Ultrasound Imaging of The Posterior Circulation

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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
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
VERTEBRAL ARTERIES

- FIRST BRANCH OFF SUBCLAVIAN
- COURSE POSTERIOR THROUGH C-SPINE TRANSVERSE PROCESSES.
- JOIN TO FORM THE BASILAR ARTERY
- LOW RESISTIVE WAVEFORM
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)
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.
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
  • 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\textsubscript{org})
  • Also analyzed diagnostic performance of PSV ratio, EDV\textsubscript{org}
  • **Diagnostic criteria for vertebral artery stenosis:**
    - \(> 50\%\) stenosis \(\text{PSV}_{\text{org}} > 85 \text{ cm/sec}\)
    - 50-69\% stenosis \(\text{PSV}_{\text{org}} \geq 140 \text{ cm/sec}\)
    - 70-99\% stenosis \(\text{PSV}_{\text{org}} \geq 210 \text{ cm/sec}\)

  - **Do not apply ICA diagnostic criteria to these non-ICA vessels**

Vertebral Artery Pathology

- Normal vertebral artery waveform
- Good upstroke
- Low resistance waveform
- Antegrad 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
Case Study

Restenosis Rt. Subclavian stent

Mid Rt. Subclavian distal to stent
Case Study
Case Study

“Bunny Sign” Pre-Steal
Case Study

Lt. Vertebral artery proximal stent
Case Study
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

Long Rt ICA Mid
PSV 36 cm/sec

LEFT ICA

Long Lt ICA Px
PSV 130 cm/sec
Right Subclavian and Vertebral Arteries
Found It! Innominate Artery Stenosis
THANK YOU!