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For Techniques in Noninvasive Vascular Diagnosis-4th edition.

by Robert J. Daigle, BA, RVT, RVS, FSVU, FSDMS

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Chapter 4. Vertebral-Subclavian- Innominate Artery Imaging

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Definitions for this chapter

- **Bruit** - a sound heard with a stethoscope that results from turbulent blood flow.
- **CCA** – common carotid artery
- **Antegrade**- normal flow direction
- **Retrograde**- abnormal, reversed flow direction
- **MRA**- magnetic resonance angiography (an MRI that looks at perfusion)

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Definitions for this chapter

- **"steal"**- blood flow that is "re-routed" from it's natural destination to another region.
- **Spectra, spectrum, spectral display** – all pertain to the Doppler waveform display.
- **Tardus parvus** – a waveform of low amplitude and delayed rise to systole.
- **High resistance waveform**- a waveform with low or absent diastolic flow.

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Vertebral Exam- Indications

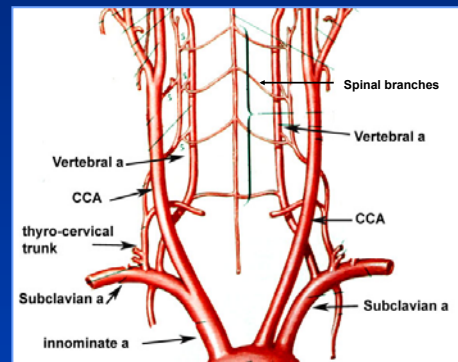
- Flow direction analysis during routine carotid duplex exam.
- Vertigo.
- Syncope.
- Drop attacks.
- Diplopia (double vision).
- Other vertebro-basilar symptoms.

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Subclavian Artery Axam- Indications

- Supraclavicular bruit.
- Reduced arm blood pressures.
- Abnormal vertebral spectra or abnormal vertebral artery flow direction.
- Arm weakness.
- ICAVL accreditation requirement

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Vertebral Method

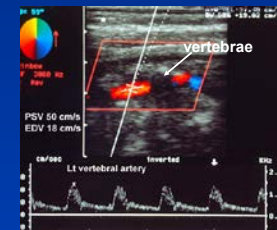
- Identify the CCA in longitudinal view from an anterolateral position.
- Scan in a posterior direction to identify the shadowed vertebrae (see below).
- Color may be helpful in identifying the vertebral artery and vein between the transverse processes of the vertebrae.



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Vertebral Artery

- Place the Doppler sample volume between a vertebral segment lying between two vertebrae



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Vertebral Artery

- Record spectral waveforms and pay close attention to FLOW DIRECTION
- Vertebral analysis may be difficult in some elderly patients due to close spacing of vertebrae; if so image the VA proximally

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Scan the vertebral origin if mid vertebral waveforms are abnormal

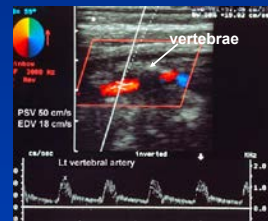


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Vertebral Artery

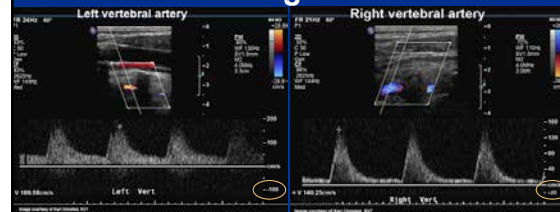
1. Normal mid vertebral artery waveform

Waveform reflects low resistance flow and is similar to the CCA. Normal flow is in an antegrade direction.



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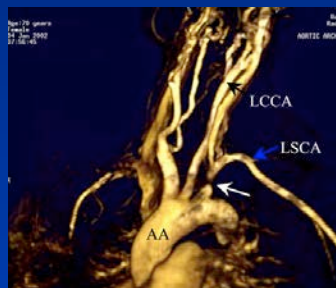
Which Vertebral is Retrograde?



Pay attention to flow direction.

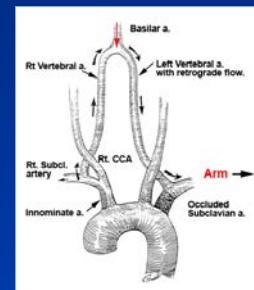
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Lt. Subclavian Artery Stenosis- MRA



Lt. Subclavian Steal

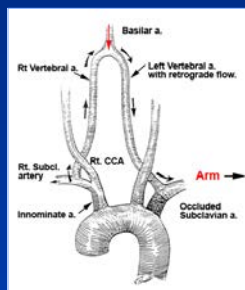
- Proximal subclavian artery stenosis or occlusion can cause ipsilateral vertebral artery flow to be altered or reversed.
- Flow in Rt. vertebral augments to supply Lt. arm.



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Lt. Subclavian Steal

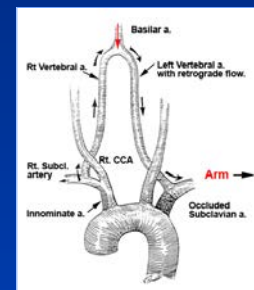
- Subclavian steal is more common on left side
- Usually, subclavian steal does not cause neurological symptoms.



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Lt. Subclavian Steal Syndrome

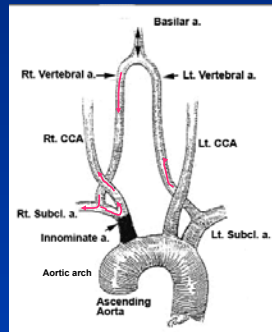
- Flow in the basilar artery may reverse direction, causing neurologic symptoms related to the posterior hemisphere. This is known as Subclavian Steal Syndrome.
- The syndrome is not common



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Rt. Subclavian Steal

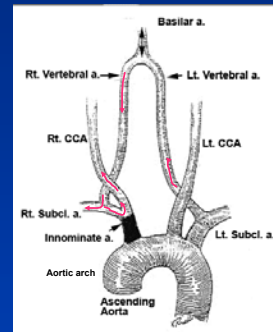
- If the presence of innominate or Rt. subclavian obstruction, a right vertebral steal can occur.
- Rt. vertebral flow may supply the Rt. CCA



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Rt. Subclavian Steal

- If Rt. vertebral has retrograde flow, carefully evaluate the innominate, the CCA and the subclavian (the latter for flow direction).



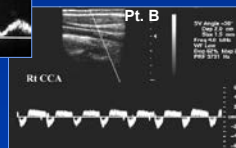
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Rt. CCA flow patterns are usually abnormal if the innominate artery is stenosed or occluded.



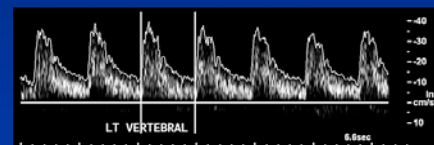
Pt. with innominate stenosis.

Pt. with innominate artery occlusion



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Normal Vertebral Waveform

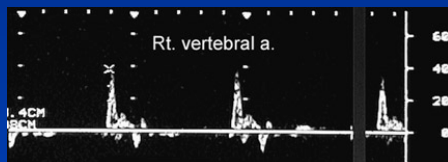


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Abnormal Vertebral Waveform

2. Resistive Spectra

This pattern is often seen with distal obstruction in the vertebral or basilar arteries. Vertebral dissection can also cause this high resistance waveform pattern.

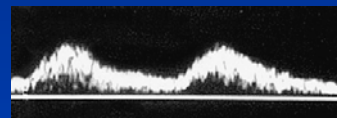


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Abnormal Vertebral Waveform

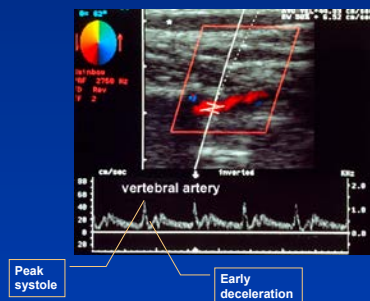
3. Tardus Parvus waveform

The waveform is of low amplitude and has a pronounced delay in the rise time from the onset to completion of systole. The waveform looks somewhat rounded. This pattern is consistent with proximal vertebral artery obstruction.



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4. Early systolic deceleration
in a vertebral waveform is an early sign of
subclavian stenosis



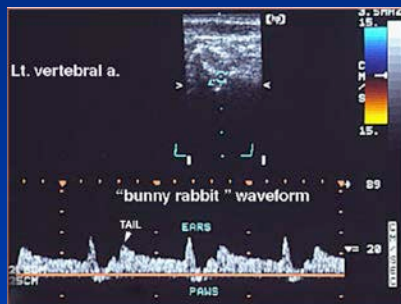
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Early systolic deceleration (ESD),
aka, "bunny rabbit" waveforms

- Changing pressure patterns in the left arm in the presence of proximal subclavian artery stenosis affect the vertebral waveforms
- The following vertebral waveform patterns demonstrate increasing degrees of subclavian obstruction.

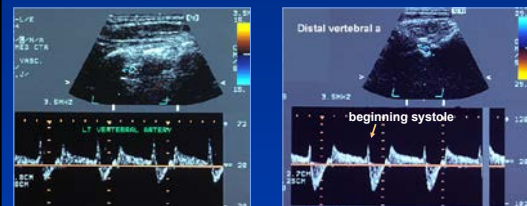
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5. The "bunny rabbit" waveform



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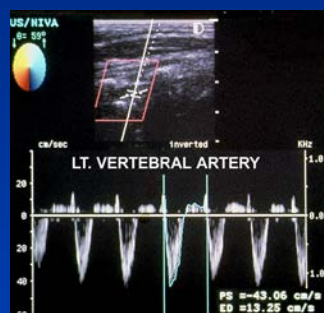
6. Progressive early systolic
deceleration, "To & Fro" flow pattern



Progression of subclavian
disease exacerbates ESD

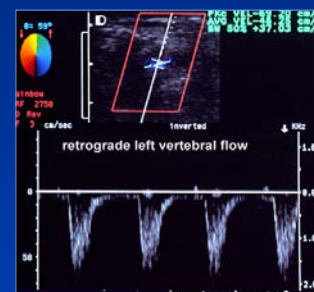
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7a. Predominately retrograde flow



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7b. Retrograde Flow



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When in PowerPoint Show, click on link below for video demo on youtube.

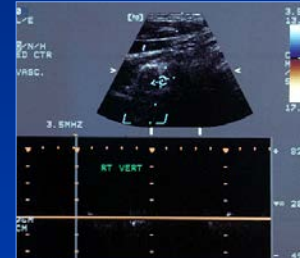
http://youtu.be/wl_c7jXuZRU



Movie= Lt. vertebral - to & fro.sm.wmv

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No flow detected, probable vertebral occlusion.



Ensure that the Doppler beam is not blocked by bone of the vertebrae

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Vertebral- Subclavian Assessment

- A 20 mmHg gradient between left and right brachial pressures suggests subclavian stenosis or occlusion.



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Color Doppler can help determine flow direction but not assess waveform morphology

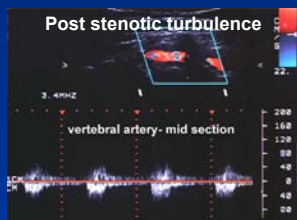


Normal flow direction

Retrograde flow

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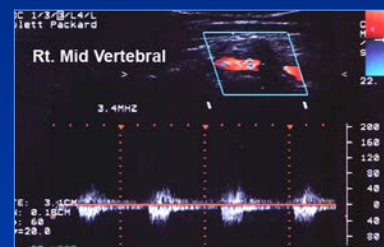
Post stenotic turbulence



look for stenosis!

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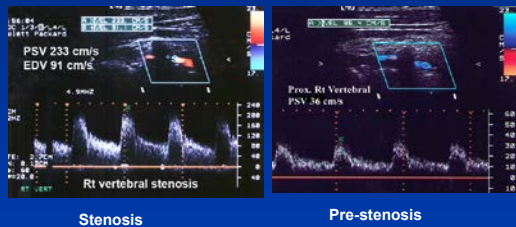
Abnormal Mid- Vertebral Waveform



Post-stenotic vertebral flow?

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Rt. Mid-Vertebral Stenosis



Stenosis

Pre-stenosis

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Subclavian Imaging Methods



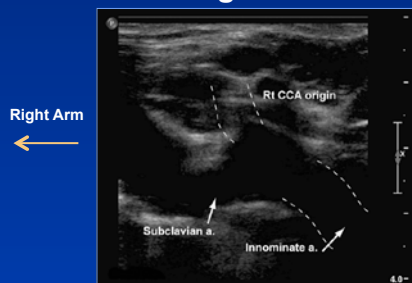
Innominate-prox. subclavian transducer position



Distal subclavian transducer position

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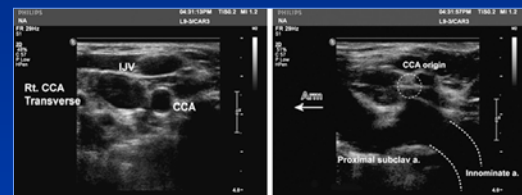
Rt. Subclavian Anatomy Longitudinal.



Right Arm

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Rt. Subclavian Anatomy

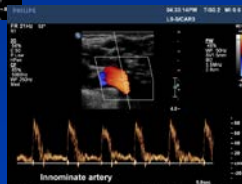


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Normal Rt Subclavian a.

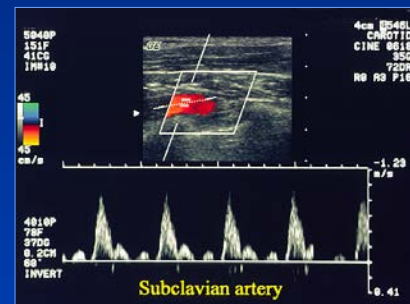


Normal Innominate artery



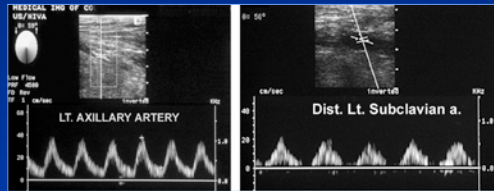
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Normal Lt. Subclavian Artery Waveform



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Abnormal Axillary and Subclavian Waveforms



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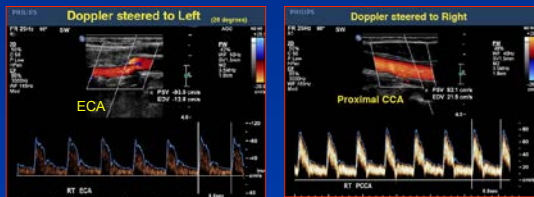
Proximal Lt. Subclavian a. Post-stenosis turbulence, and high stenotic velocity



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Flow Direction Drill!

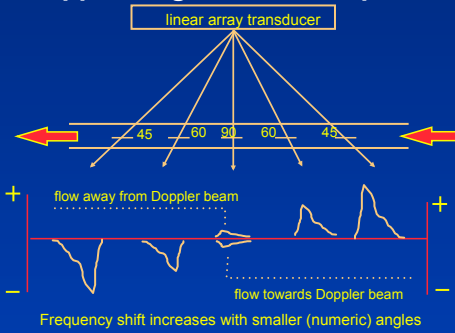
- Flow is either towards or away from the Doppler beam



Using the "negative" sign on the spectral scale is an excellent method to determine flow direction

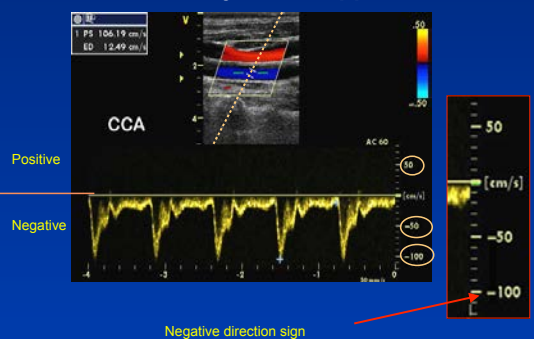
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Doppler angle versus freq. shift



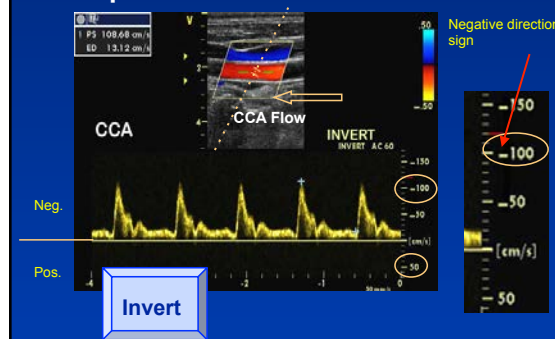
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Flow Away from Doppler Beam

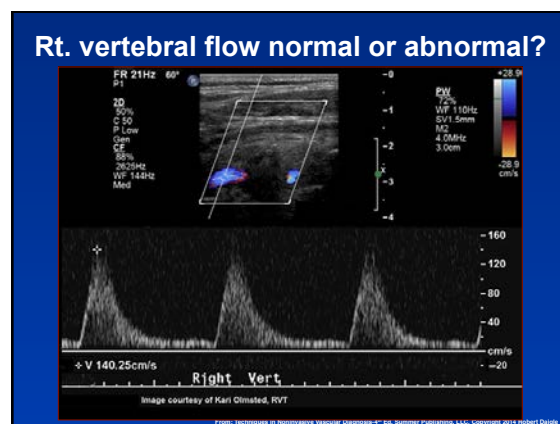
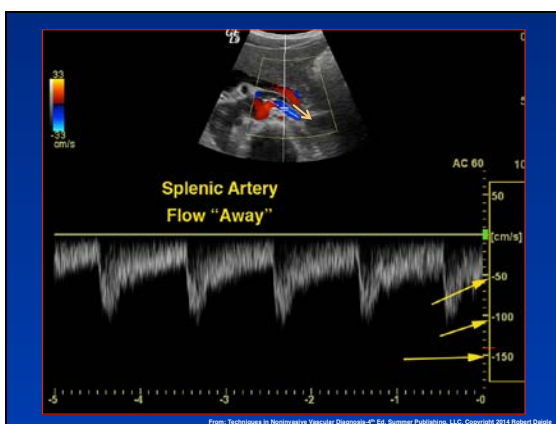
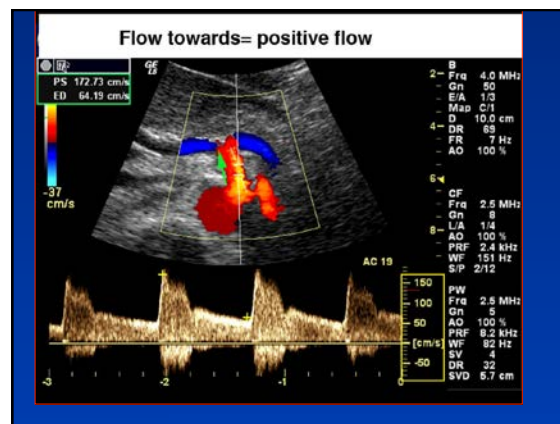
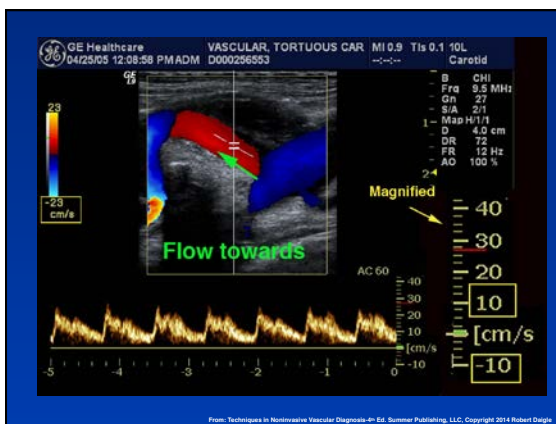
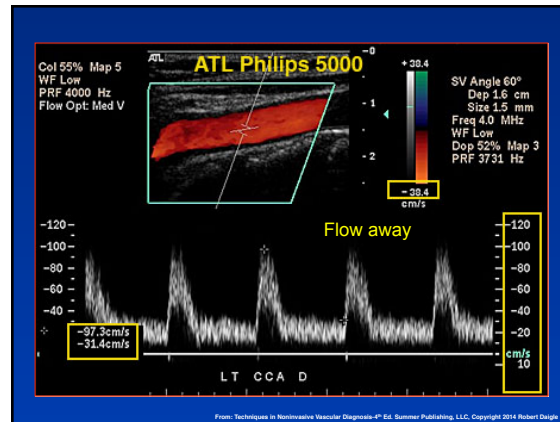
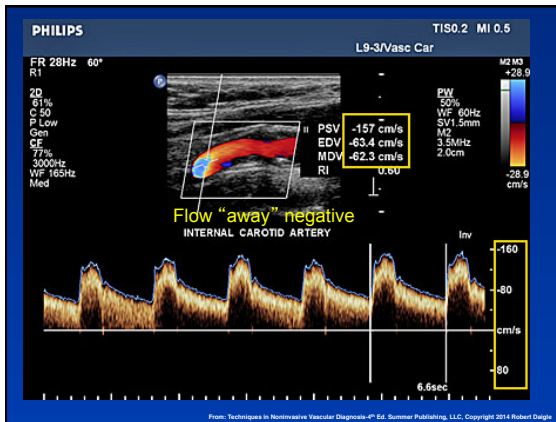


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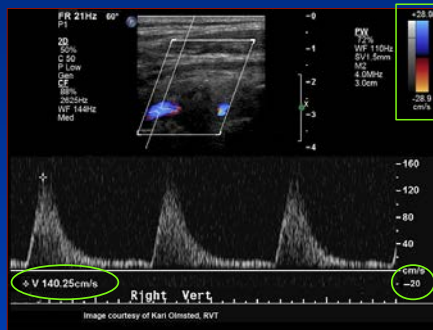
Spectrum and color INVERTED



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Rt. vertebral flow normal or abnormal?



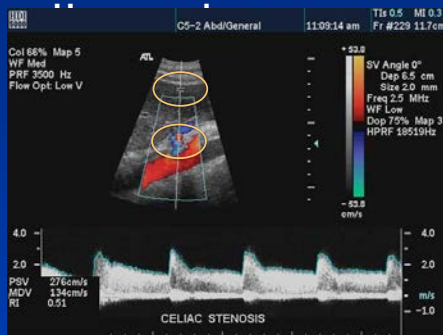
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Simple method (for those too confused) to confirm direction:

Compare to CCA flow on same side, with same steering direction.

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Exam



Homework #1

- What is the name of the phenomenon that creates multiple sample volumes?
- What is the advantage?
- What is the limitation?
- Hint: _____

SV Angle 0°
Dep 6.5 cm
Size 2.0 mm
Freq 2.5 MHz
WF Low
Dop 75% Map 3
HPRF 18519Hz

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