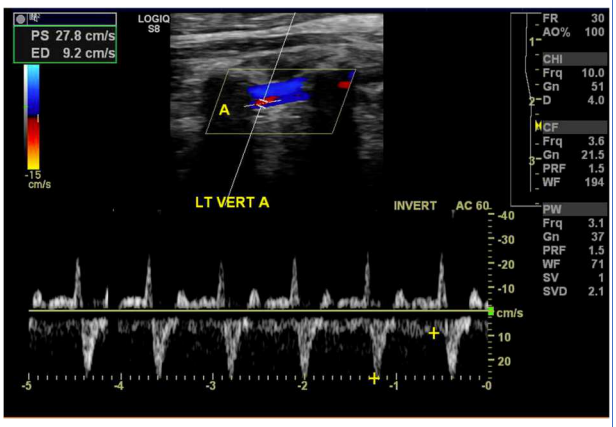
SUBCLAVIAN STEAL





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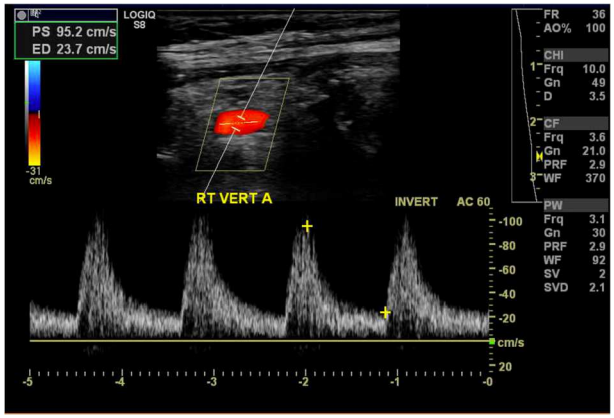
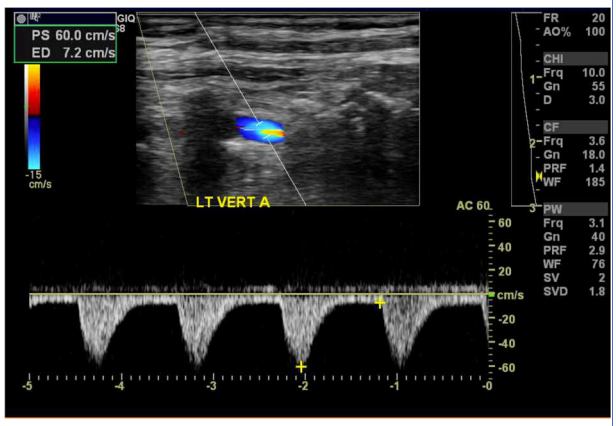
SUBCLAVIAN STEAL





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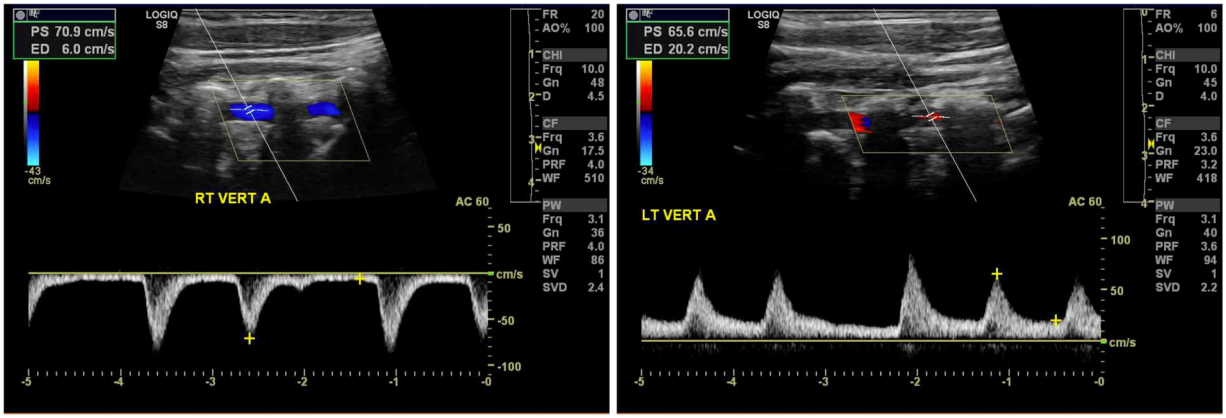
SUBCLAVIAN STEAL



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SUMMARY AND CONCLUSIONS

- ✓ Duplex evaluation of the subclavian vessels and of the VA is a useful diagnostic tool in the assessment of various pathologies affecting these vessels
- ✓ The same principles and basic techniques of imaging of other vascular districts also apply to these vessels

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SUMMARY AND CONCLUSIONS

- ✓ Knowledge of the anatomical features, circulatory physiology, pathologic processes, and provocative maneuvers is necessary to correctly perform the duplex ultrasound and interpret its results

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