Ultrasound Imaging of The Posterior Circulation

Michigan Sonographers Society
2Nd Annual Fall Vascular Conference

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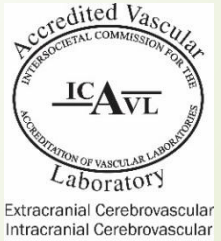
Cleveland Ohio



Posterior Circulation Stroke Symptoms

- Visual field loss
- Double vision
- Visual agnosia (lack of recognition or understanding of visual objects.
- Inability to recognize faces.
- Unable to read (words are treated as if they are a foreign language.
- Memory impairment.
- Motor dysfunction, gait problems
- Syncope
- Dizziness

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Posterior Circulation Strokes

Less common than strokes in the anterior circulation

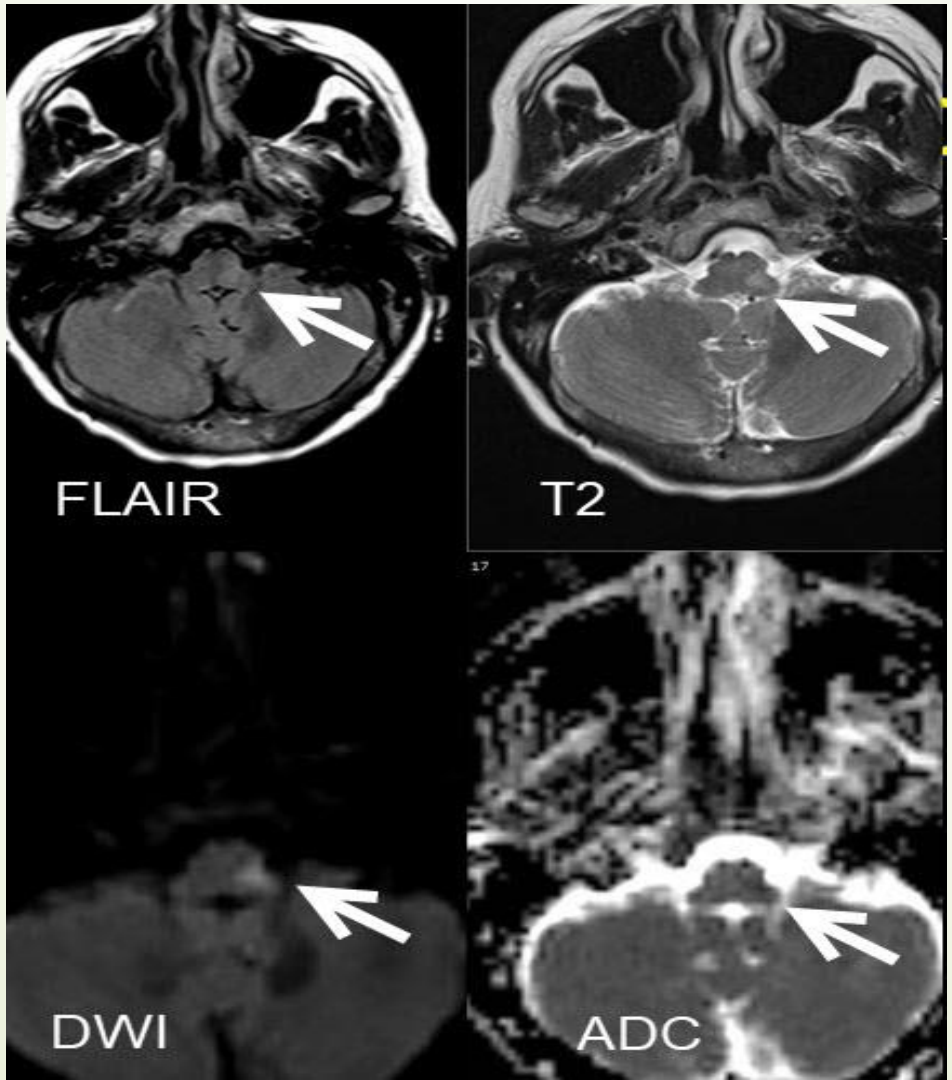
- ***ISCHEMIC***
- 80 %
- THROMBUS
- EMBOLISM
- STENOSIS

- ***RUPTURED VESSEL***
- 20 %

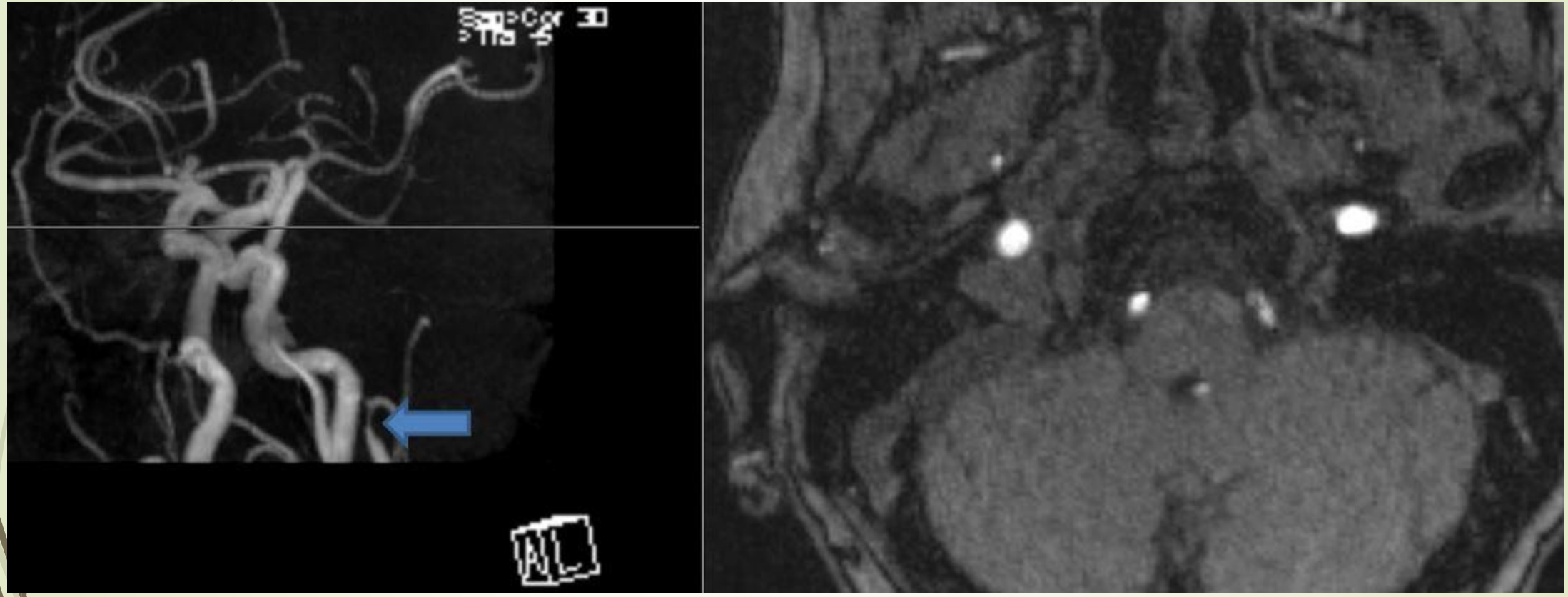
Posterior Circulation Strokes

- Proximal disease – Vertebrobasilar artery disease which may cause artery to artery embolism.
- Proximal stenosis or vessel occlusion.
- Dissection of the vertebral arteries that can happen spontaneously or result from trauma.

Posterior Circulation Strokes



Posterior Circulation Strokes



Lt. PICA stenosis

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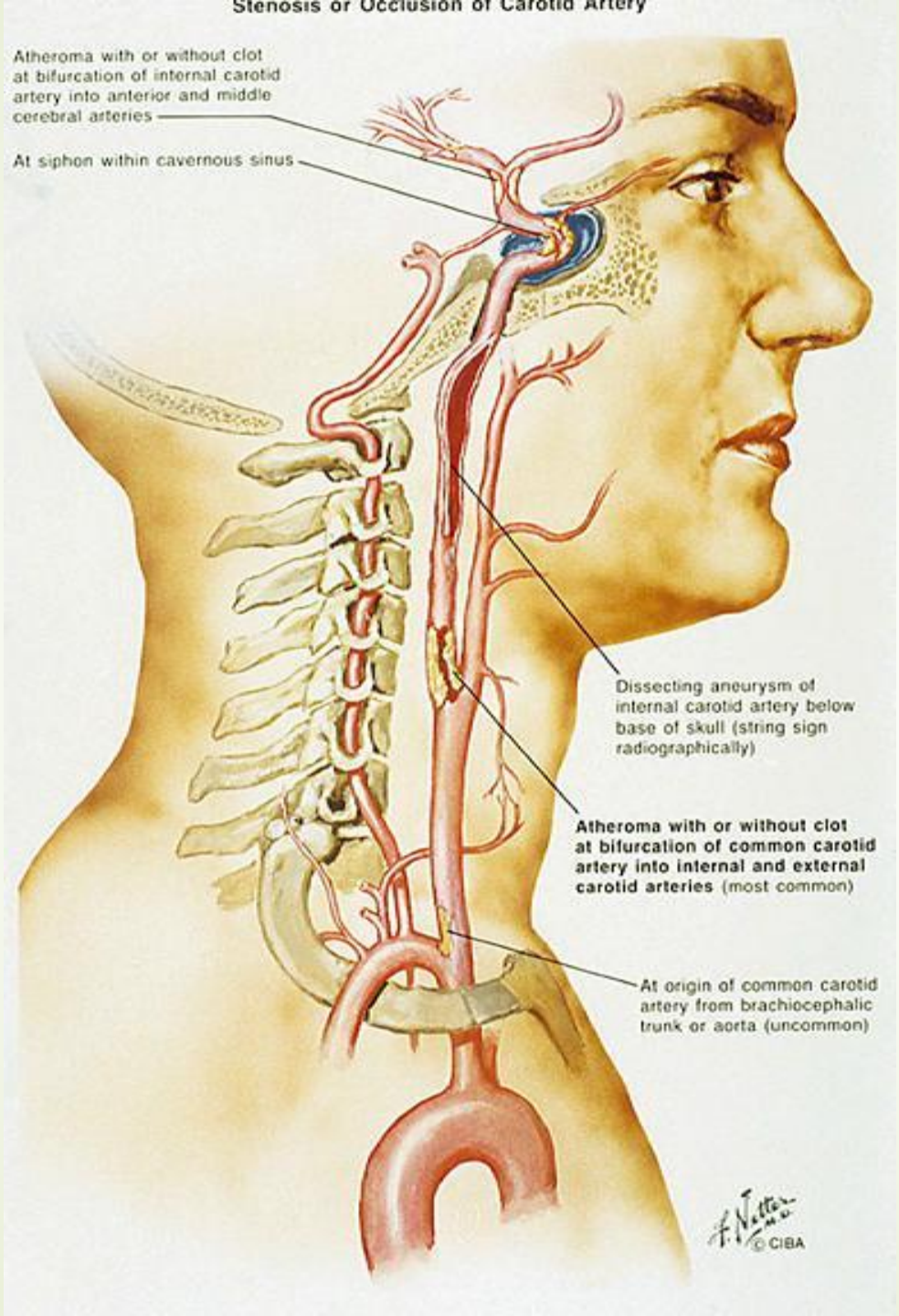
VERTEBRAL ARTERIES

- FIRST BRANCH OFF SUBCLAVIAN
- COURSE POSTERIOR THROUGH C-SPINE TRANSVERSE PROCESSES.
- JOIN TO FORM THE BASILAR ARTERY
- LOW RESISTIVE WAVEFORM


Stenosis or Occlusion of Carotid Artery
Atheroma with or without clot at bifurcation of internal carotid artery into anterior and middle cerebral arteries
At siphon within cavernous sinus
Dissecting aneurysm of internal carotid artery below base of skull (string sign radiographically)
Atheroma with or without clot at bifurcation of common carotid artery into internal and external carotid arteries (most common)
At origin of common carotid artery from brachiocephalic trunk or aorta (uncommon)
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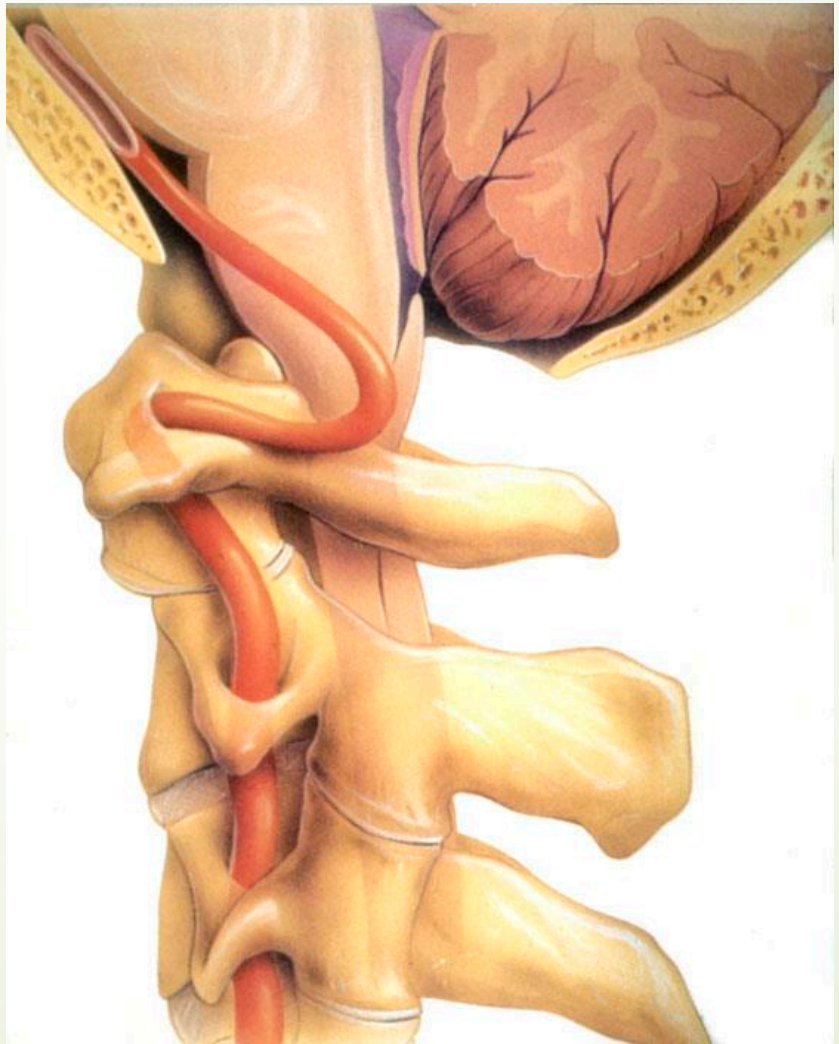
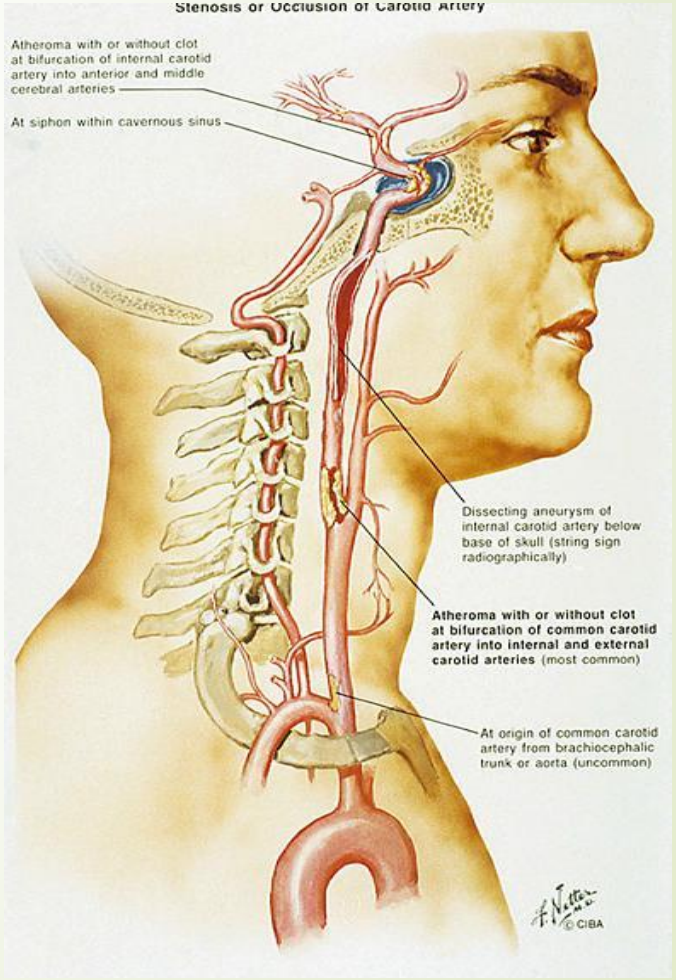
Intracranial Vertebral Arteries



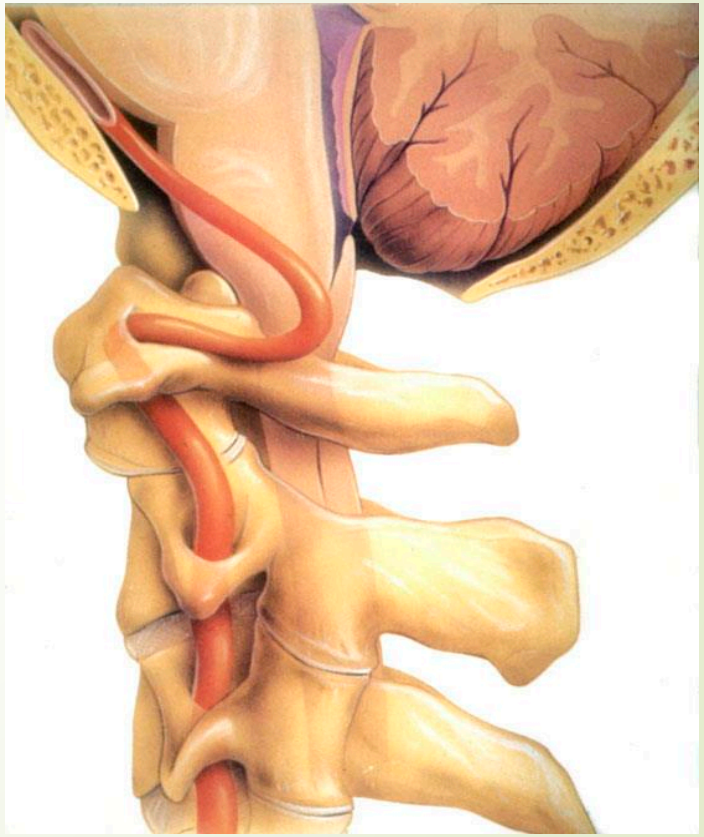
Ultrasound Examination of Posterior Circulation - TCP

- Examination of the extracranial vertebral arteries.
- Subclavian arteries



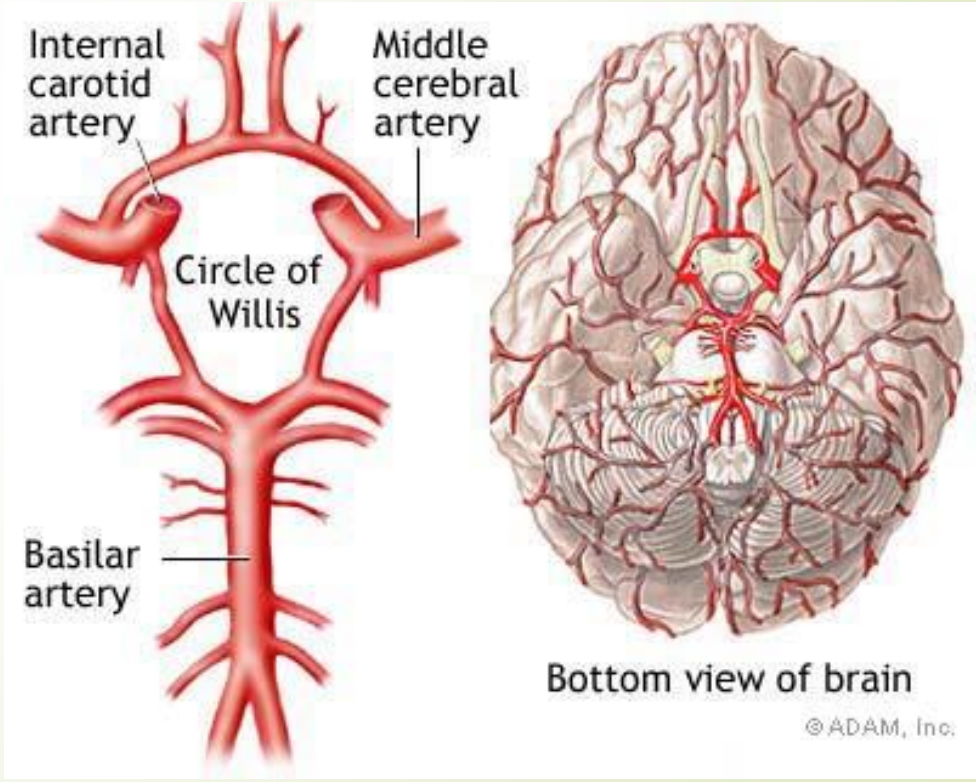
Ultrasound Examination of Posterior Circulation - TCP

- Examination of the intracranial vertebral arteries



Ultrasound Examination of Posterior Circulation - TCP

Basilar artery

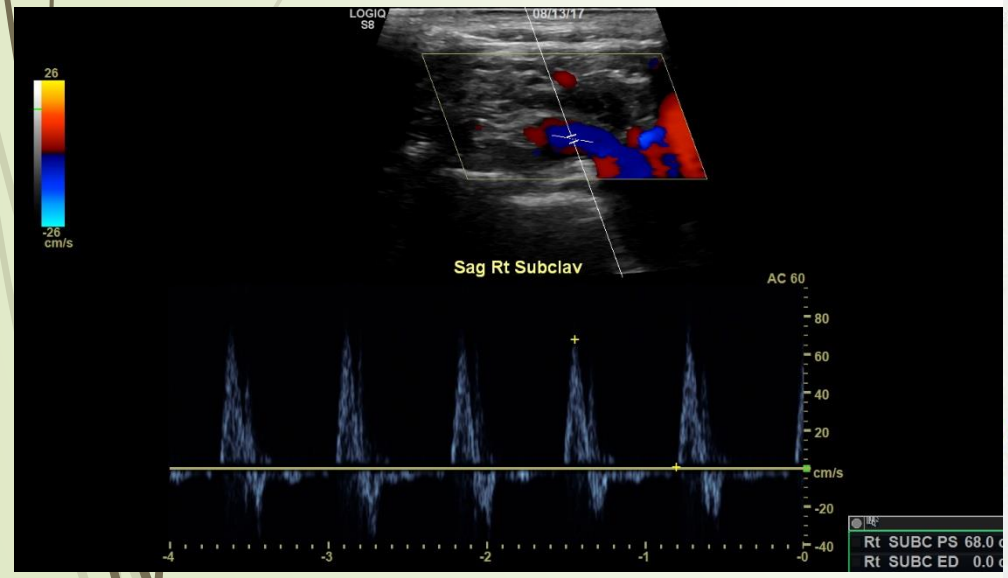


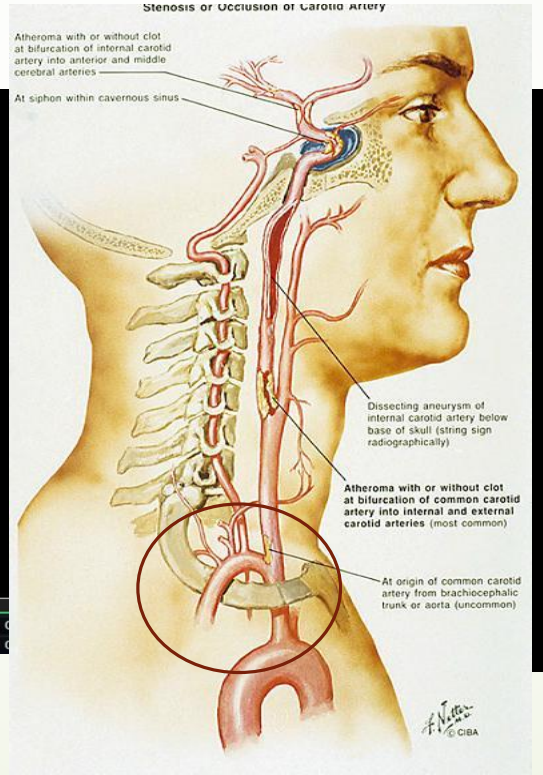
The TCP Examination

- *Images (vessels) to be identified bilaterally*
- Proximal Subclavian
- Vertebral artery origin
- Proximal, mid and distal extracranial vertebral artery
- Intracranial vertebral artery
- Basilar artery

The TCP Examination / Extracranial

Right Subclavian

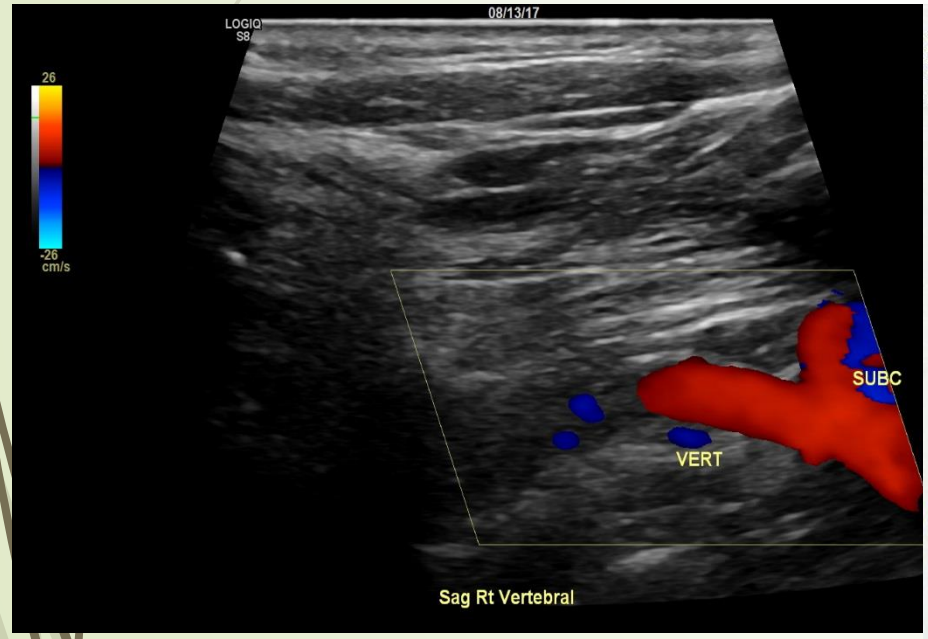


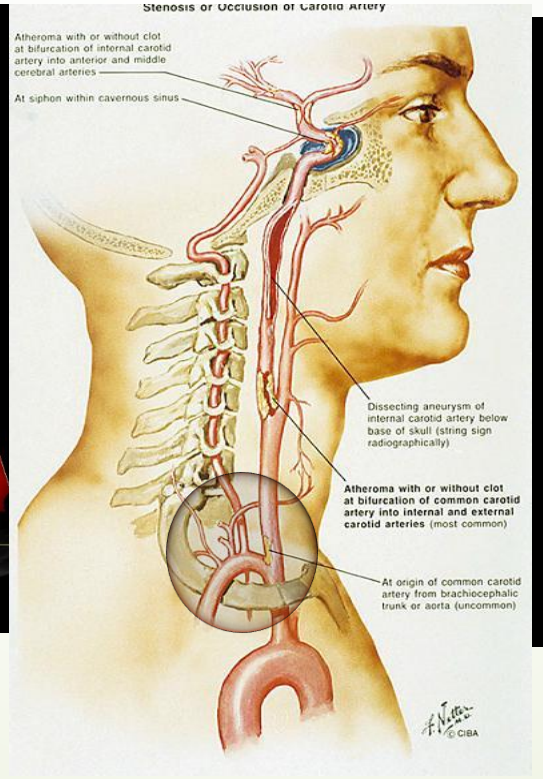


Left Subclavian

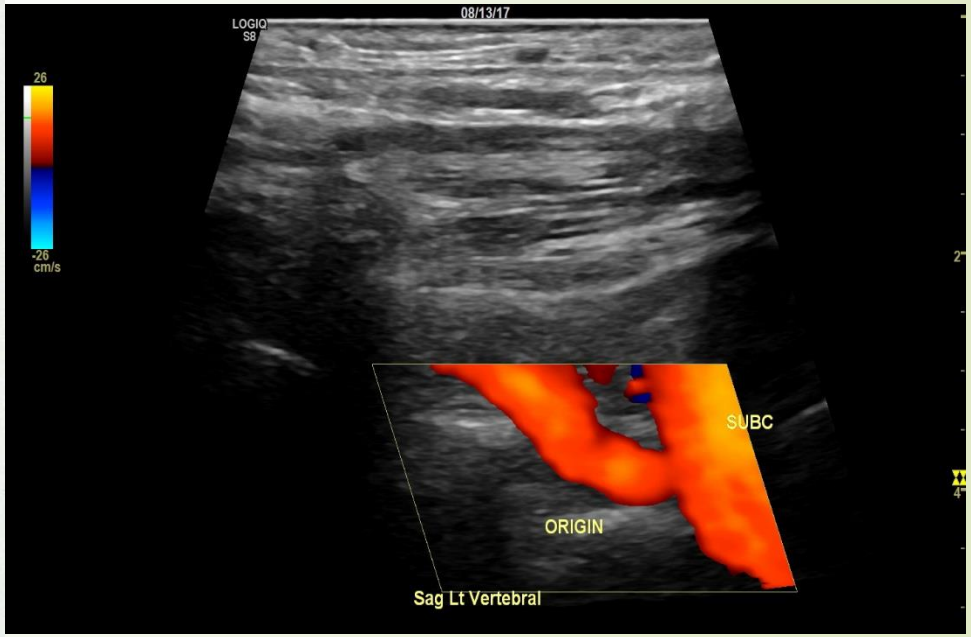
The TCP Examination

Right vertebral origin



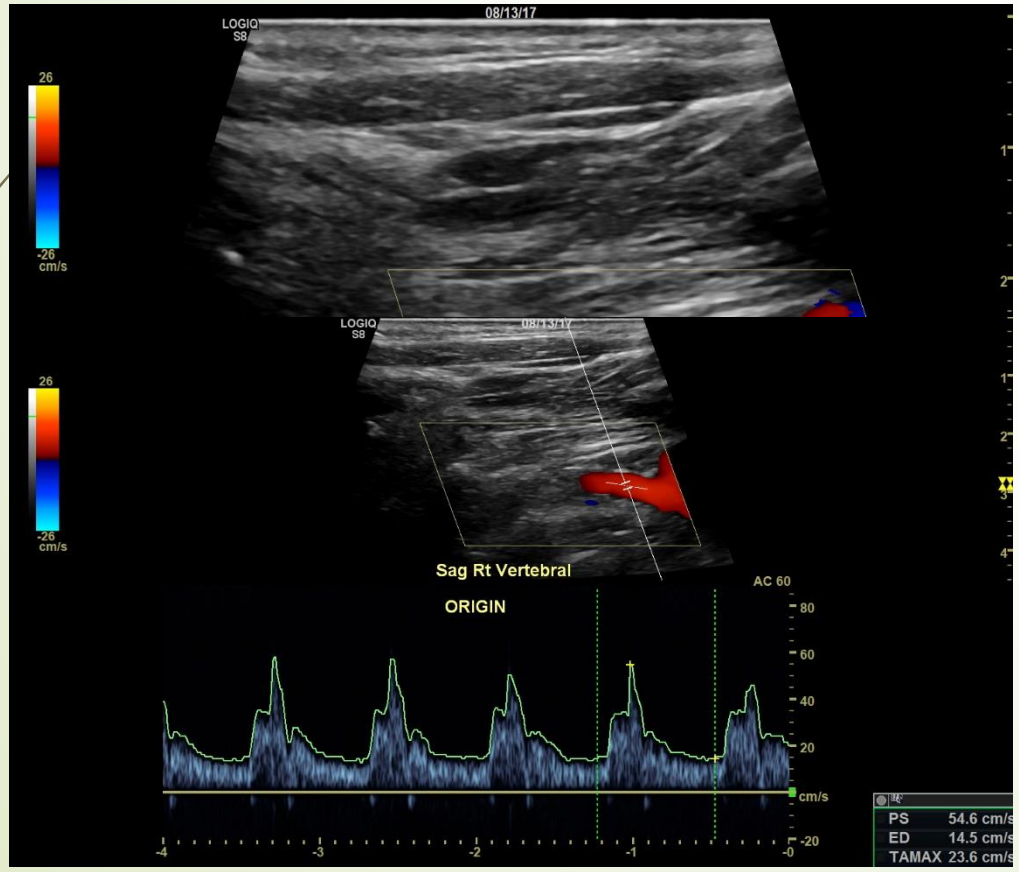


Left vertebral origin

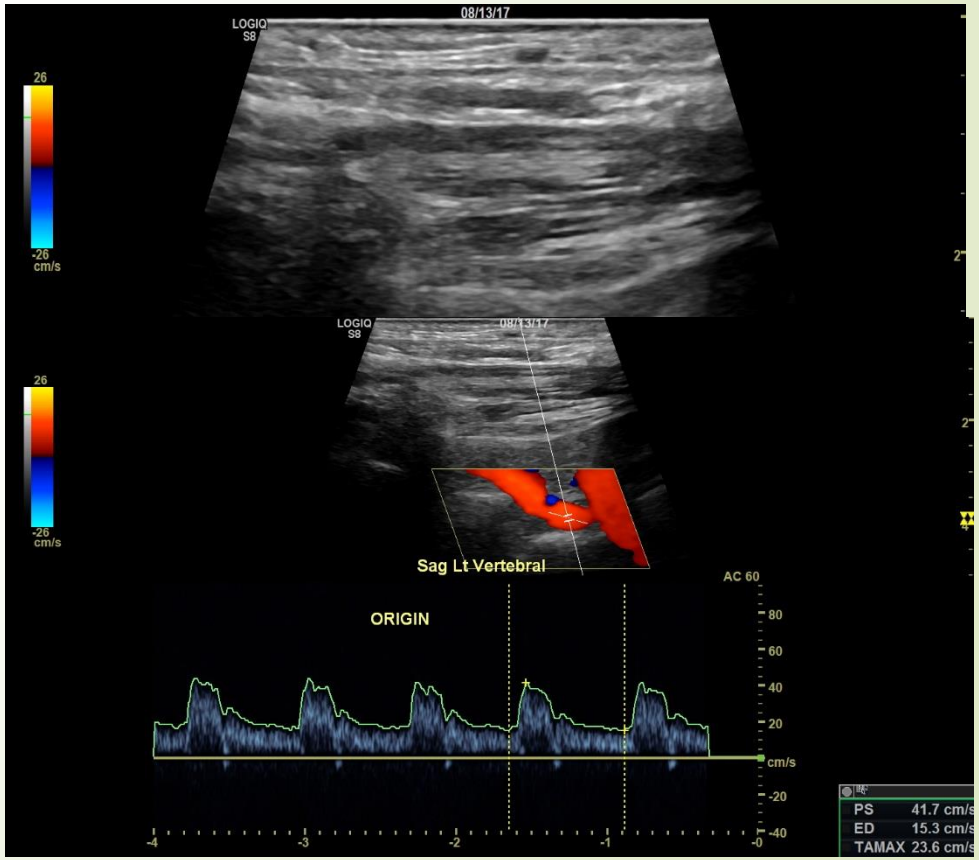


The TCP Examination / Extracranial

Right vertebral origin

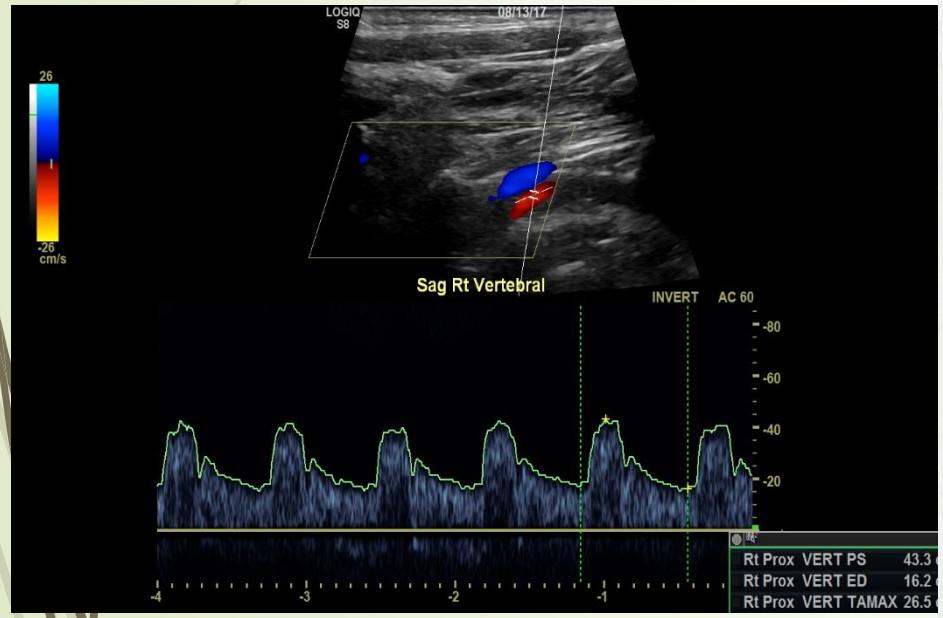


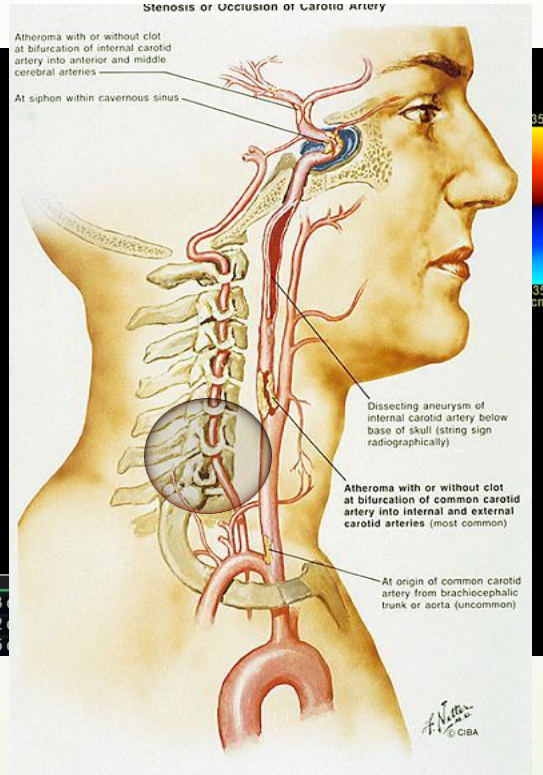
Left vertebral origin



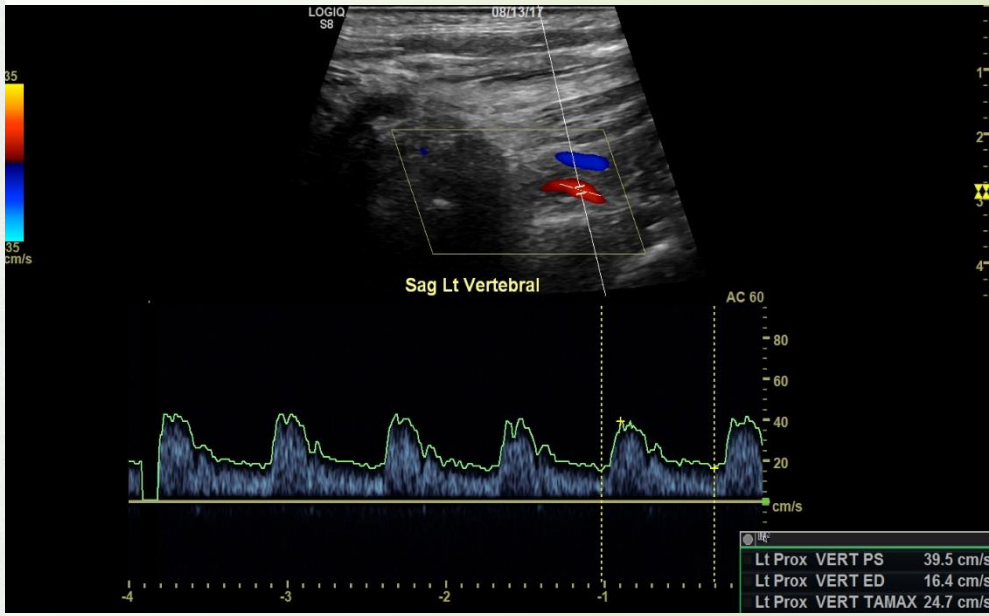
The TCP Examination / Extracranial

Rt. Vertebral Proximal



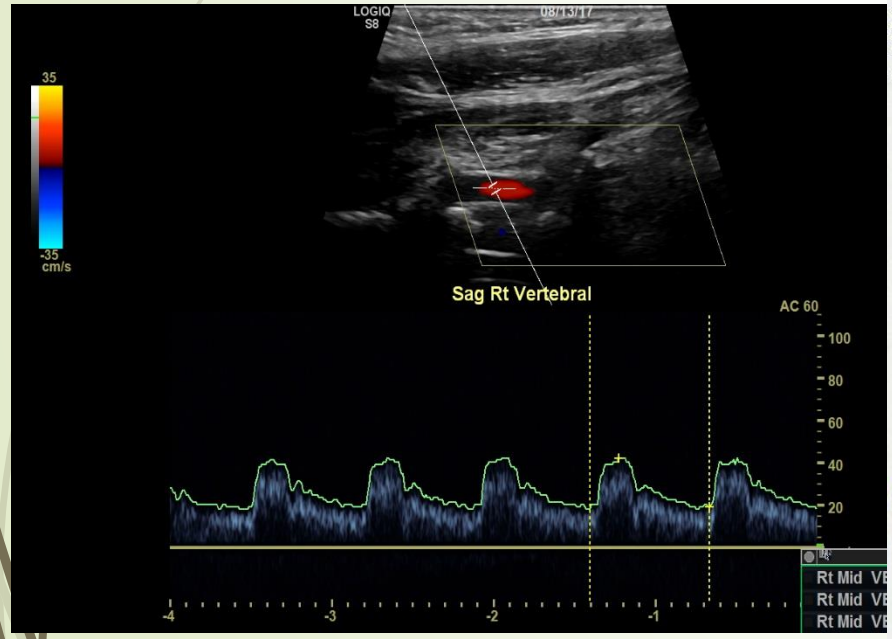


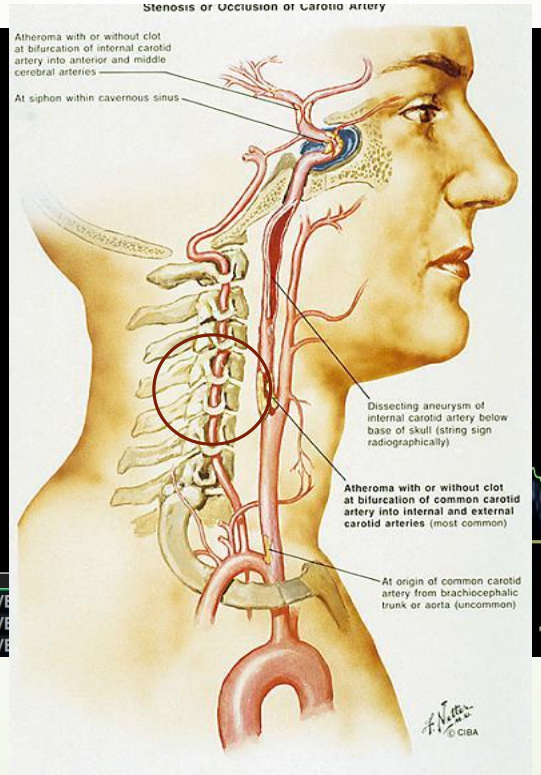
Lt. Vertebral Proximal



The TCP Examination / Extracranial

Rt. Vertebral Mid

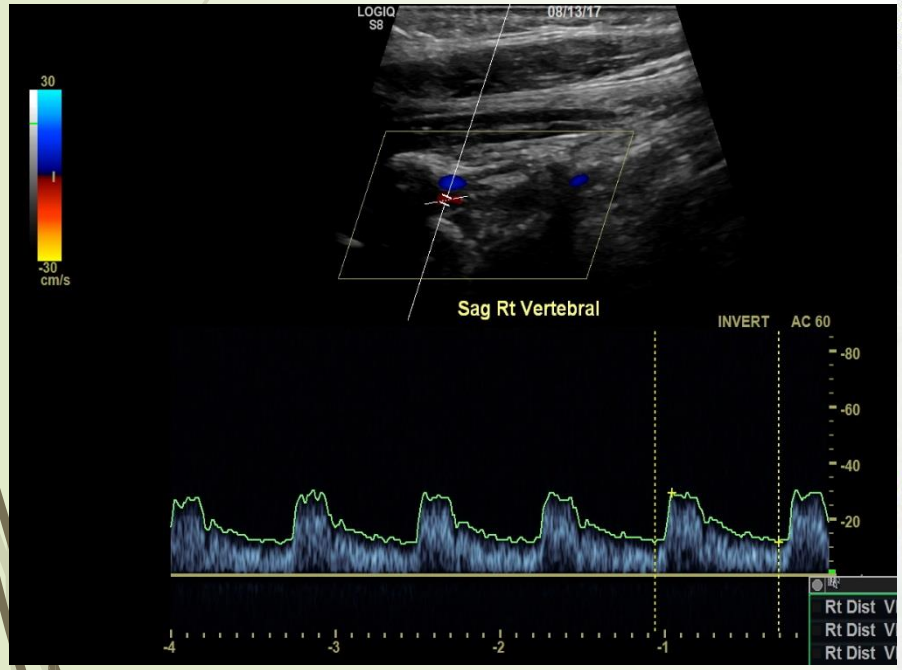


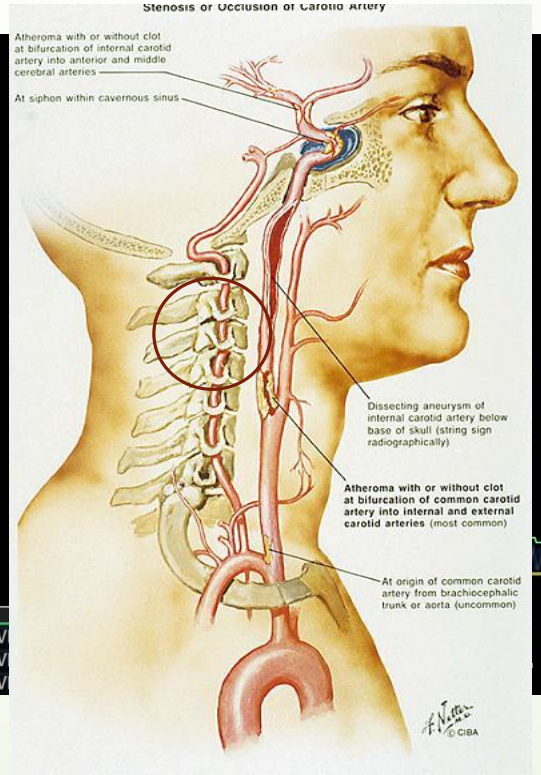


Lt. Vertebral Mid

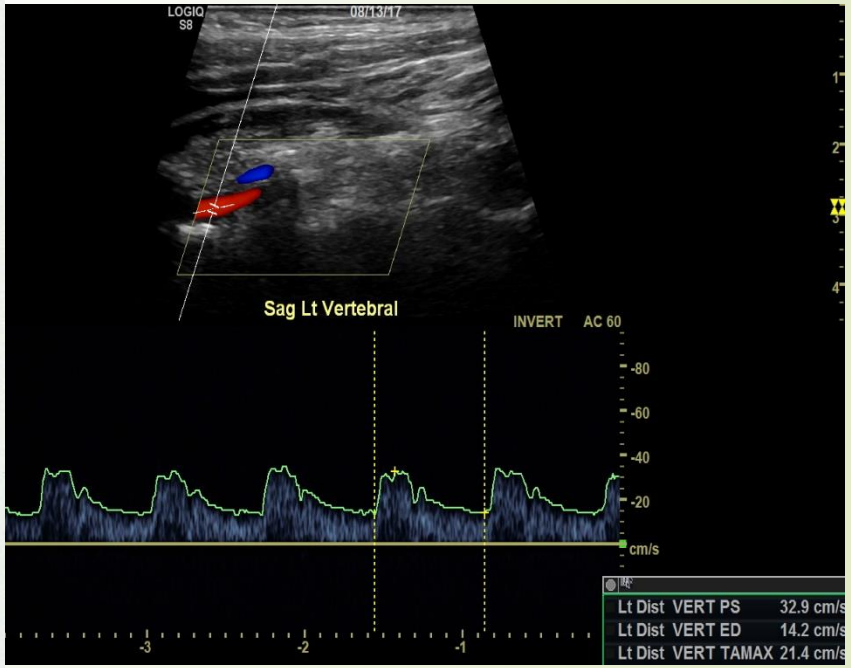
The TCP Examination / Extracranial

Rt. Vertebral Distal





Lt. Vertebral Distal



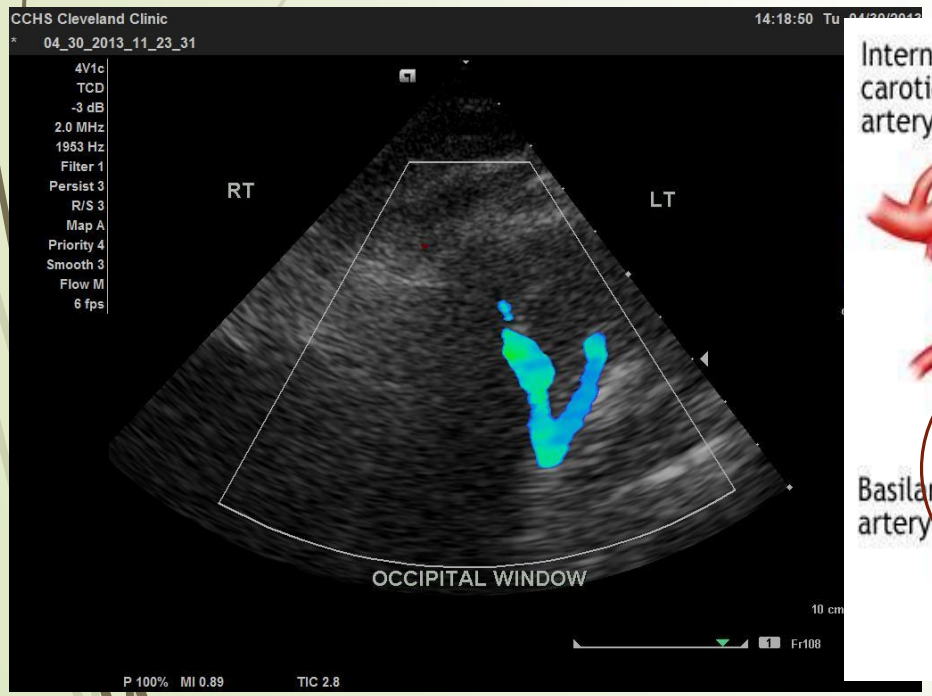
The TCP Examination / Intracranial

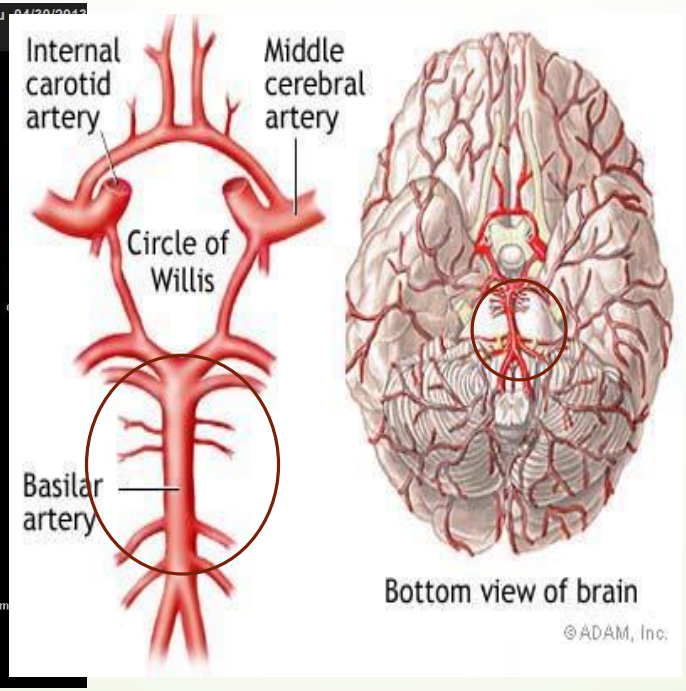
TCI

TCD

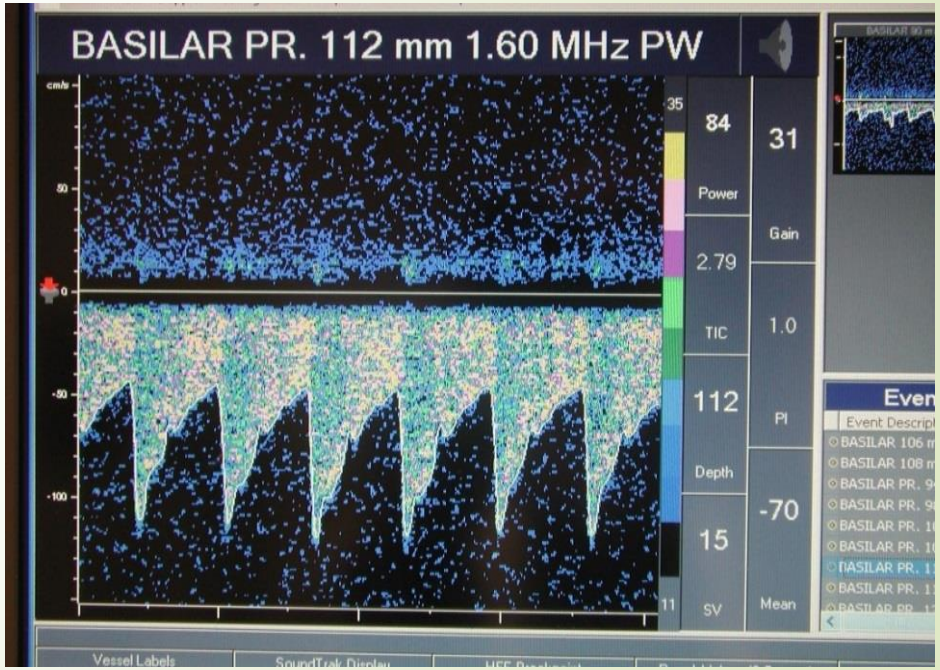
The TCP Examination / Intracranial Basilar Artery

TCI



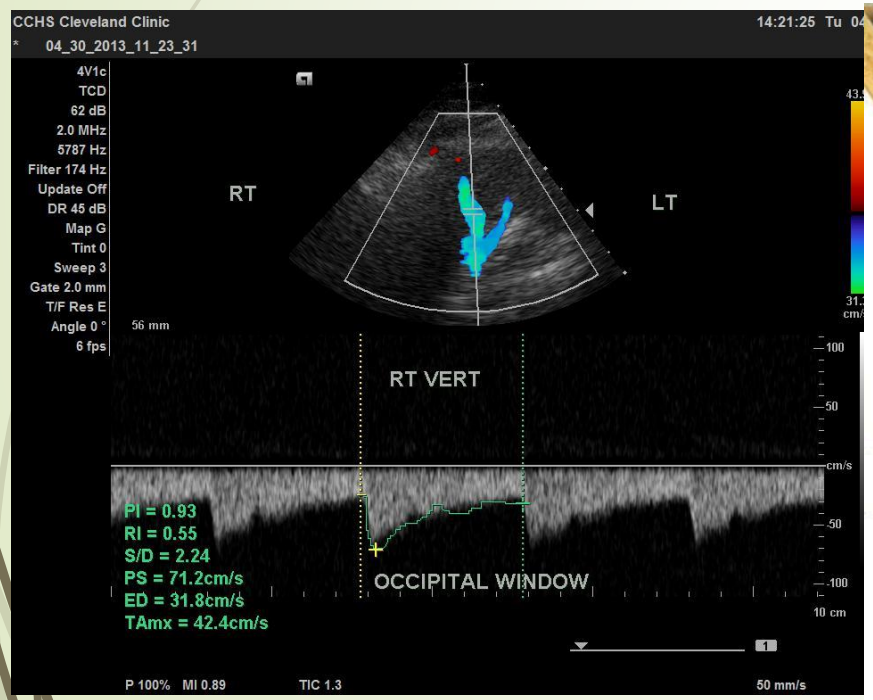


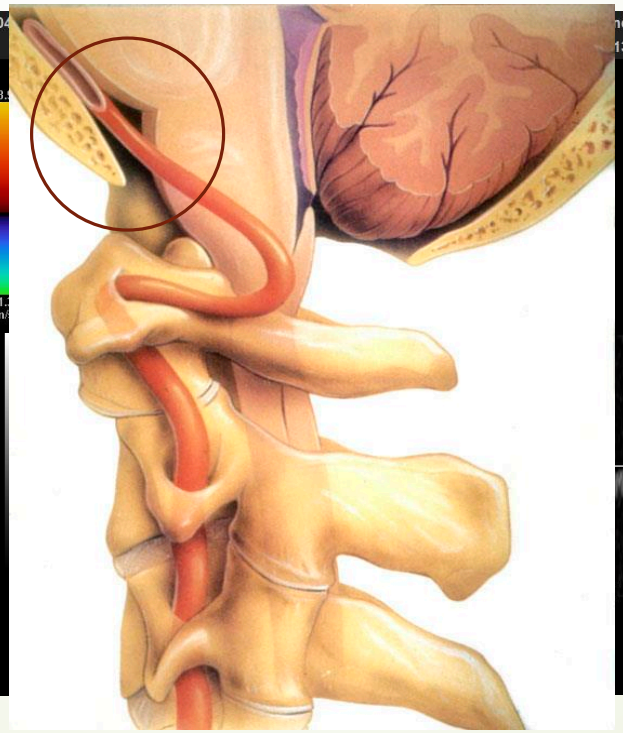
TCD



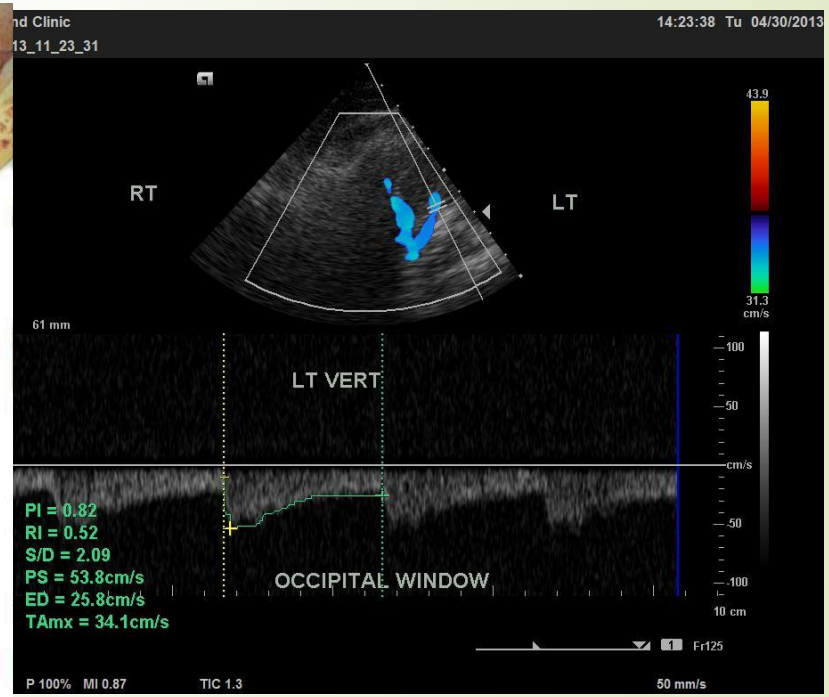
The TCP Examination / Intracranial

Rt. Intracranial Vertebral





Lt. Intracranial Vertebral



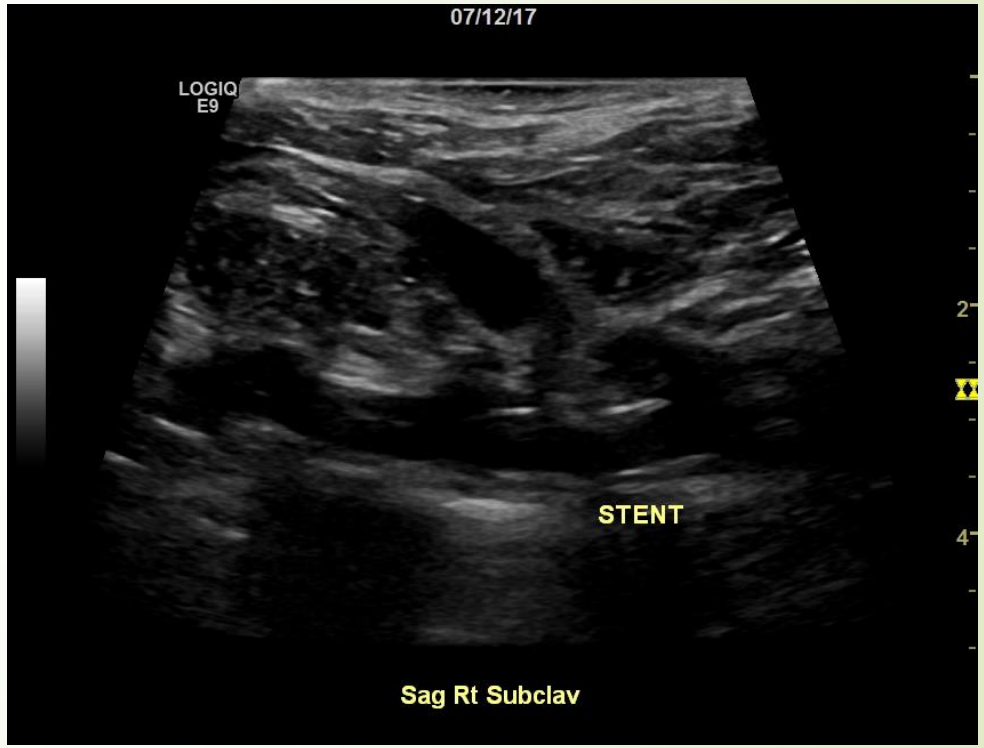
Subclavian Artery Pathology

Subclavian Artery Pathology

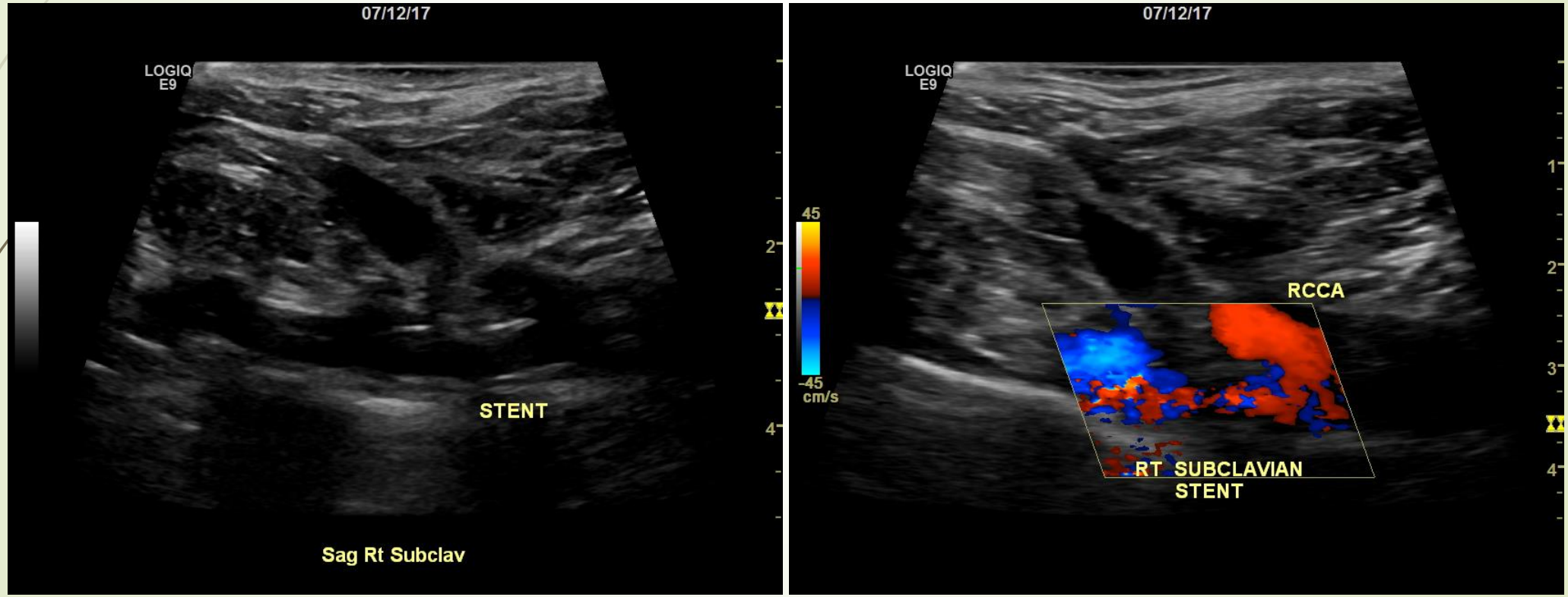
- Duplex criteria not well established for the subclavian
- Criteria in the neurovascular laboratory and the vascular lab at the Cleveland Clinic
- A PSV of >275 cm/sec at the proximal subclavian artery with plaque and turbulent waveform would indicate a stenosis of 50-99%.
- Or doubling of the PSV associated with a visualized lesion would indicate stenosis of 50-99%

Subclavian Artery Pathology Stenosis

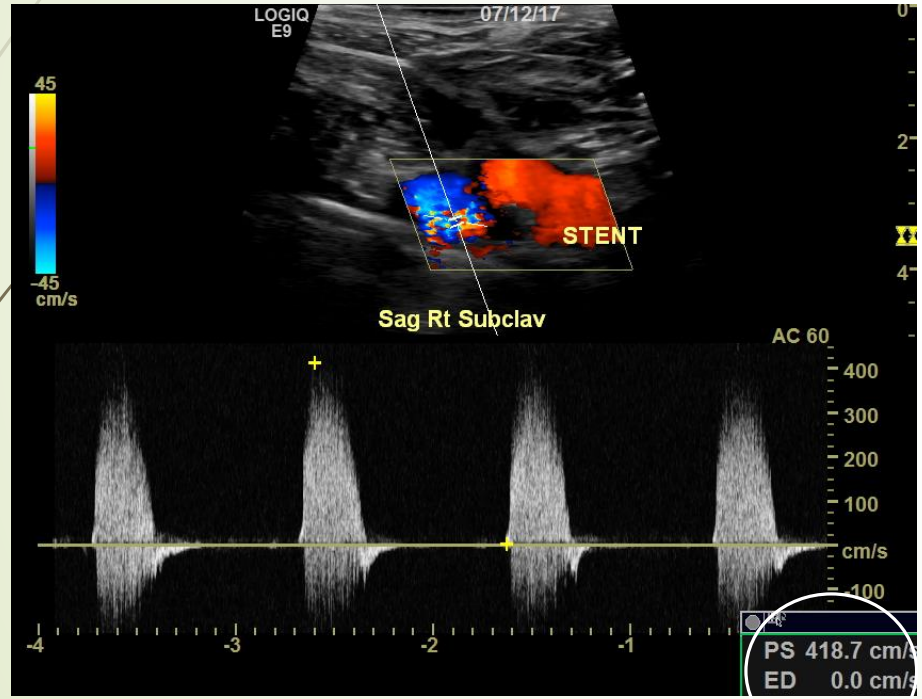
- 59yo female with Moya Moya.
- Hx. right subclavian stent placement
- Routine follow up

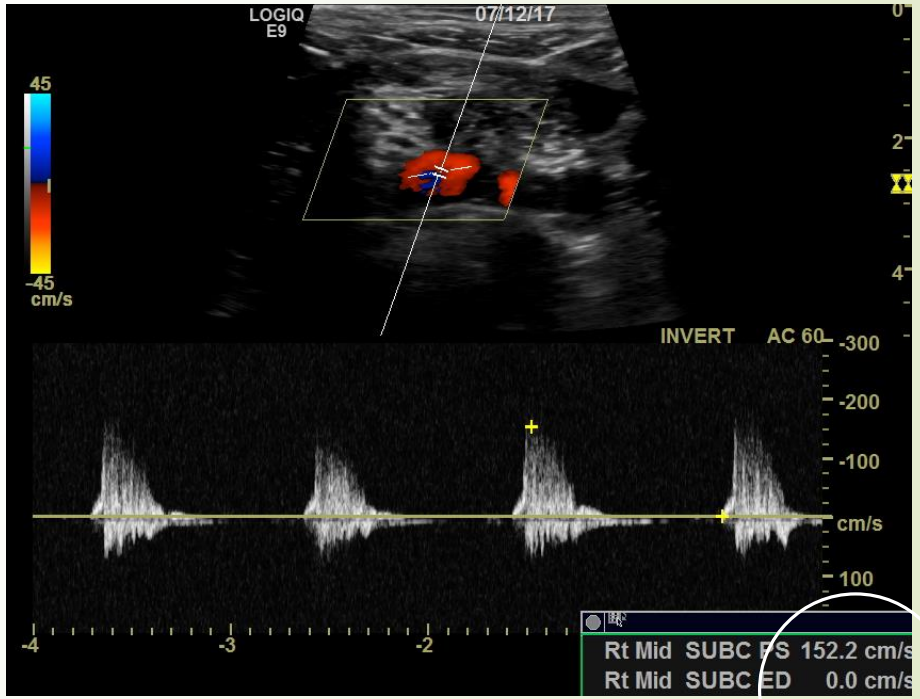


Subclavian Artery Pathology Stenosis



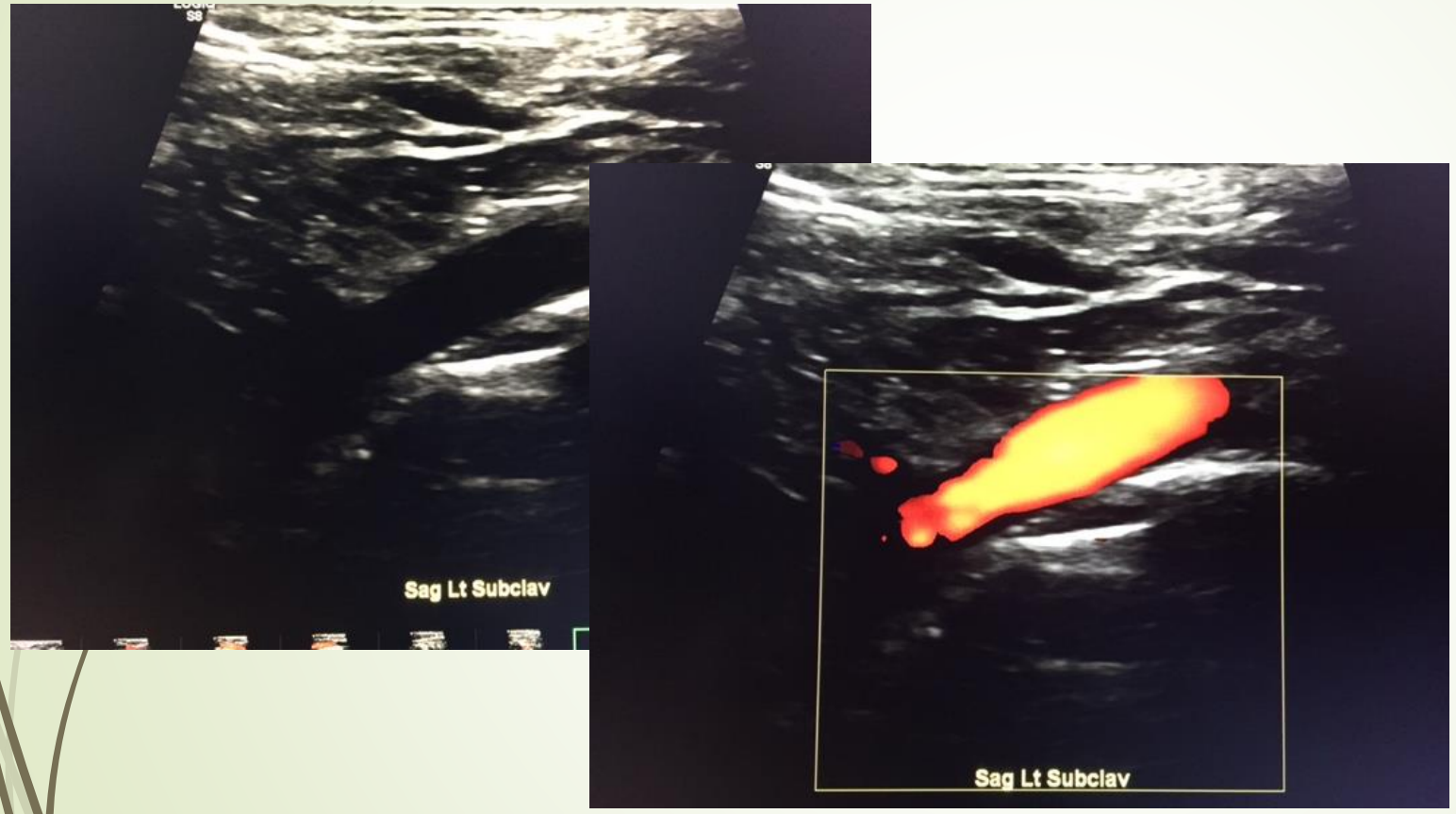
Subclavian Artery Pathology Stenosis



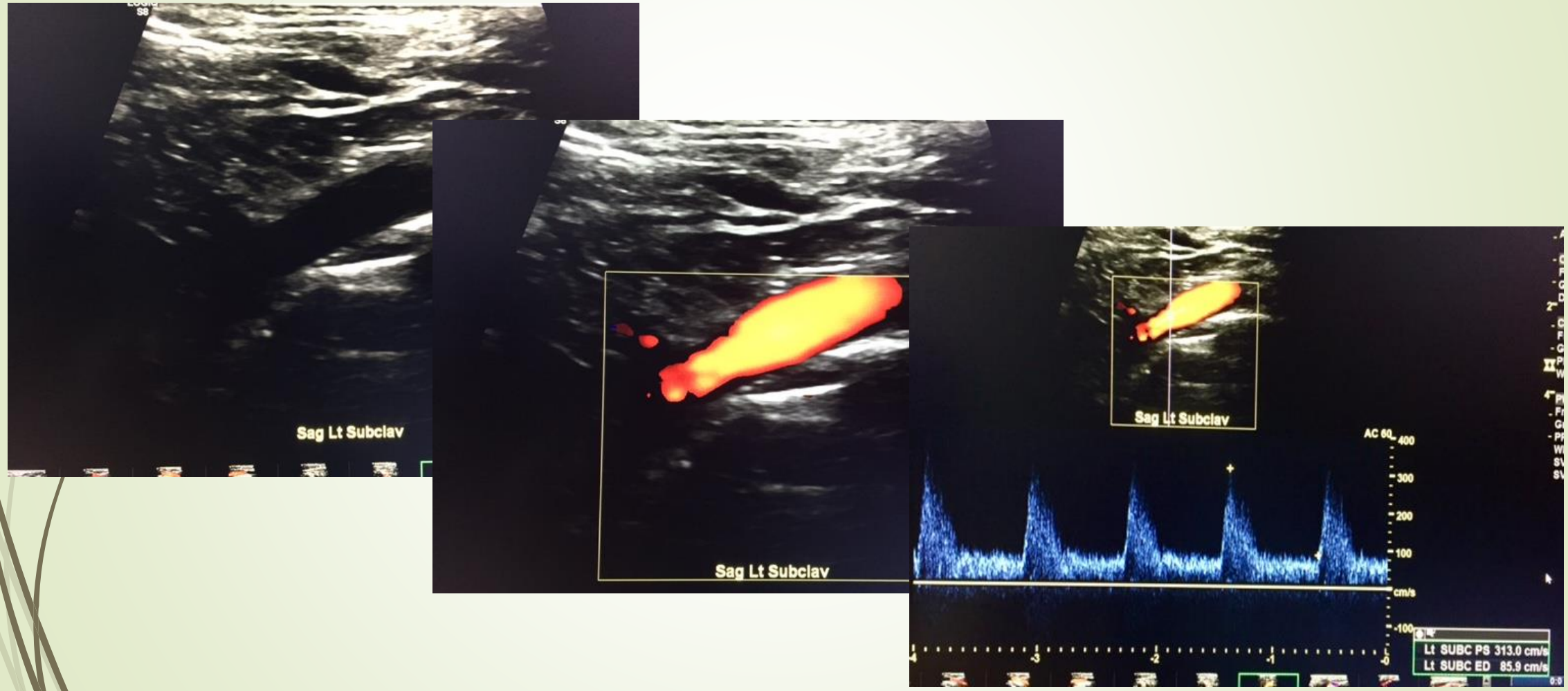


Subclavian Artery Pathology

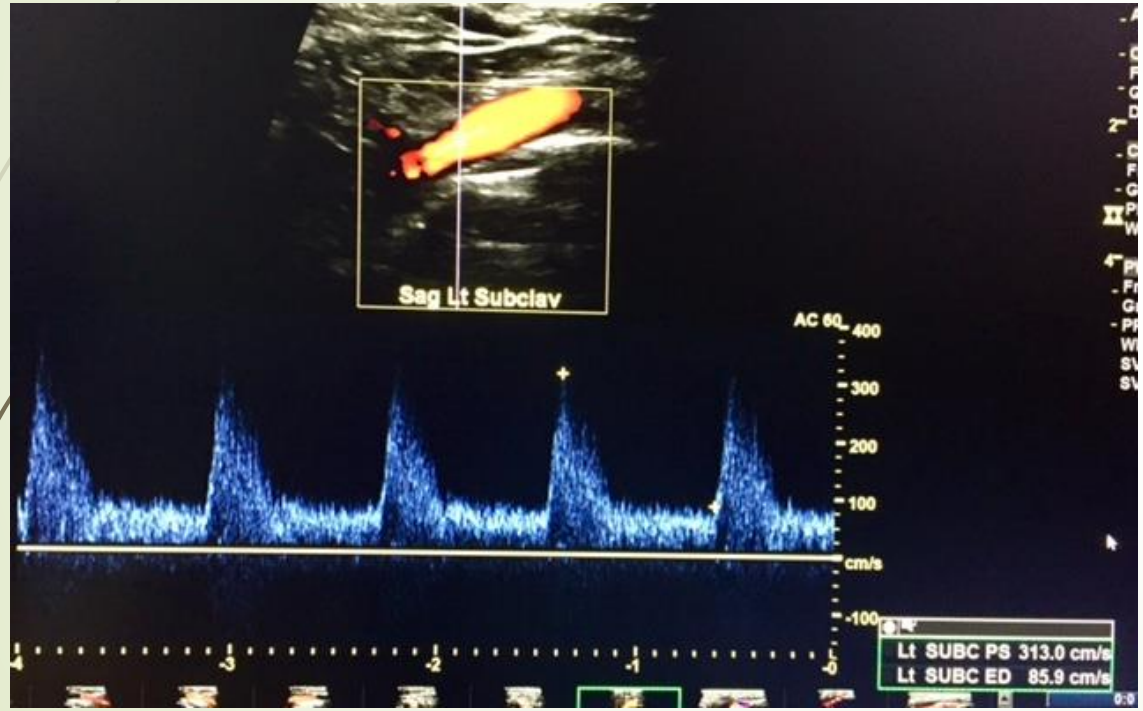
Subclavian Artery Pathology



Subclavian Artery Pathology

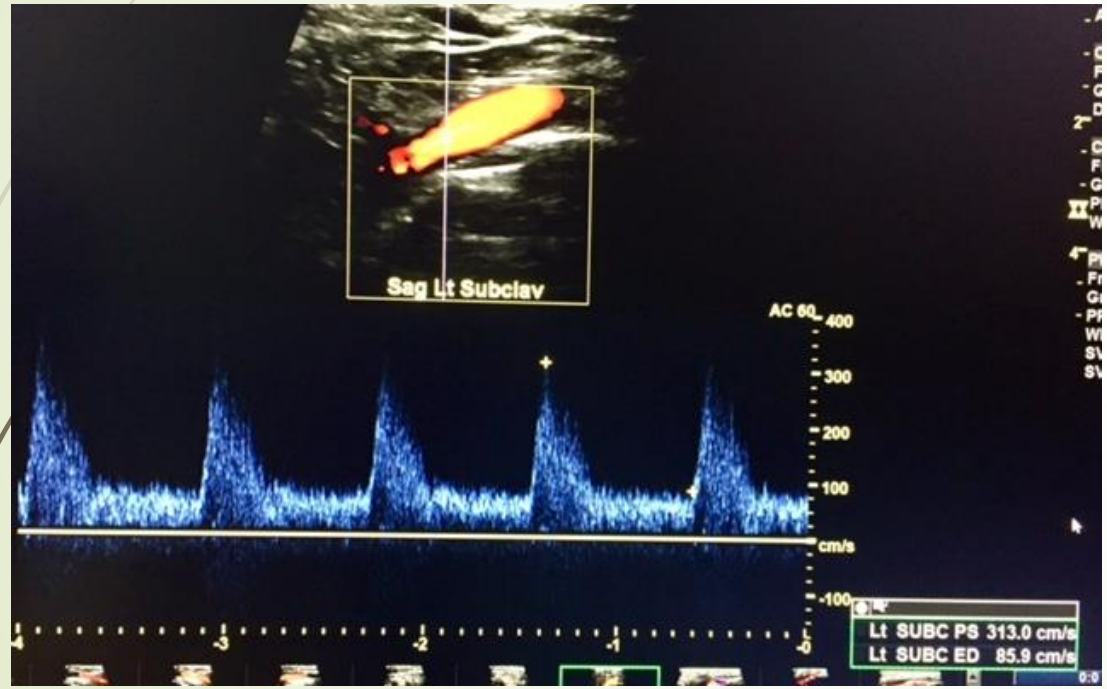


Subclavian Artery Pathology



- Left Subclavian artery – no plaque identified on gray scale of color Doppler
- Increase velocities identified with low resistant monophasic turbulent waveform
- Normal upstroke not parvus tradus waveform
- Stenosis?

Subclavian Artery Pathology



- Patient has a left arm dialysis graft with physiologic changes to inflow artery waveform.

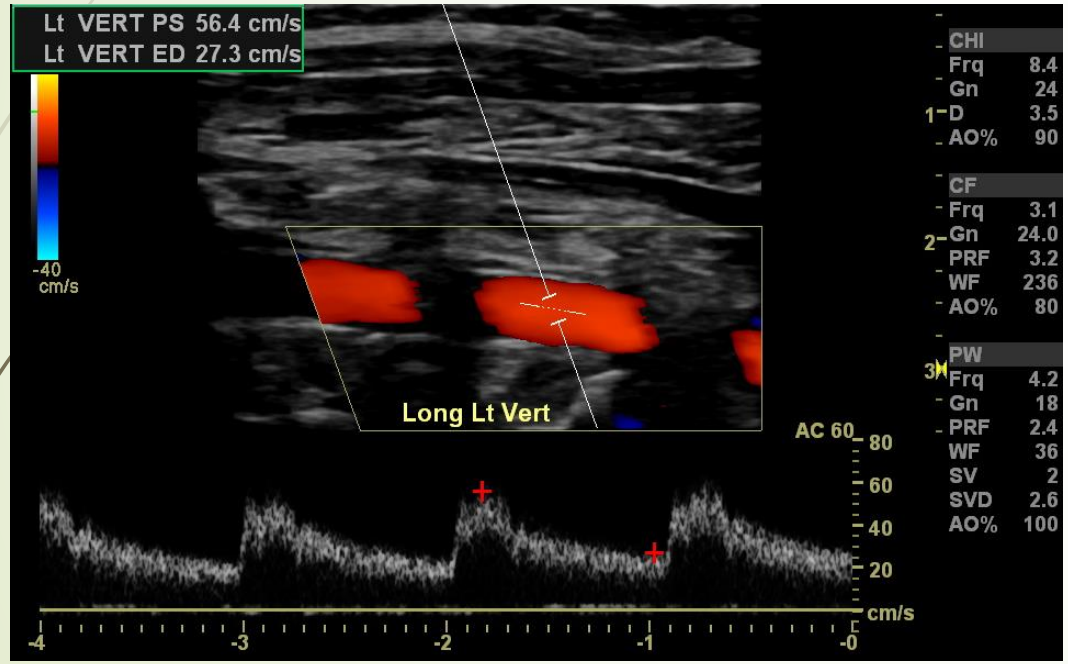
Vertebral Artery Pathology

Diagnostic Criteria: Vertebral Artery Stenosis

- Common location for atherosclerotic vertebral artery stenosis is at vertebral artery origin off subclavian artery
- Hua Y, et al. (2009) Doppler criteria for proximal vertebral artery stenosis[1]
  - Duplex-angiogram correlation study of N=247 patients (angio within 2 weeks of duplex)
  - Used ROC analysis to identify best duplex parameters
  - Most sensitive/specific and accurate hemodynamic parameter – PSV of vertebral artery origin (PSV_{org})
  - Also analyzed diagnostic performance of PSV ratio, EDV_{org}
  - Diagnostic criteria for vertebral artery stenosis:
    - ≥ 50% stenosis $PSV_{org} \geq 85$ cm/sec
    - 50-69% stenosis $PSV_{org} \geq 140$ cm/sec
    - 70-99% stenosis $PSV_{org} \geq 210$ cm/sec
    - ***Do not apply ICA diagnostic criteria to these non-ICA vessels***

[1]Hua Y, et al. AJR 2009;193:1434.

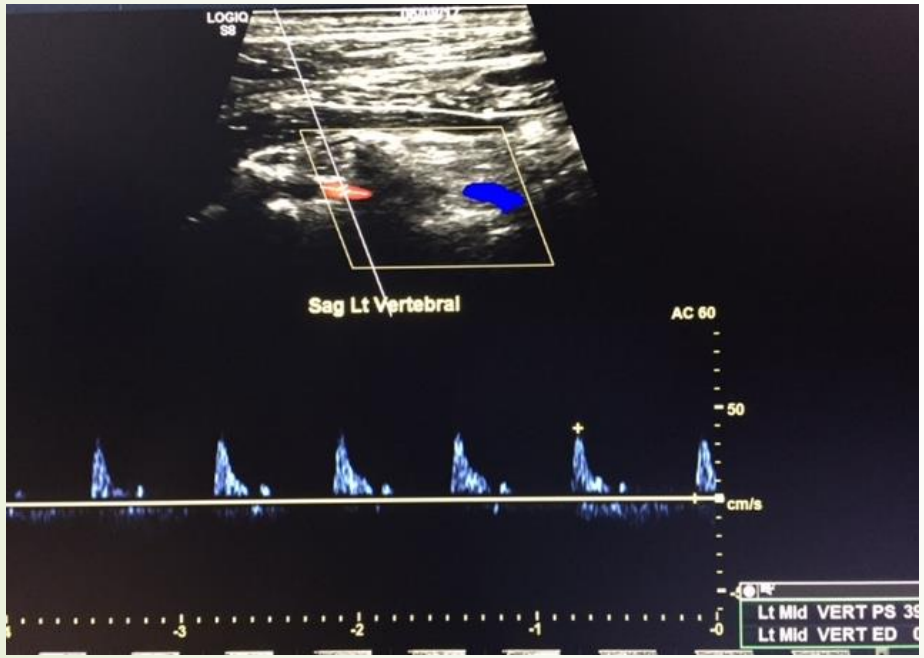
Vertebral Artery Pathology



- Normal vertebral artery waveform
- Good upstroke
- Low resistance waveform
- Antegrade flow

Vertebral Artery Pathology

Vertebral high resistant waveform

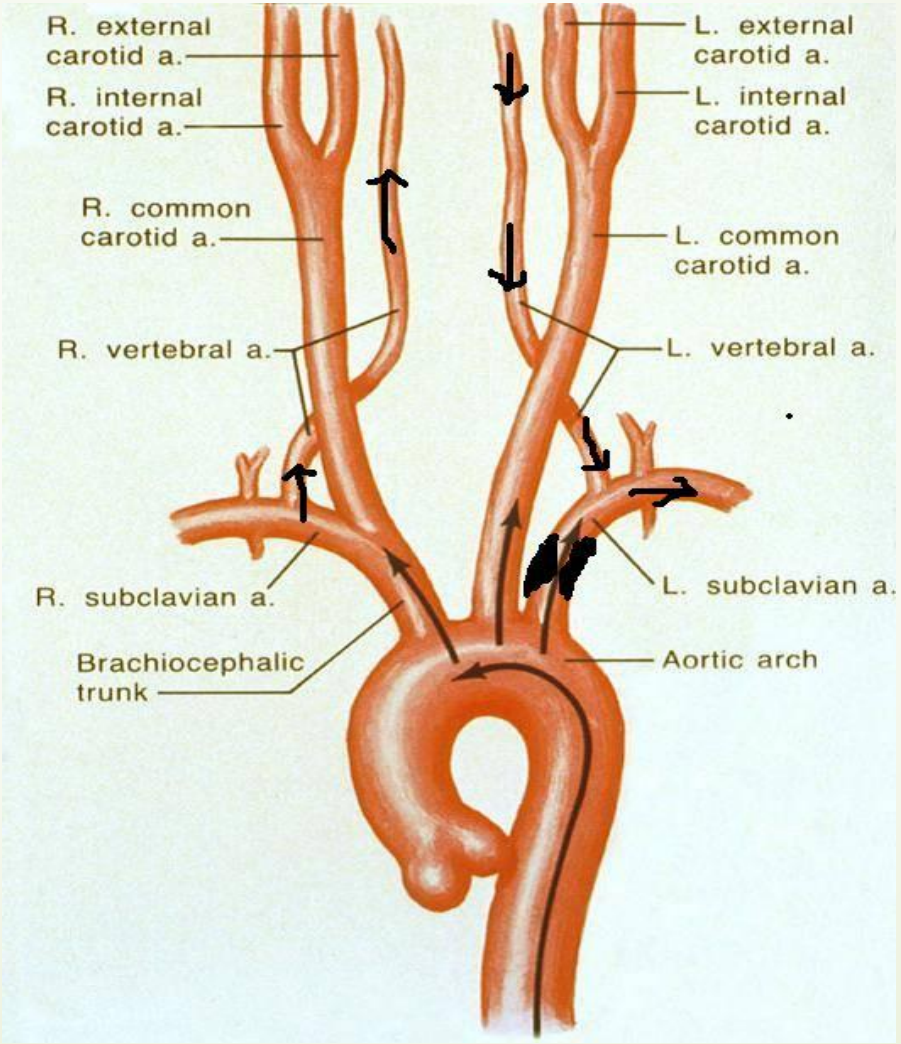


- High resistant waveform , loss of diastolic flow would indicate distal disease.
- Distal vertebral artery stenosis, occlusion or dissection.
- If high resistant waveforms noted bilateral vertebral arteries must consider basilar pathology

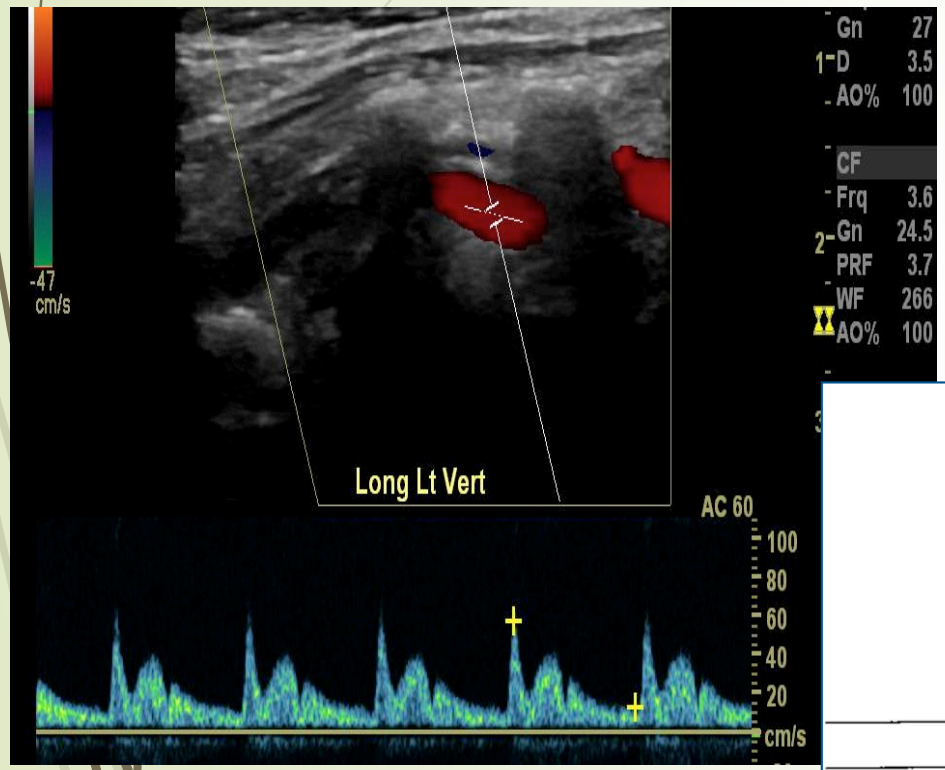
Vertebral Artery Pathology
Subclavian steal syndrome

- Pre Steal “ Bunny ears” “Bunny sign”
- Bidirectional waveform (incomplete or partial steal)
- Retrograde vertebral flow

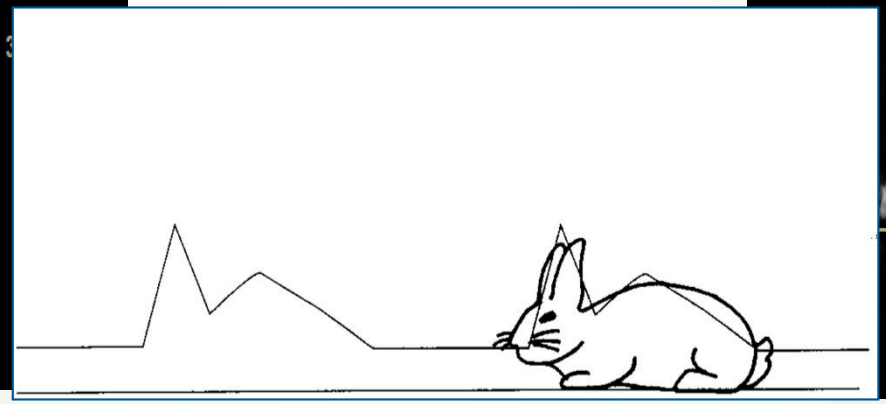
Vertebral Artery Pathology
Subclavian steal syndrome



Vertebral Artery Pathology
Subclavian steal syndrome



Pre steal
"Bunny sign"



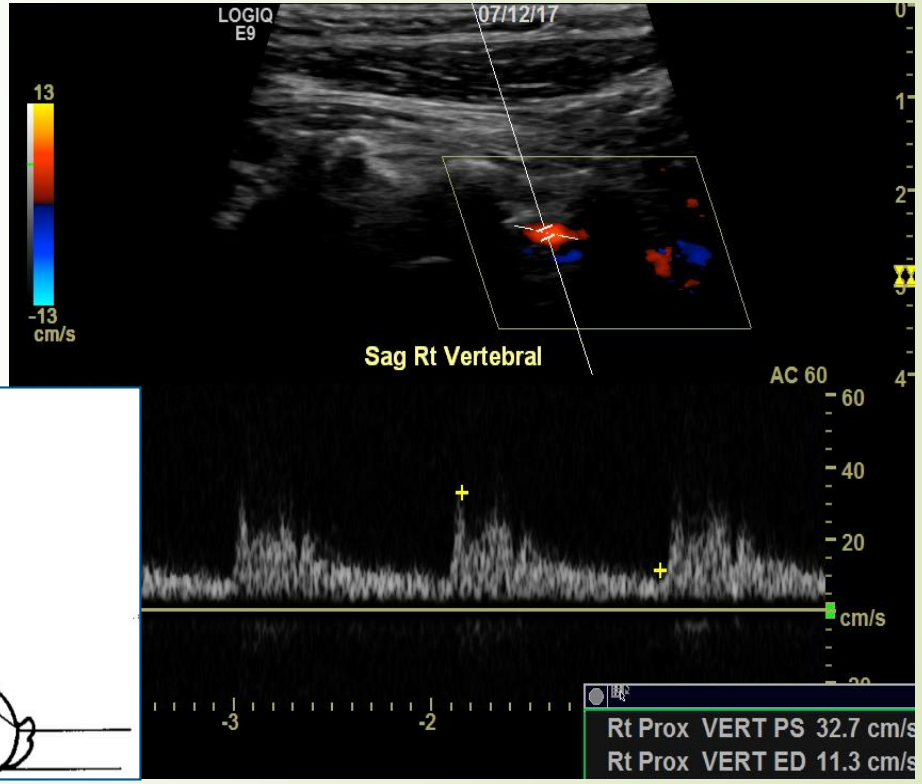
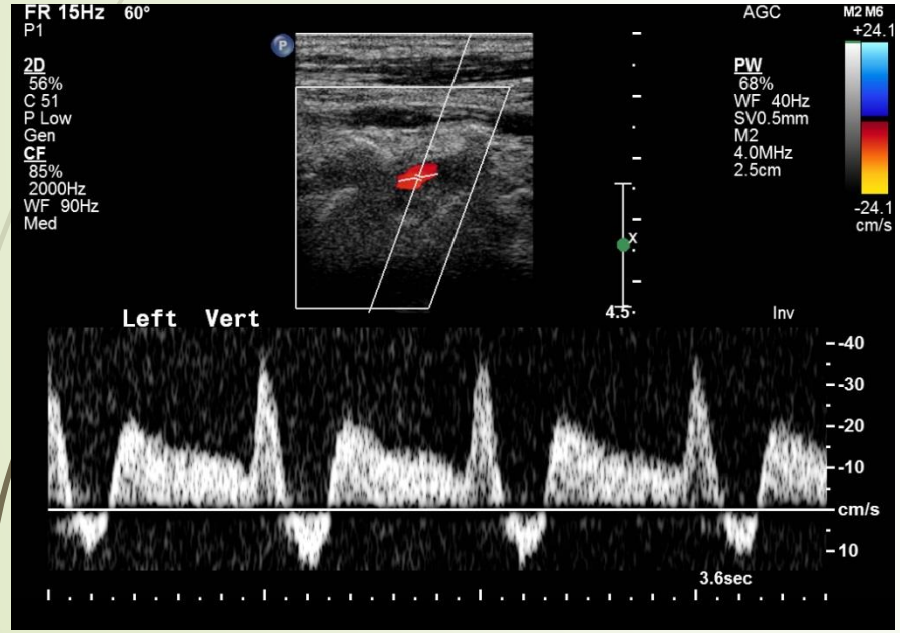


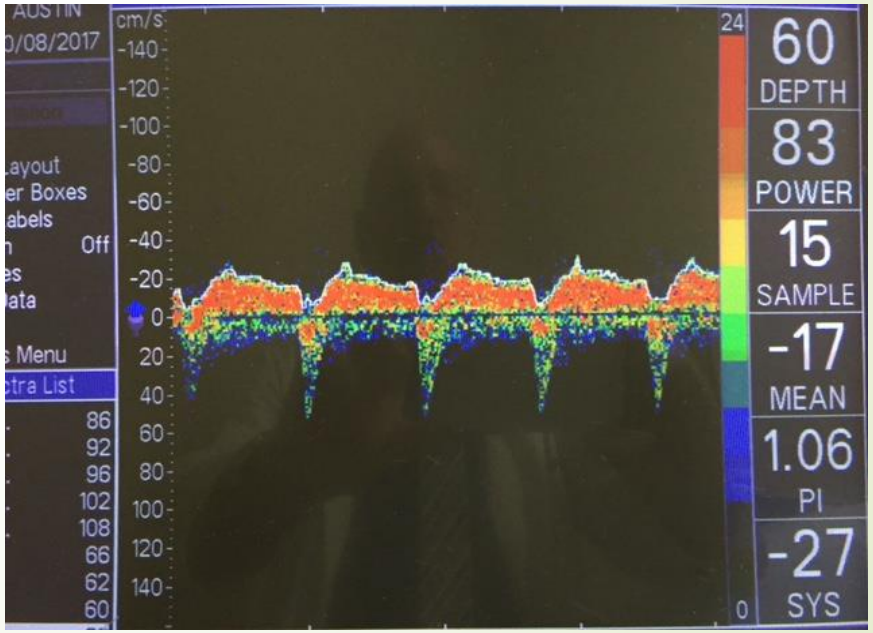
Image courtesy Dr. H. Gornik

Vertebral Artery Pathology
Subclavian steal syndrome

- Incomplete Subclavian Steal



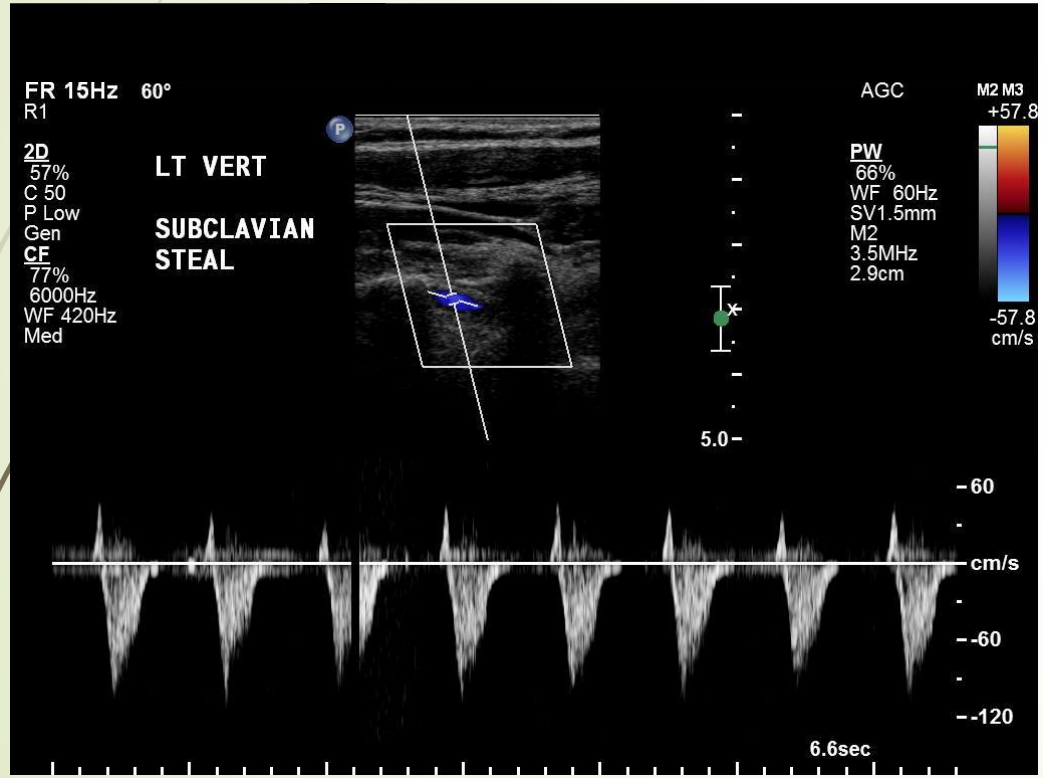
Extracranial



Intracranial

Image courtesy Dr. H. Gornik

Vertebral Artery Pathology
Subclavian steal syndrome
Complete steal



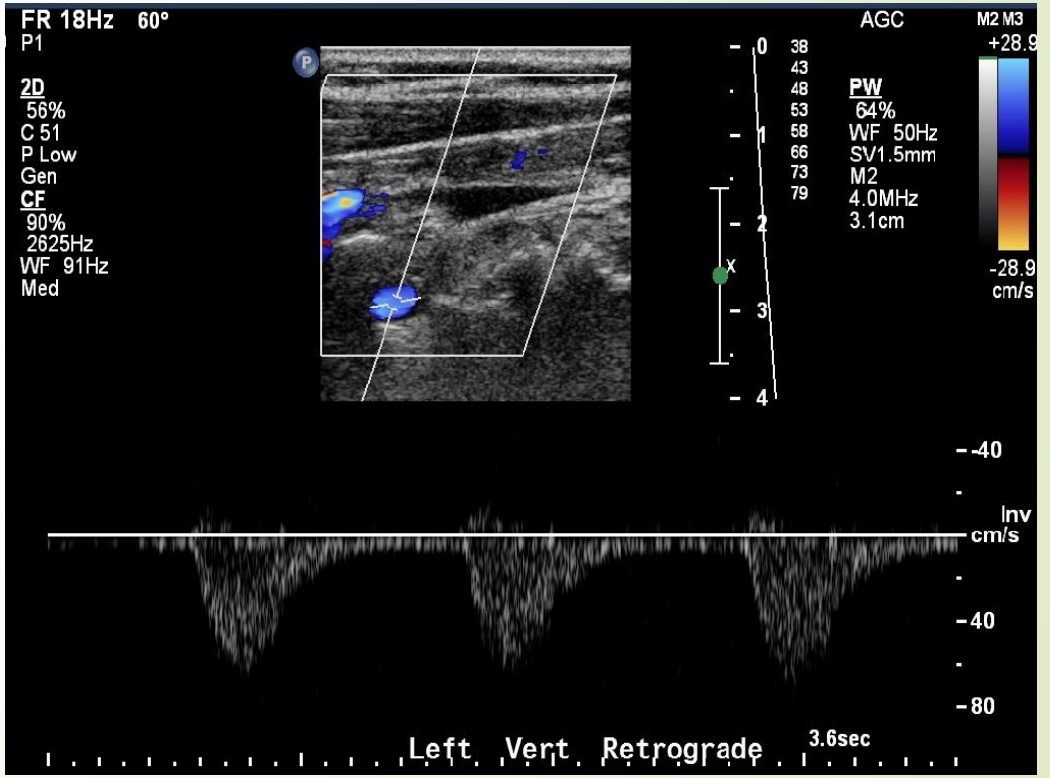


Image courtesy Dr. H. Gornik

Vertebral Artery Pathology
Subclavian steal syndrome

Steal or no Steal ??????????????????????

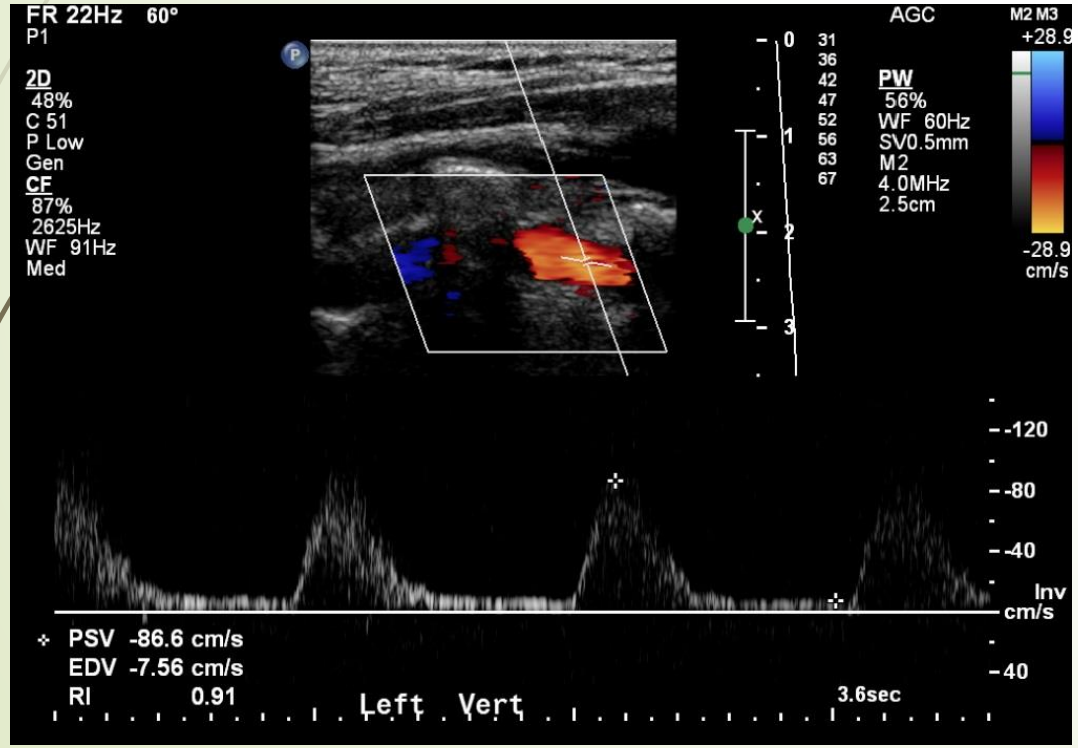


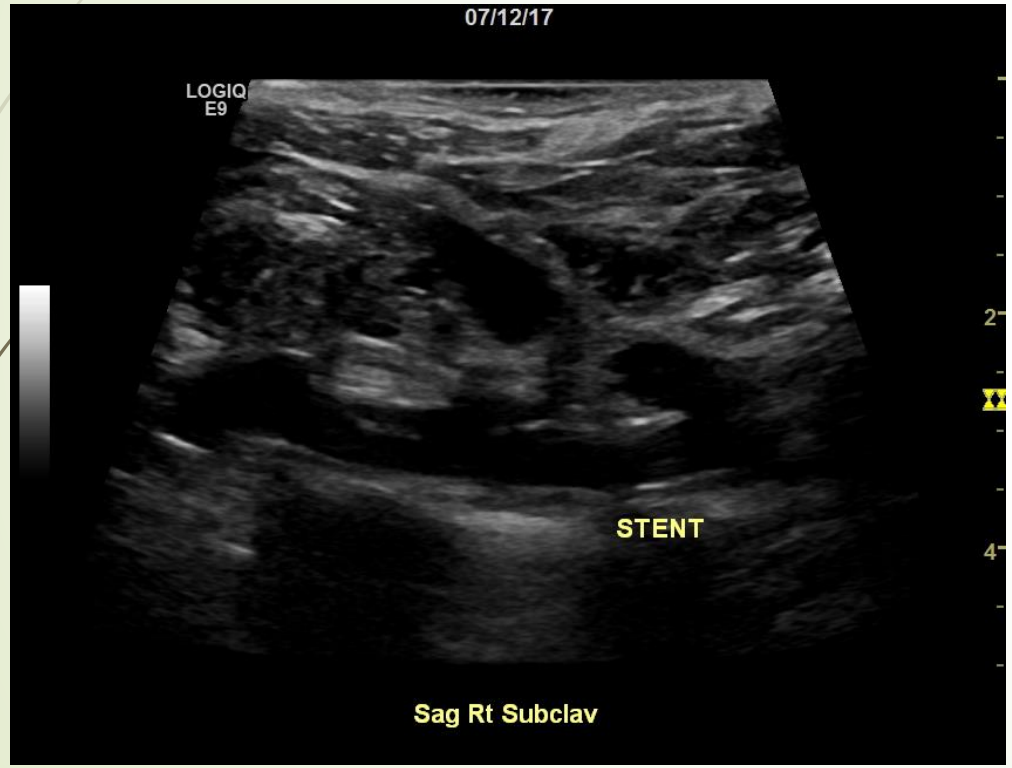
Image courtesy Dr. H. Gornik

Case Study

Case Study

- 59 yo female. Moya-Moya, HTN, hyperlipidemia and COPD.
- History of vascular disease (to put it mildly)
- Lt. ICA occlusion
- Lt. ECA stent
- Lt. proximal vertebral artery stent
- Rt. Subclavian artery stent
- Lt. CCA-ECA bypass graft
- Angioplasty bilateral renal arteries and left leg arteries
- Angioplasty SMA and IMA
- CABG 2015

Case Study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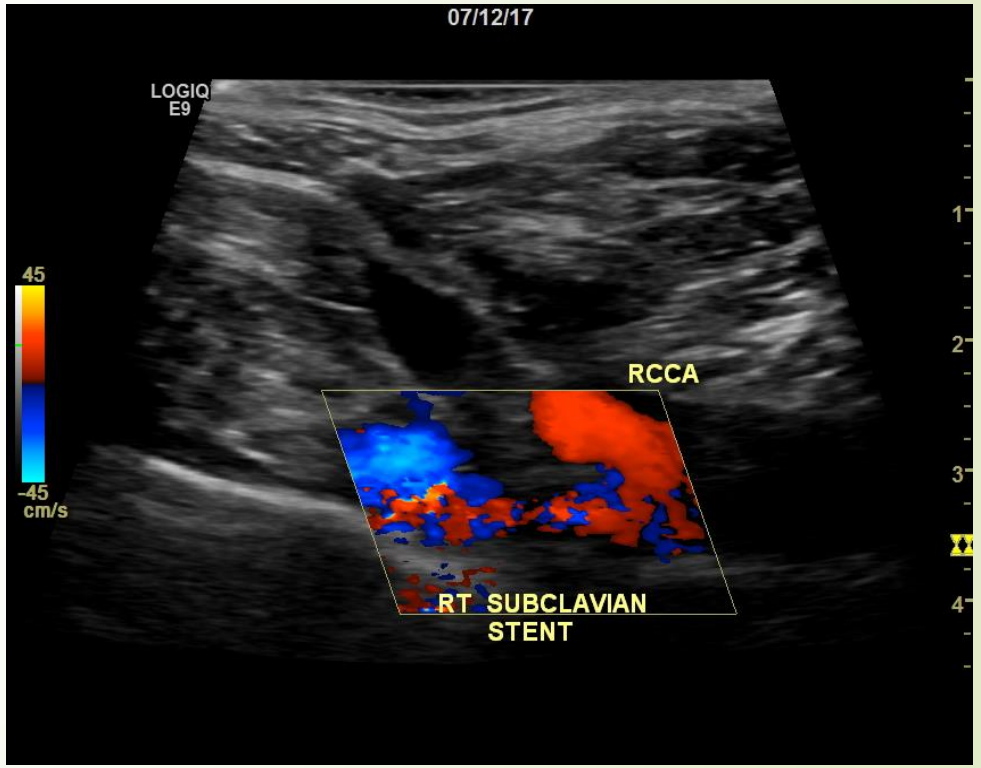
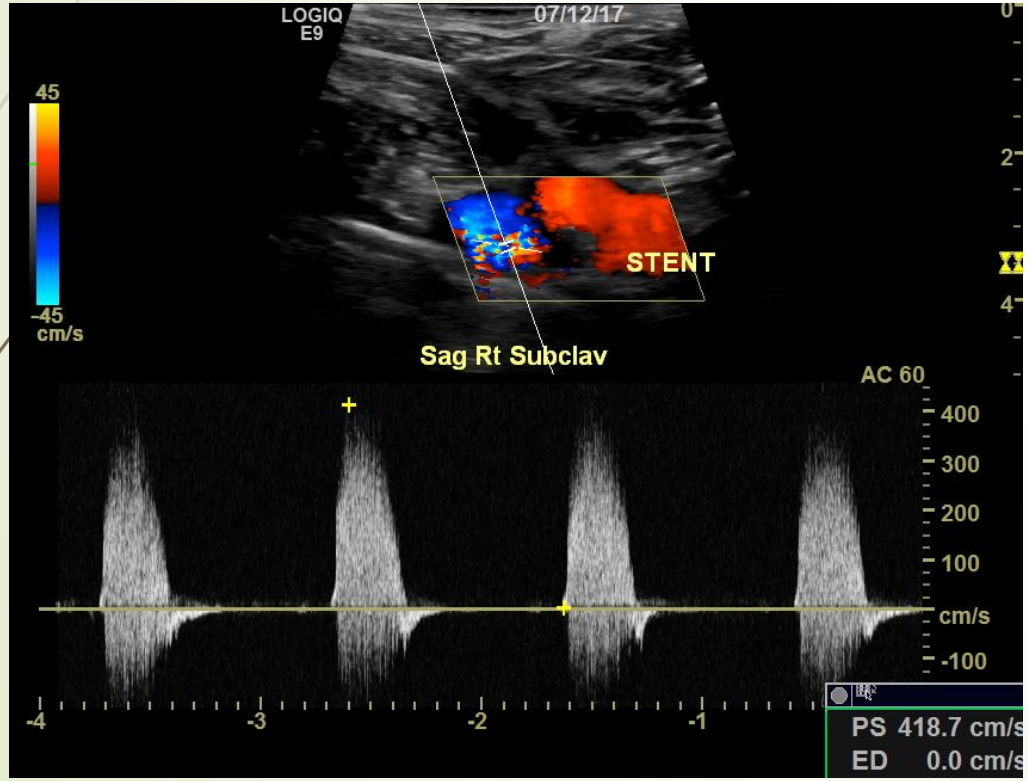
LOGIQ
E9
STENT
Sag Rt Subclav

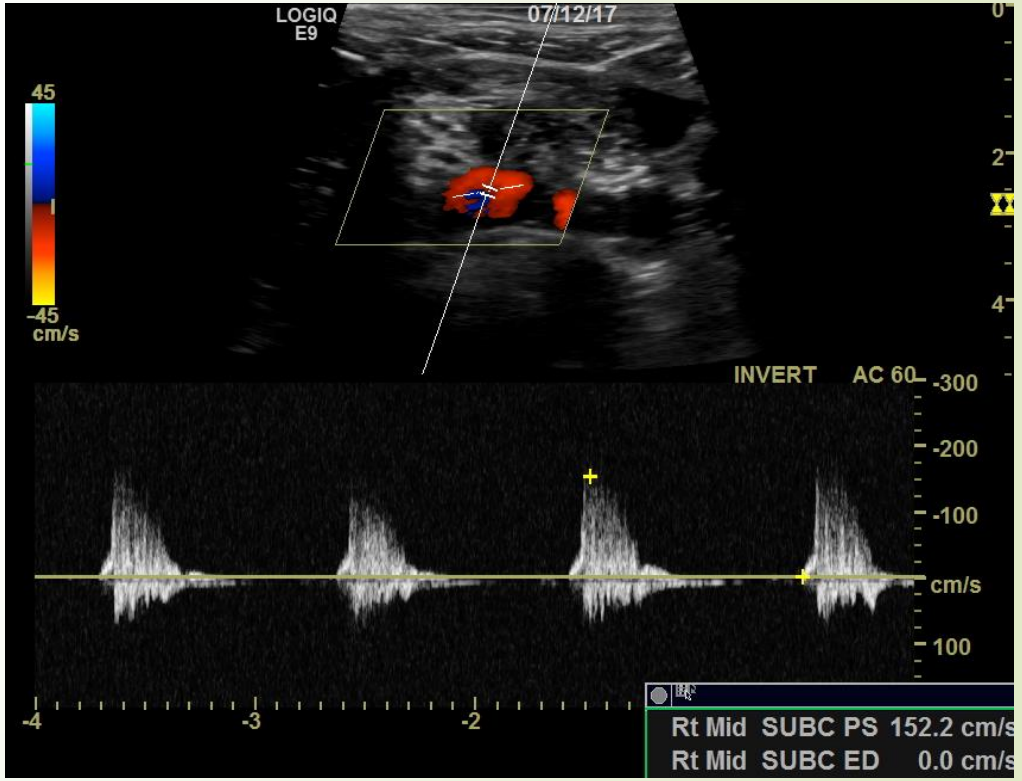

07/12/17
LOGIQ
E9
45
-45
cm/s
RCCA
RT SUBCLAVIAN
STENT

Case Study

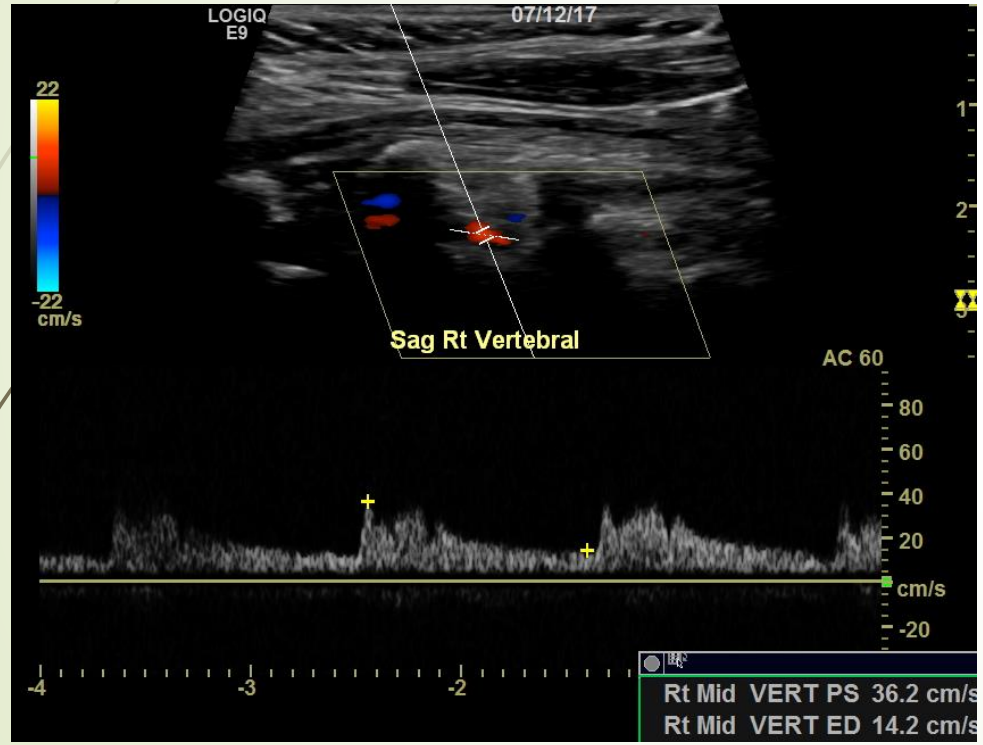
Restenosis Rt. Subclavian stent

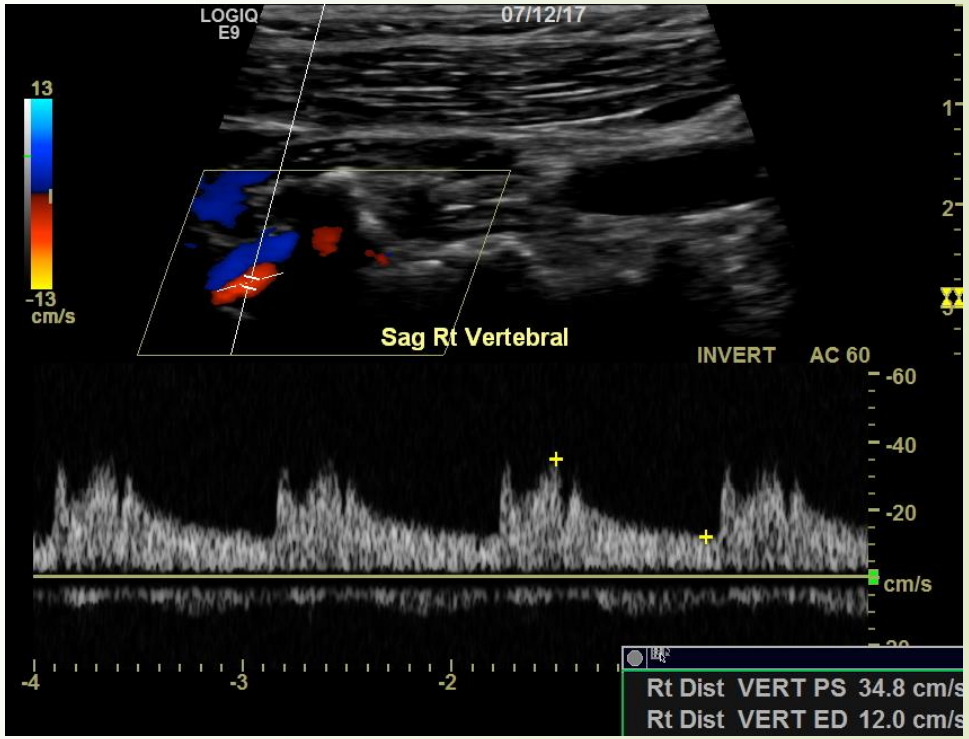


Mid Rt. Subclavian distal to stent



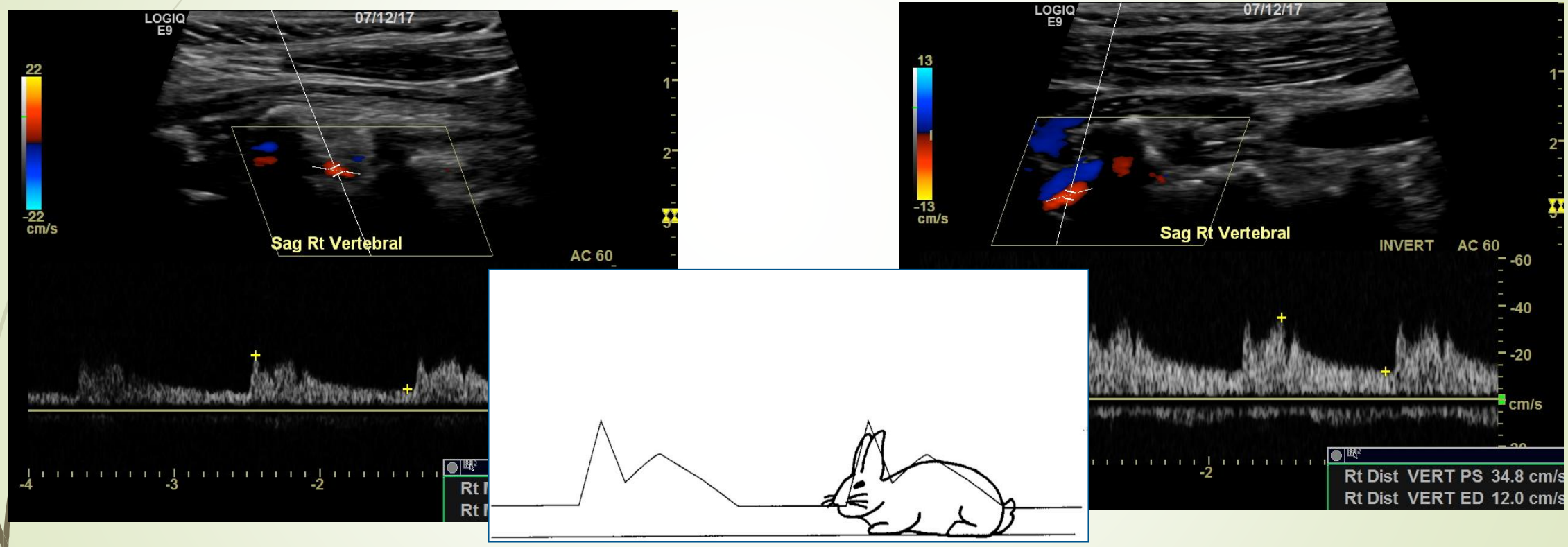
Case Study


LOGIQ
E9
07/12/17
22
-22
cm/s
Sag Rt Vertebral
AC 60
80
60
40
20
cm/s
-20
-4
-3
-2
Rt Mid VERT PS 36.2 cm/s
Rt Mid VERT ED 14.2 cm/s


LOGIQ
E9
07/12/17
13
-13
cm/s
Sag Rt Vertebral
INVERT
AC 60
-60
-40
-20
cm/s
-4
-3
-2
Rt Dist VERT PS 34.8 cm/s
Rt Dist VERT ED 12.0 cm/s

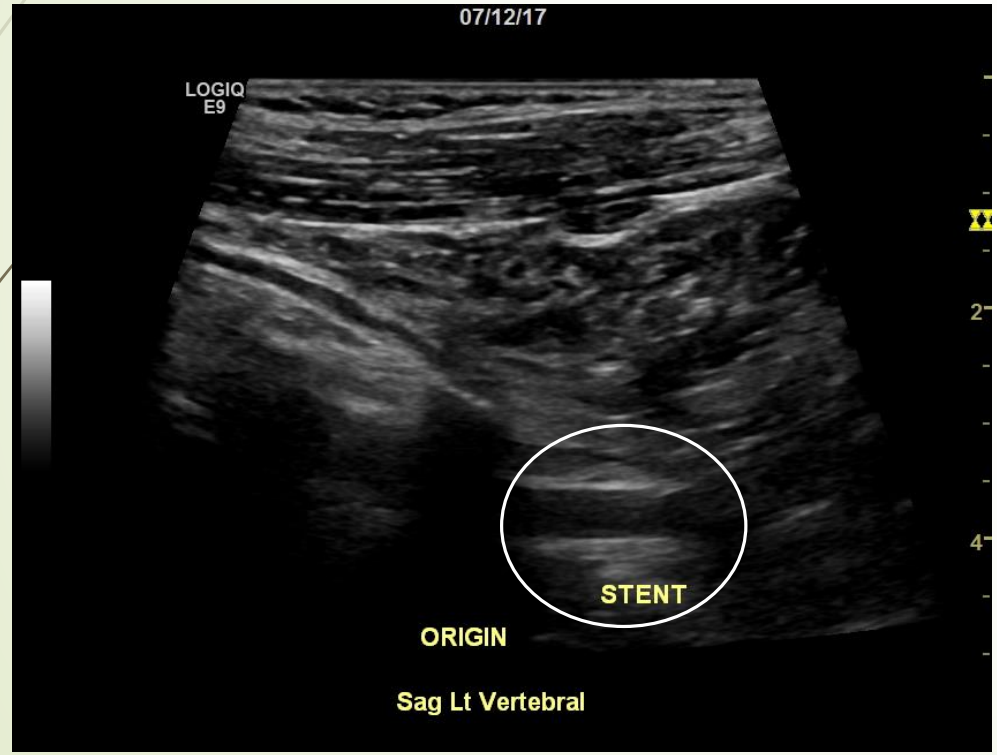
Case Study

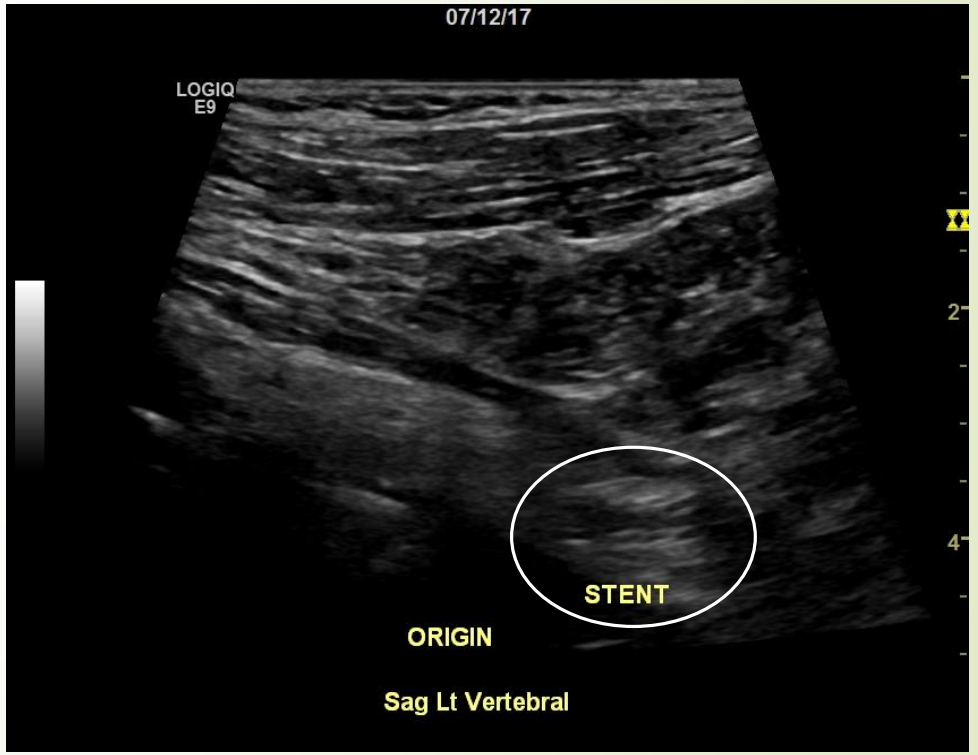
"Bunny Sign" Pre-Steal



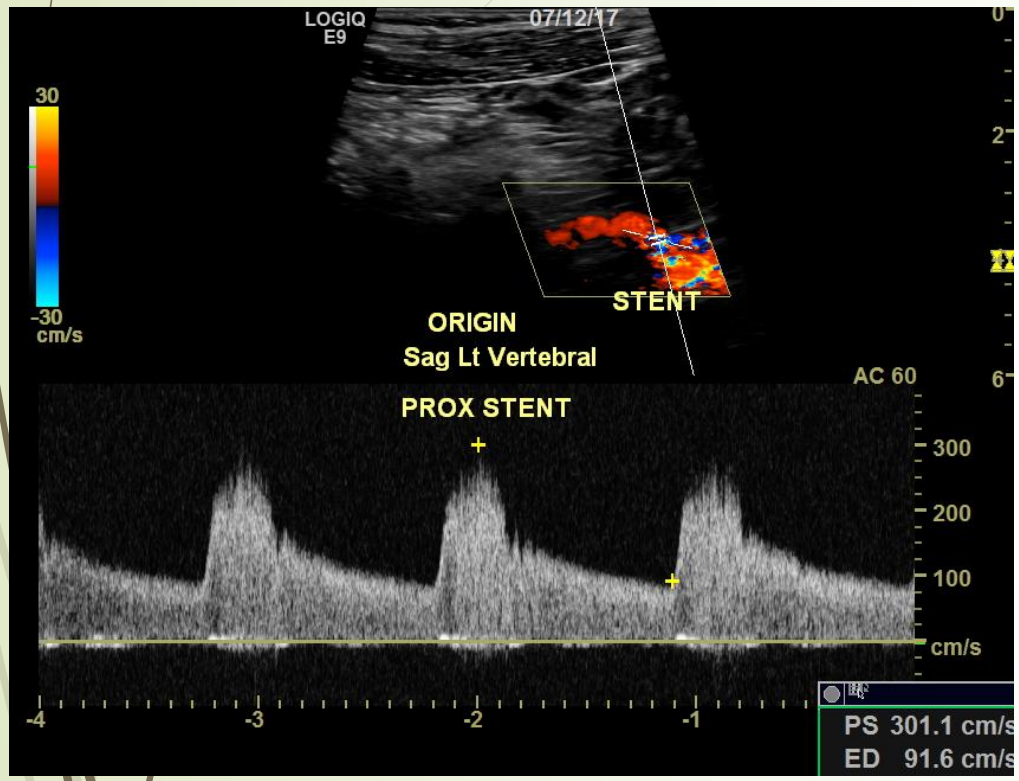
Case Study

Lt. Vertebral artery proximal stent

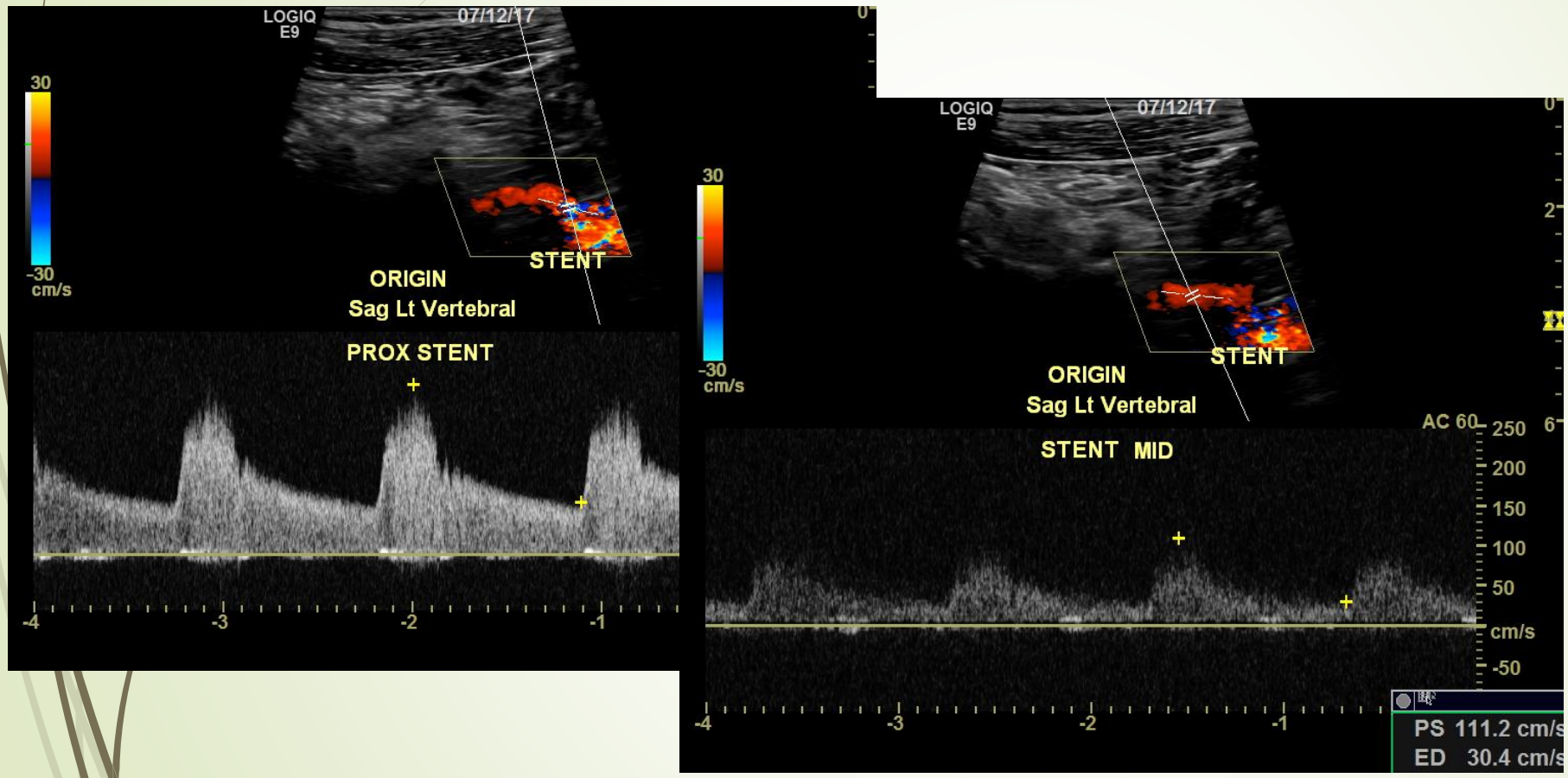




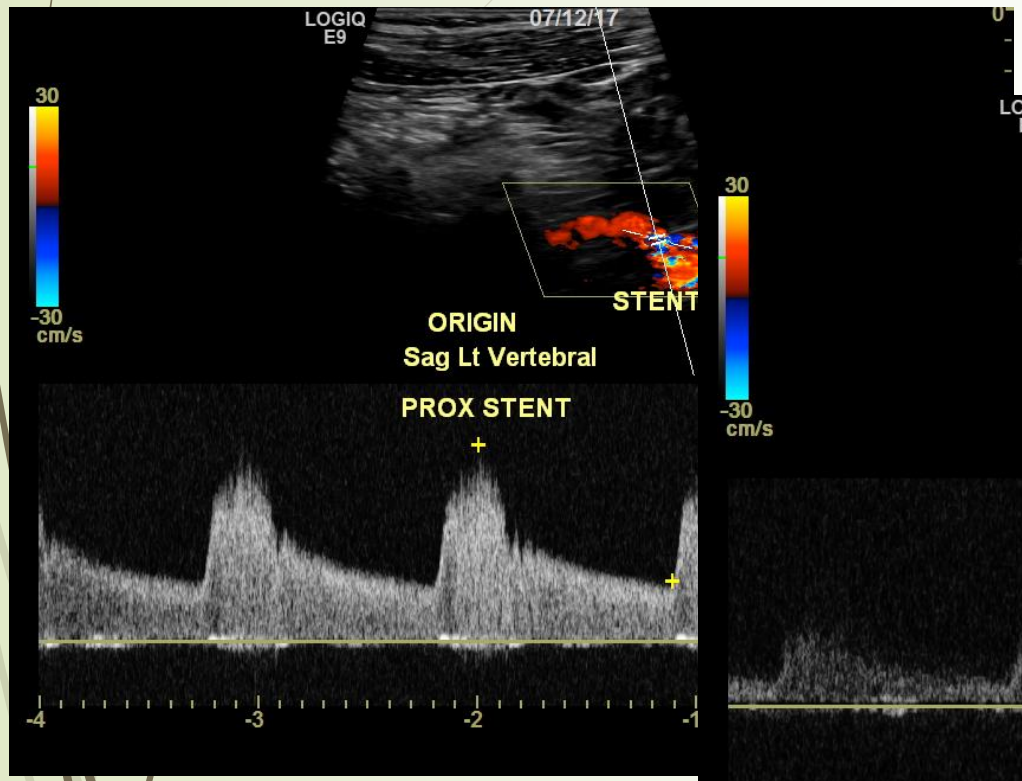
Case Study


LOGIQ
E9
07/12/17
30
-30
cm/s
STENT
ORIGIN
Sag Lt Vertebral
AC 60
PROX STENT
300
200
100
cm/s
-4
-3
-2
-1
PS 301.1 cm/s
ED 91.6 cm/s

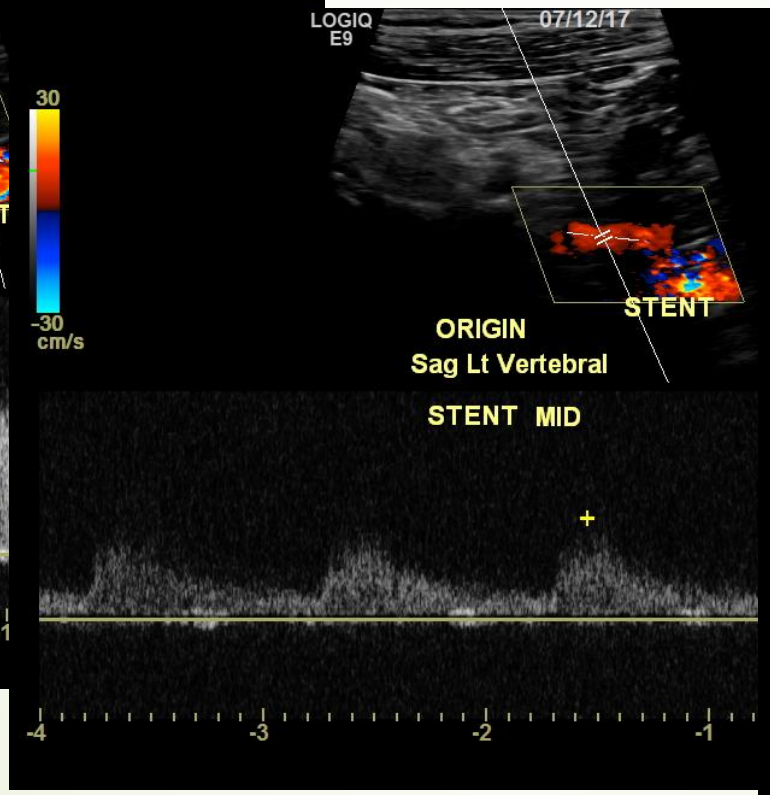
Case Study


LOGIQ
E9
07/12/17
30
-30
cm/s
ORIGIN
Sag Lt Vertebral
STENT
PROX STENT
-4
-3
-2
-1
LOGIQ
E9
07/12/17
ORIGIN
Sag Lt Vertebral
STENT
STENT MID
AC 60
250
200
150
100
50
cm/s
-50
PS 111.2 cm/s
ED 30.4 cm/s

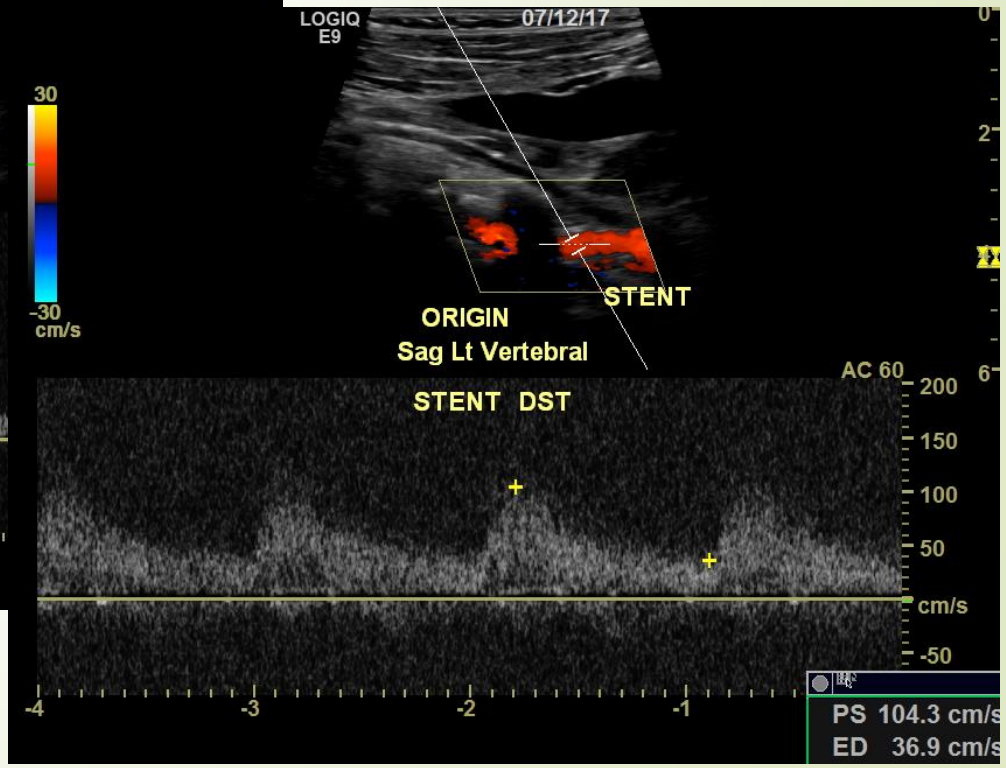
Case Study / Lt. Vertebral Artery Stent Restenosis



301 cm/sec



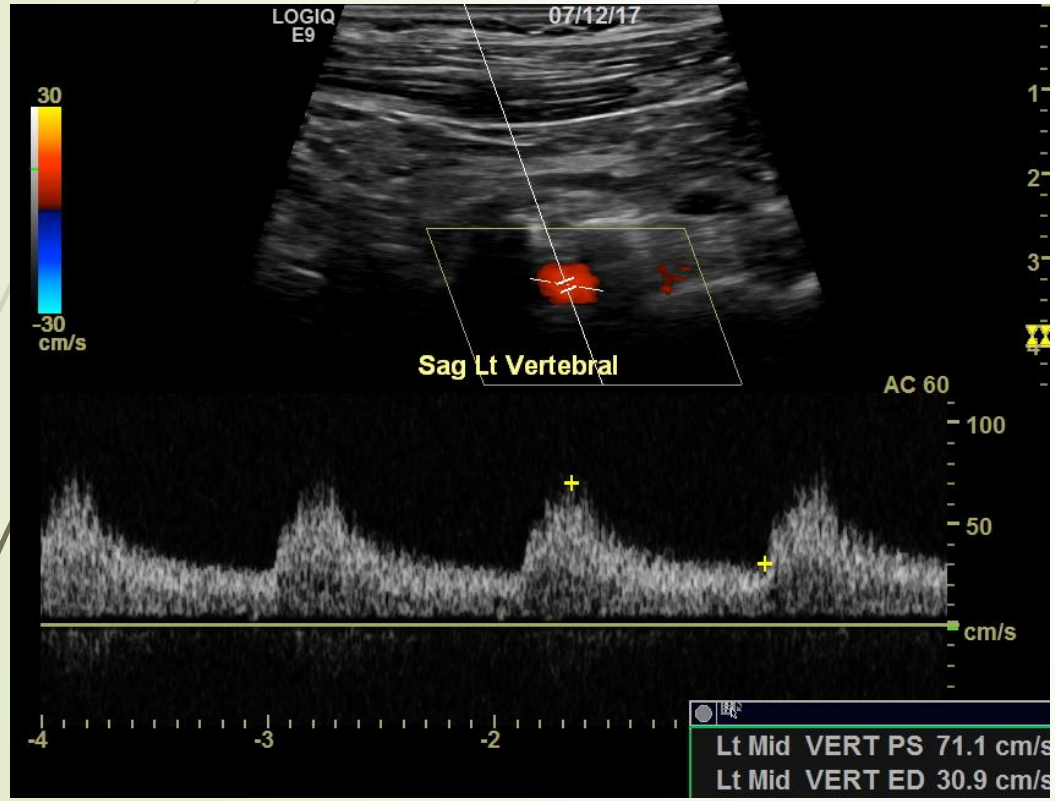
111 cm/sec

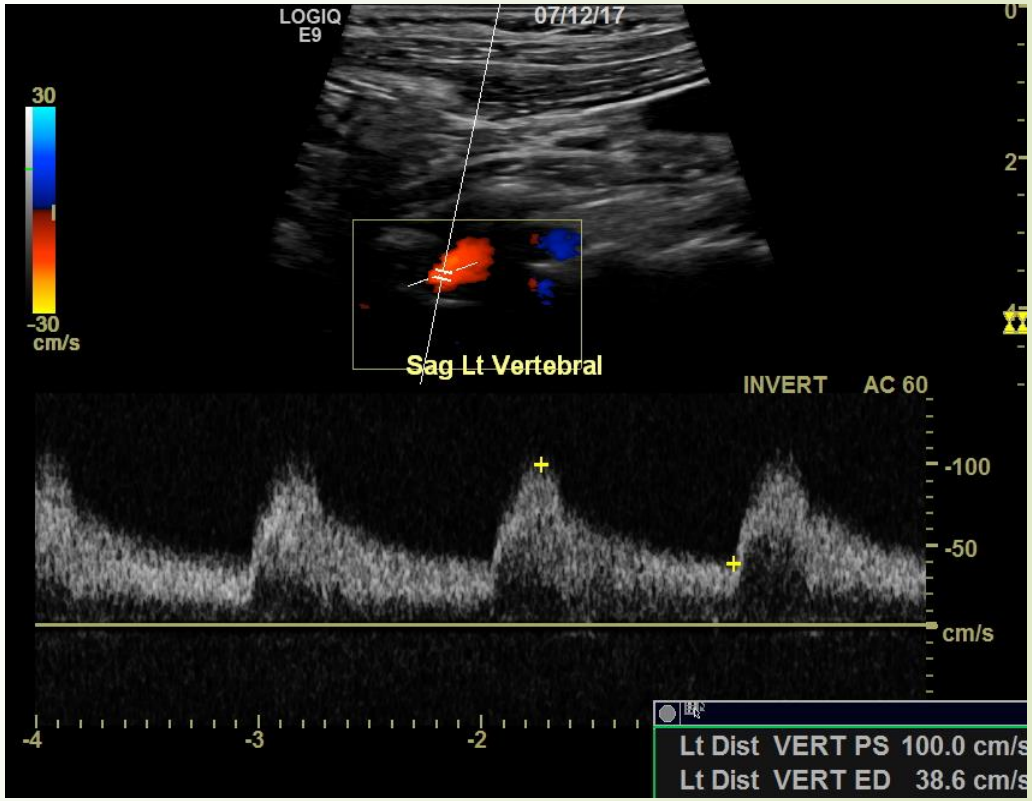


104 cm/sec

Case Study

Mid – Distal left vertebral artery - Parvus-Tardus waveforms
Compatible with more proximal disease





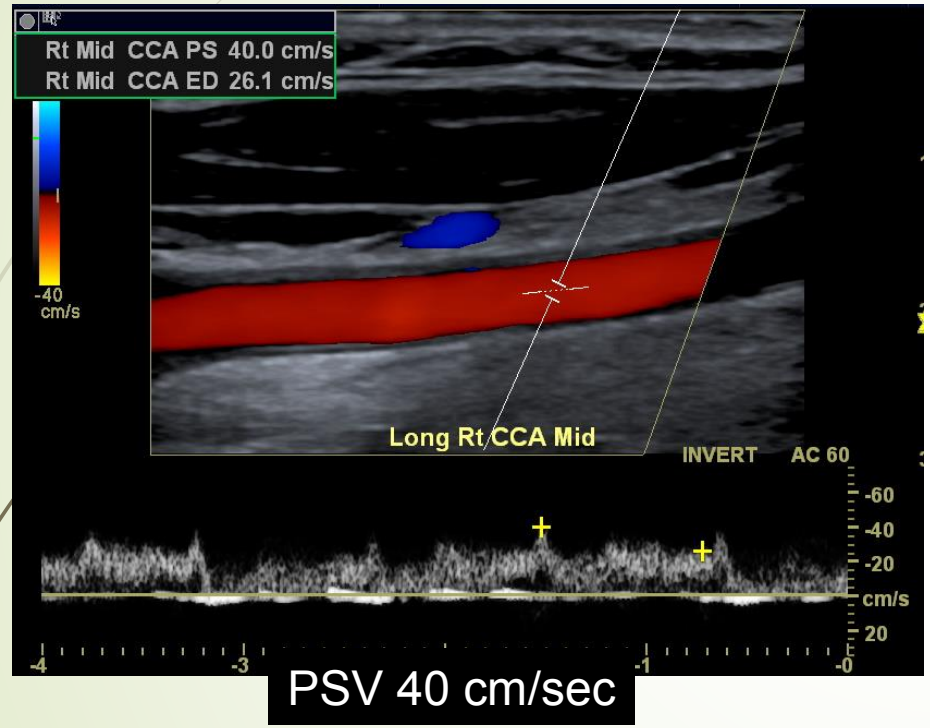
Putting It All Together… Another Case

- 41 year-old woman
- Frequent episodes of dizziness and one recent syncopal spell
- Symptoms seem worse when she uses her arms
- Referred to vascular laboratory for additional testing for further evaluation of physical examination and imaging findings

Thank you Dr. Gornik for this case!

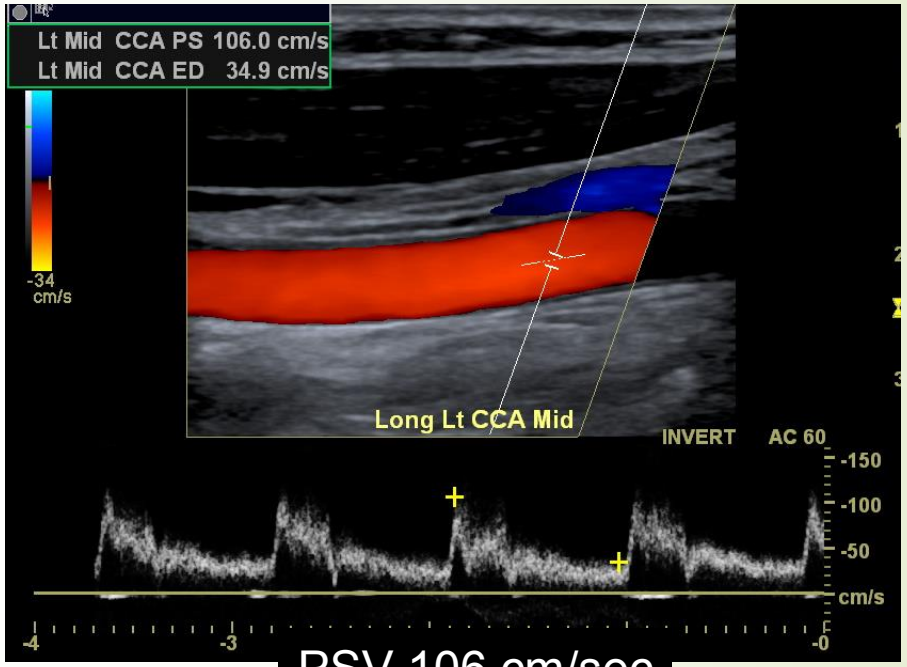
Right vs. Left CCA Waveforms

RIGHT CCA



PSV 40 cm/sec

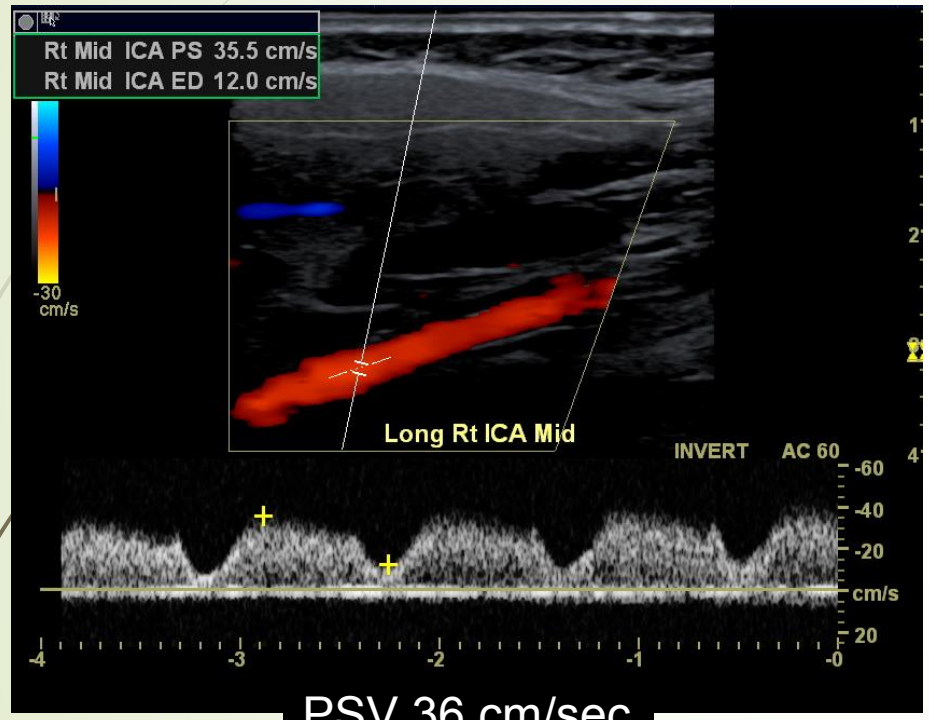
LEFT CCA



PSV 106 cm/sec

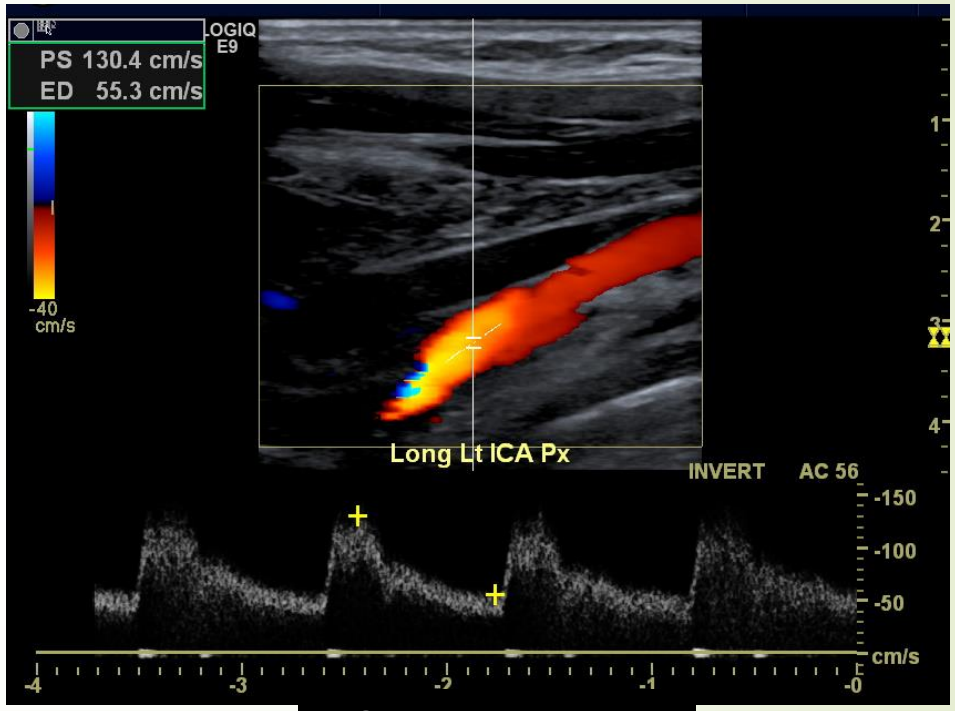
Right vs. Left ICA Waveforms

RIGHT ICA



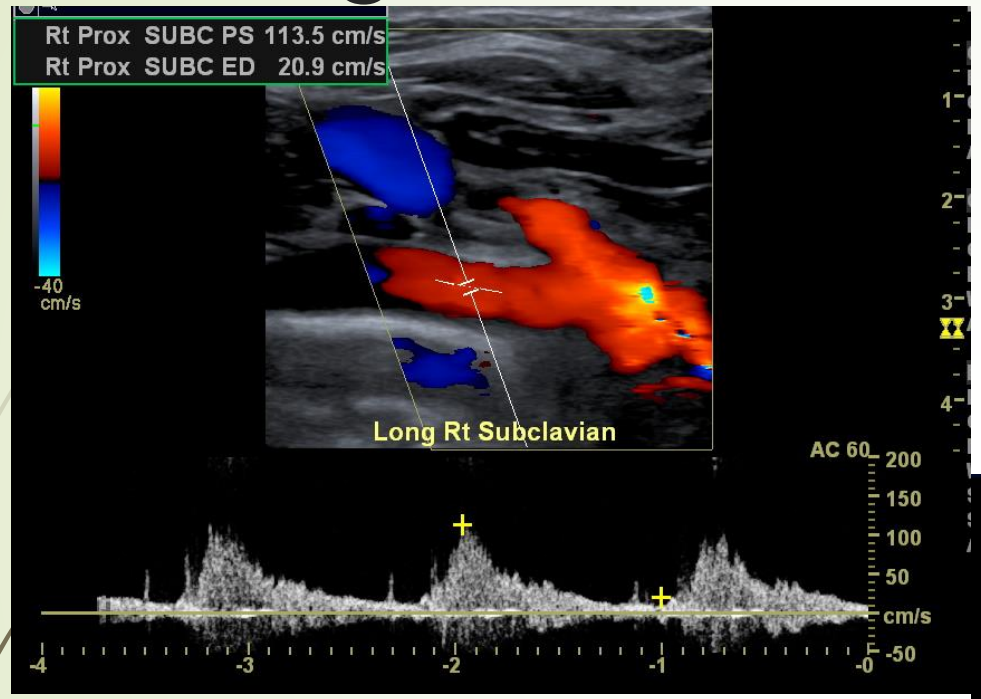
PSV 36 cm/sec

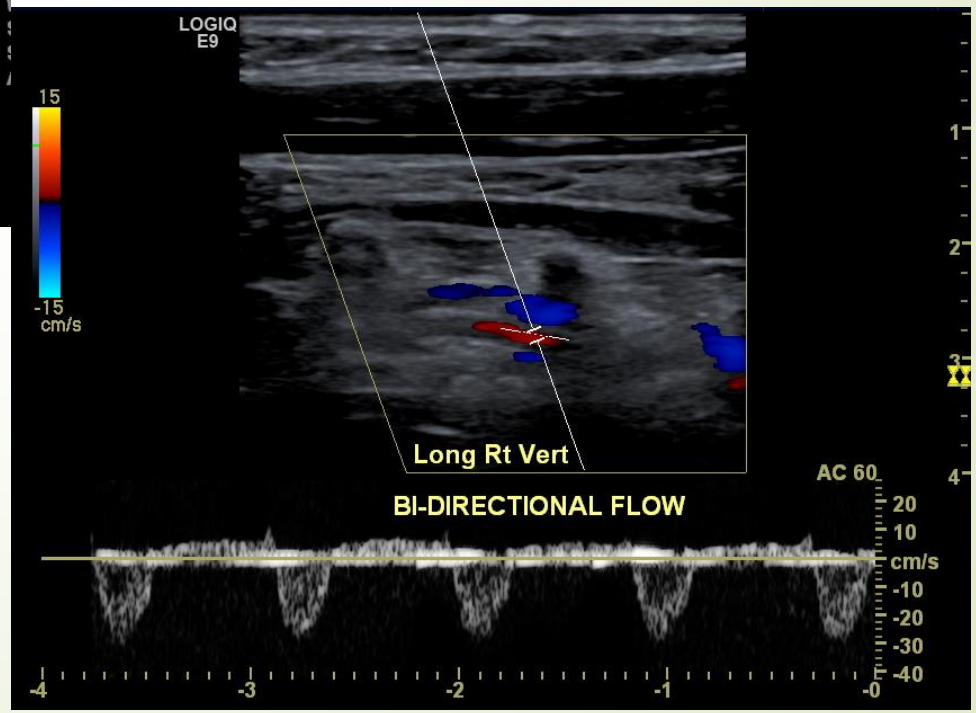
LEFT ICA



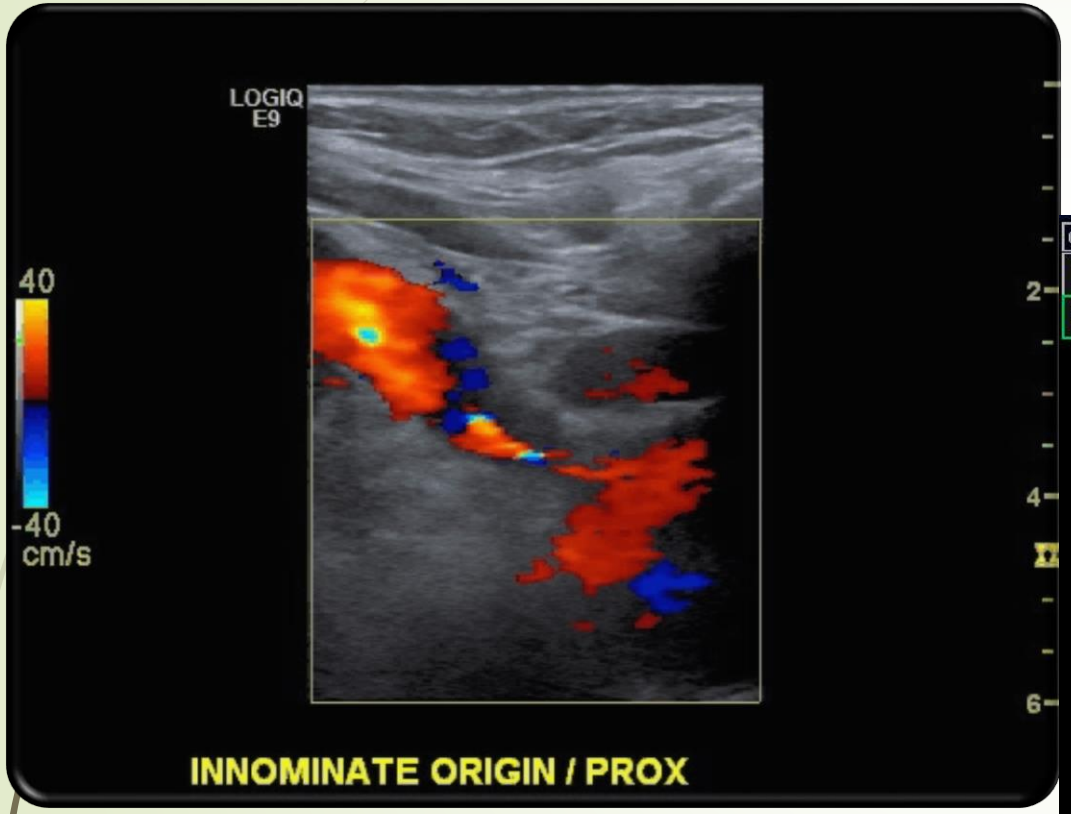
PSV 130 cm/sec

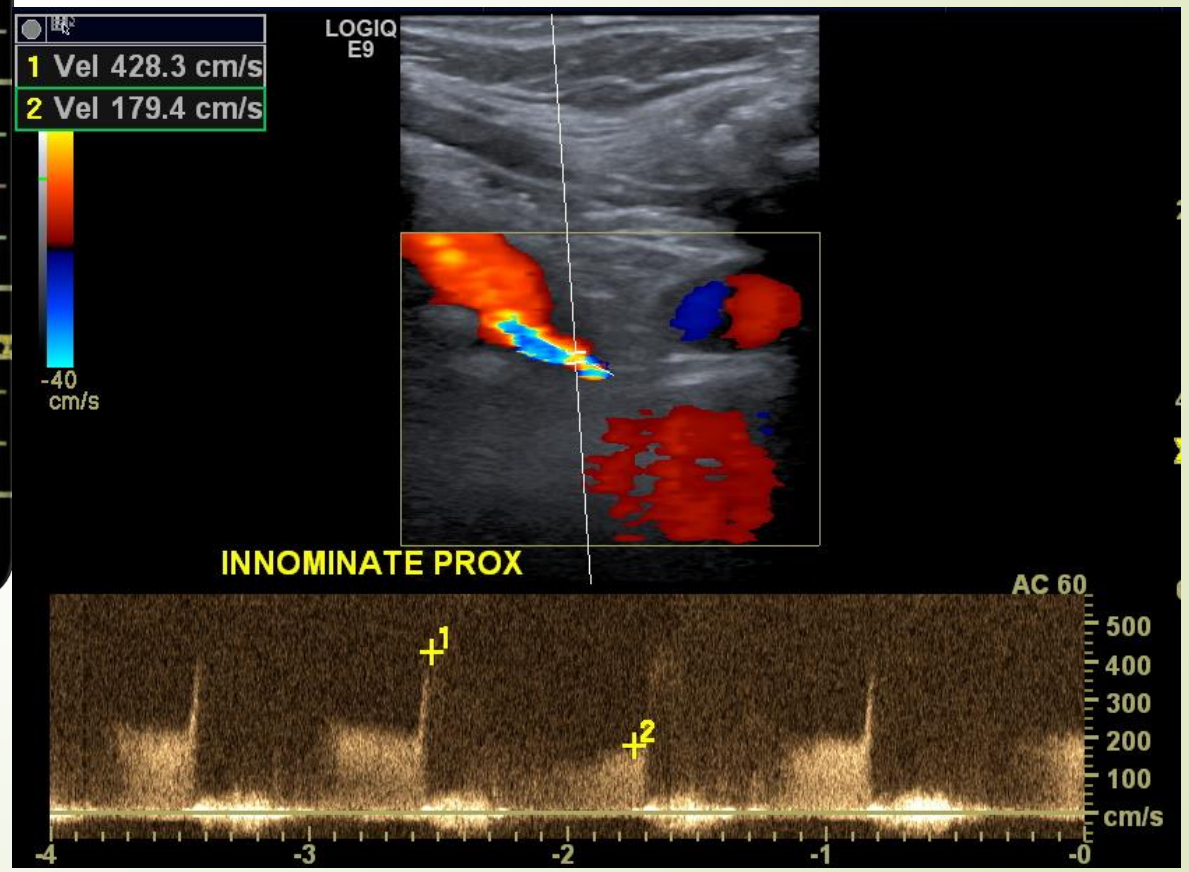
Right Subclavian and Vertebral Arteries





Found It! Innominate Artery Stenosis





THANK YOU!