



Use of Transcranial Doppler in the Acute Neurologic Patient

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- **Consulted for ECHONous.**
 - Review of TCD studies on new ultrasound machine for quality.
- **Chair of Neurocritical Care Society Ultrasound Section**

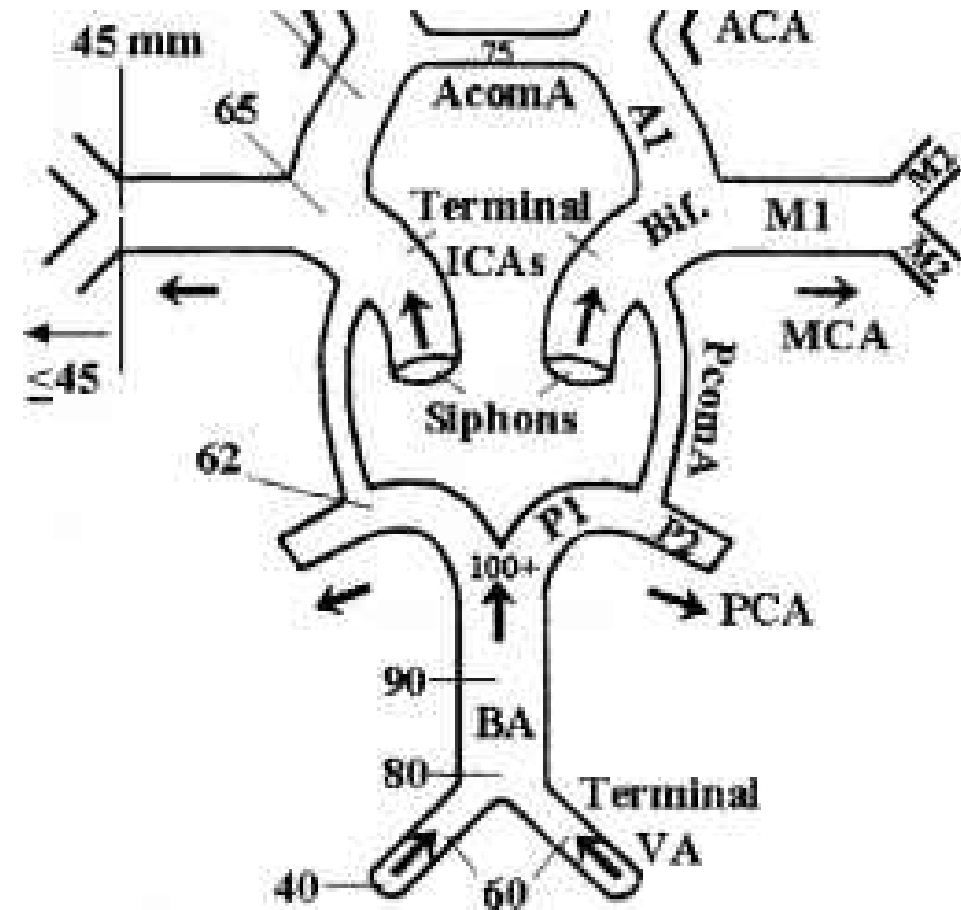
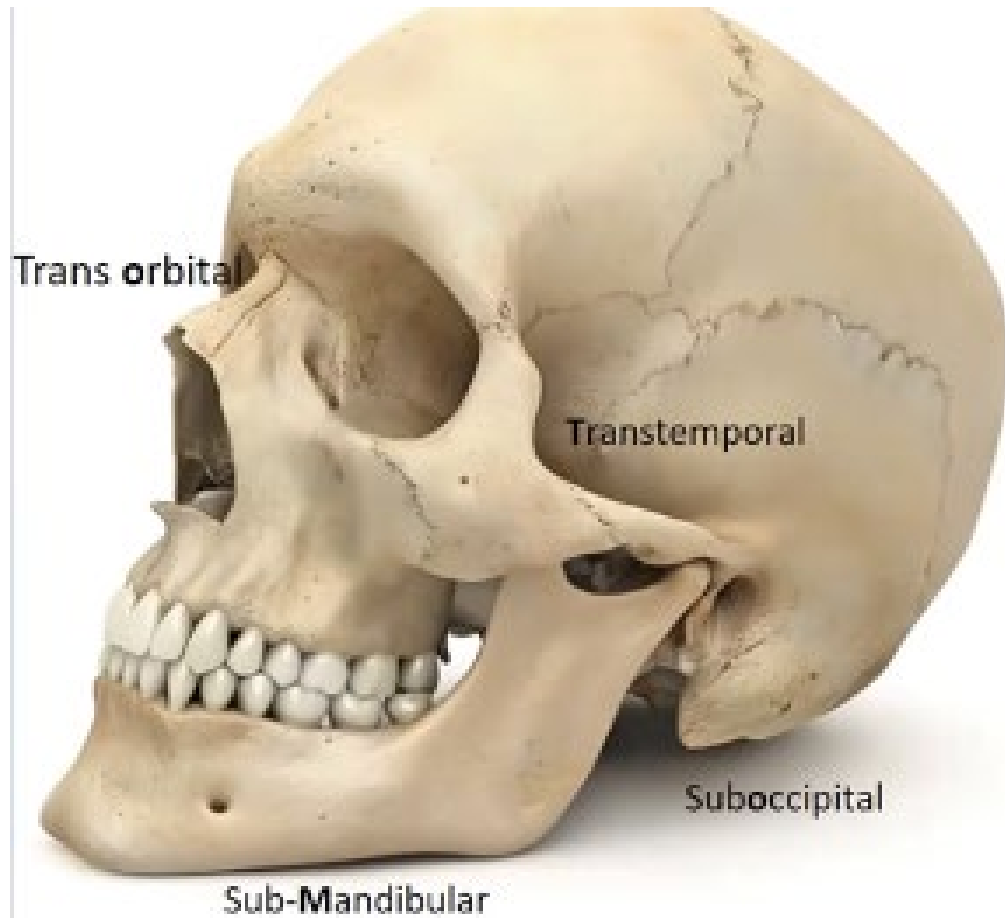
Learning Objectives

- **Describe clinical integration of TCDs in acute neurologic patients**
- **Discuss case-based evaluation and identification of vasospasm**
- **Discuss case-based evaluation of patient with ischemic stroke and identification of ICAD**
- **Discuss case-based evaluation of patients with cerebral edema and evaluation of elevated ICP**
- **Discuss case-based evaluation of patient with embolic appearing ischemic stroke and utilization of TCD with bubble during stroke workup**

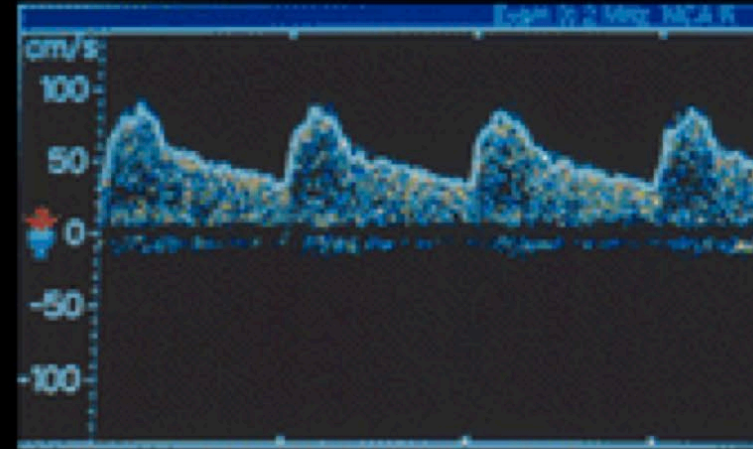
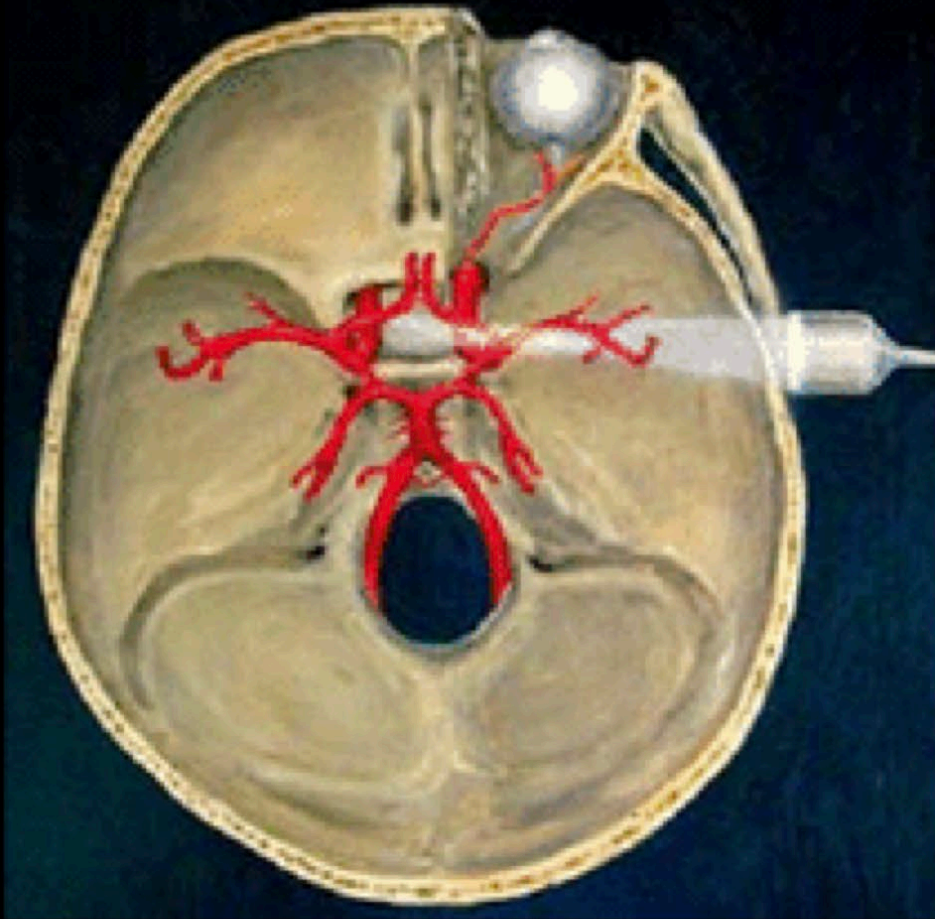


TCD Basics

TCD Basics



Transcranial Doppler (TCD)



TCD Parameters

Peak velocity (PV)

End-diastolic velocity (EDV)

Mean velocity (MV)

$$MV = PV + (2 \times EDV) / 3$$

Pulsatility index (PI)

$$PI = (PV - EDV) / MV$$

R.Aaslid. www.hemodynamic.com



<https://www.dwl.de/us>



<http://www.mmheme.org/knobology>



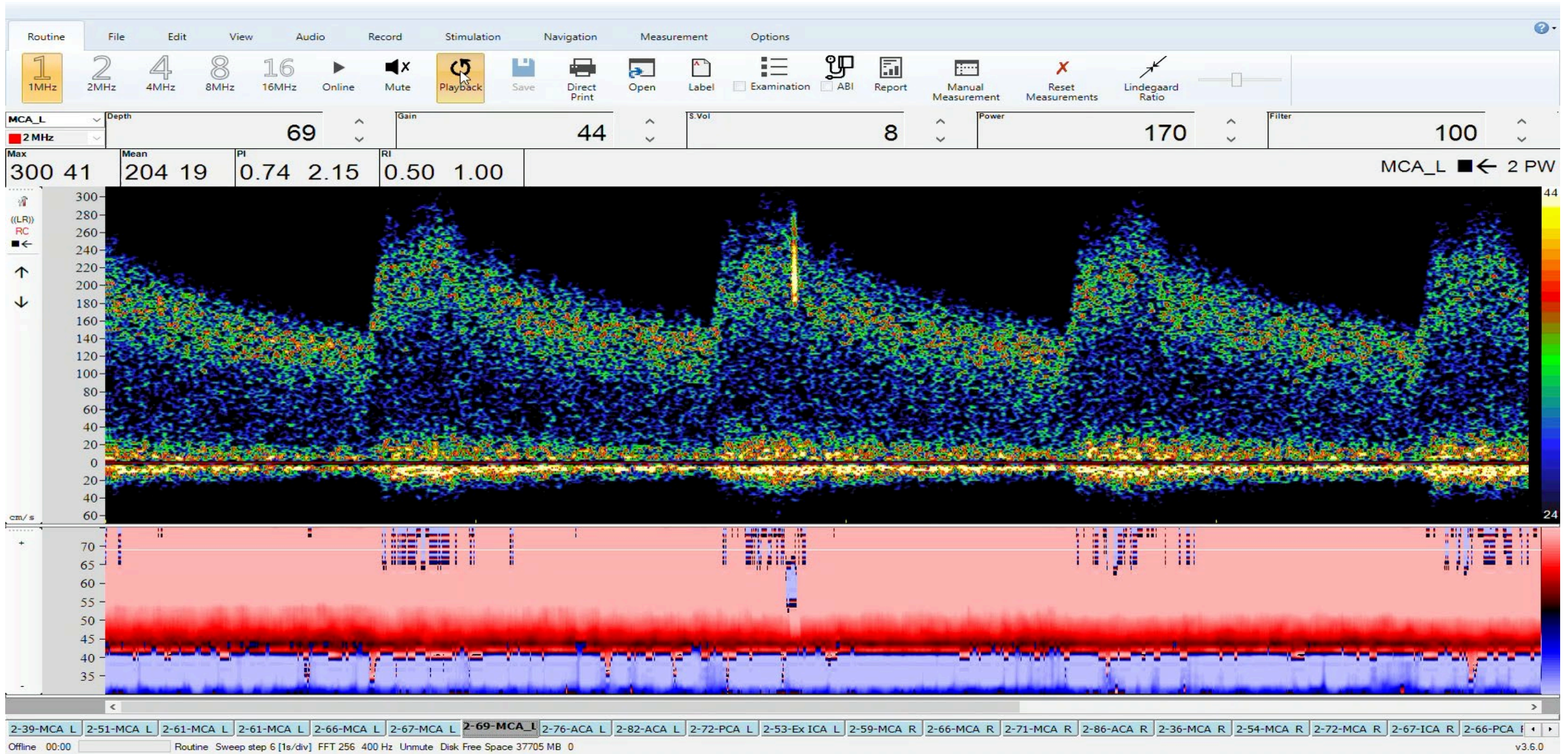
<https://www.nature.com/articles/s41598-021-04751-1>



Case Based TCD Applications

Patient Case #1

- A 44 year-old man with unknown past medical history was found down by family, who called EMS.
- Upon transfer to the ED, his CTH and CTA showed diffuse SAH from a PICA aneurysm.
- He was intubated in the ED and an EVD was placed for obstructive hydrocephalus.
- He then underwent endovascular coiling for his PICA aneurysm.



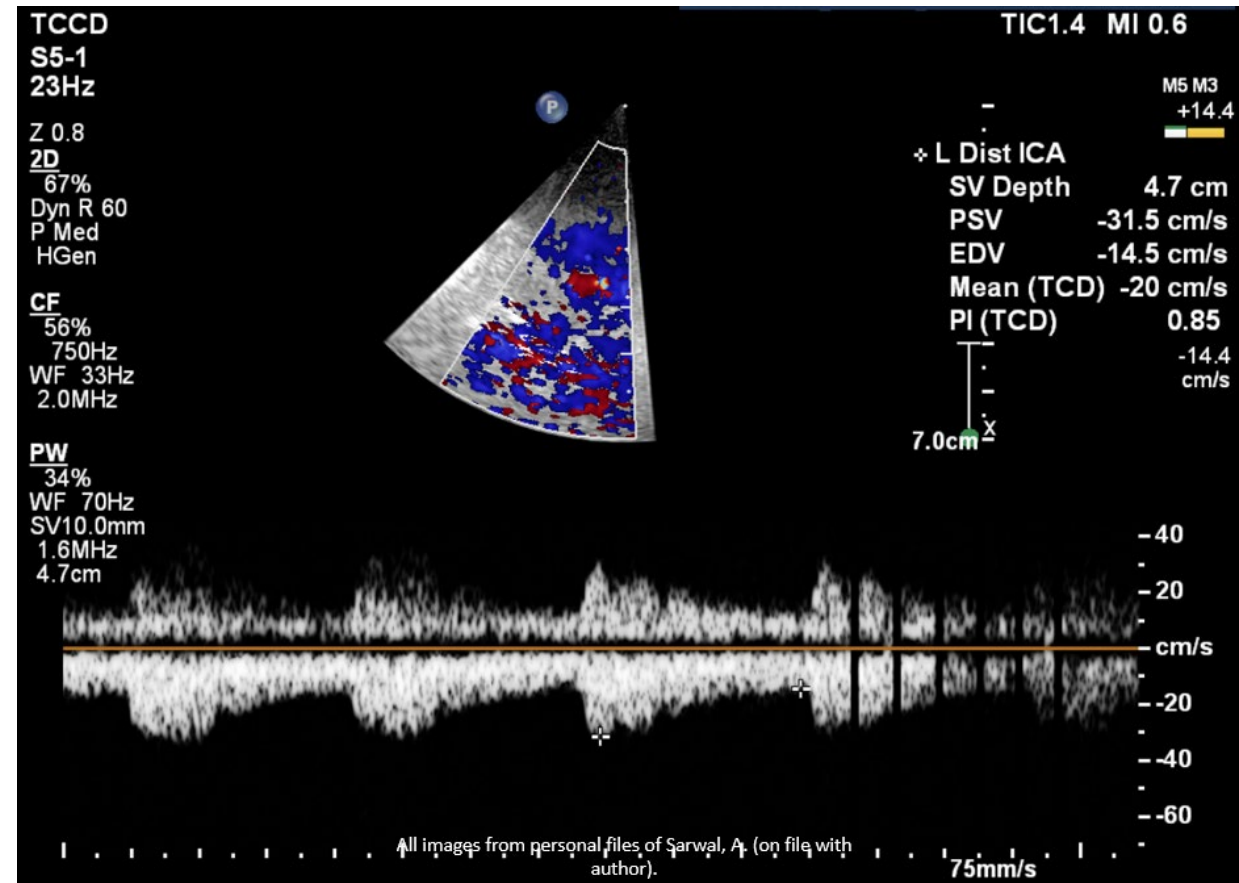
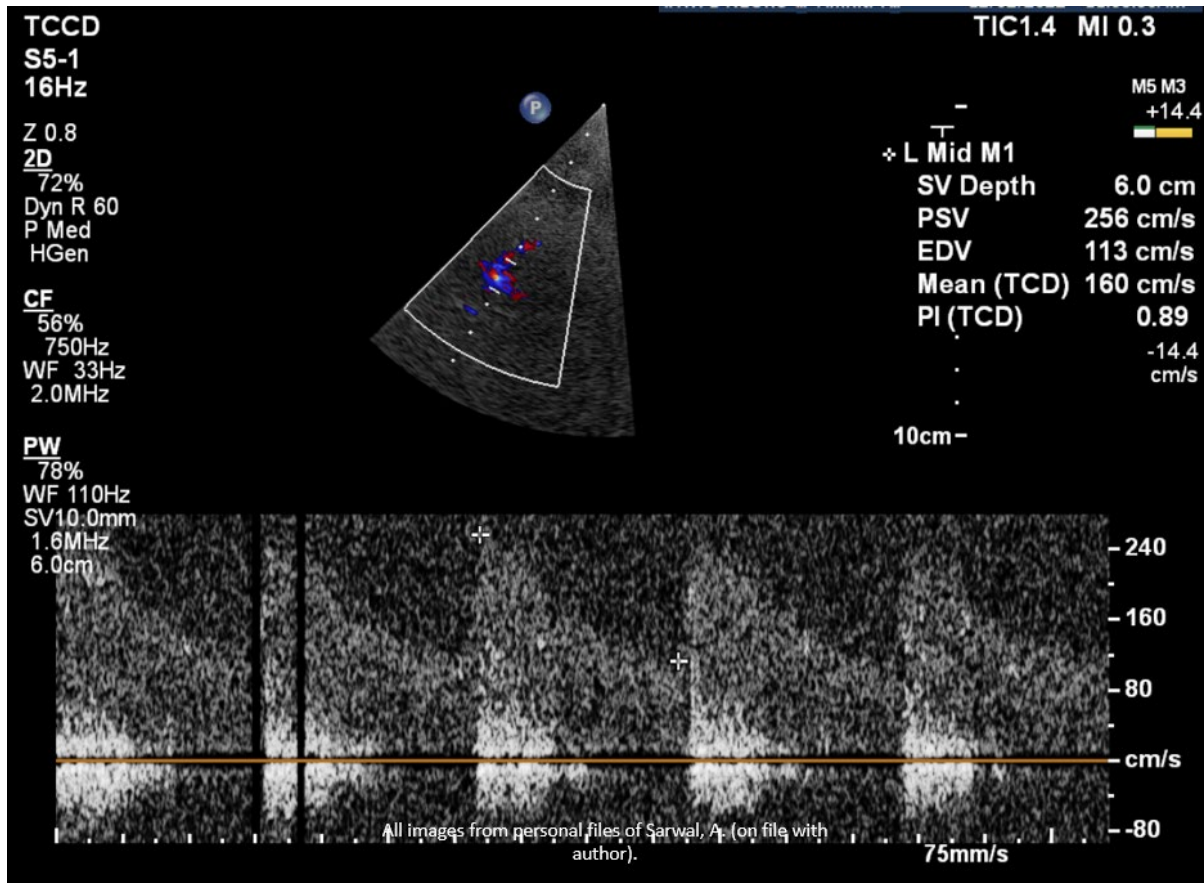
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TCD Grading Criteria for MCA Vasospasm

Lindegard Ratio = MV_{MCA}/MV_{EICA}	Degree of Vasospasm
< 3	Suggestive of hyperemia or other physiologic conditions, even though MCA velocities are high
3-6	Mild to moderate vasospasm
> 6	Severe vasospasm

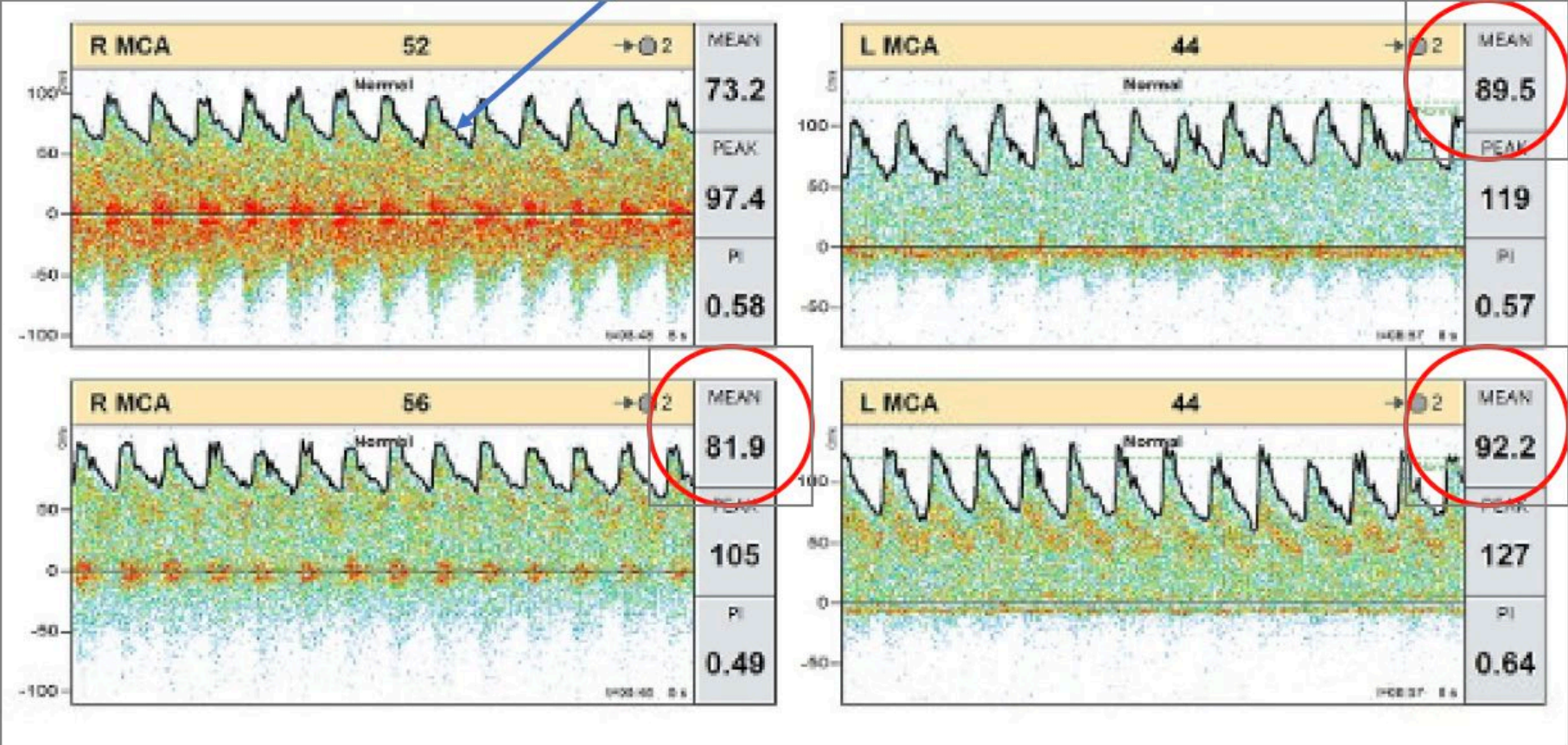
American Society of Neuroimaging TCD Grading criteria for MCA vasospasm

MFV (c/s)	Lindgaard ratio	Interpretation
<120	<3	Hyperemia
>80	3 - 4	Hyperemia + possible mild spasm
>120	3 - 4	Mild spasm + hyperemia
>120	4 - 5	Moderate spasm + hyperemia
>120	5 - 6	Moderate spasm
>180	6	Moderate to severe spasm
>200	>6	Severe Spasm
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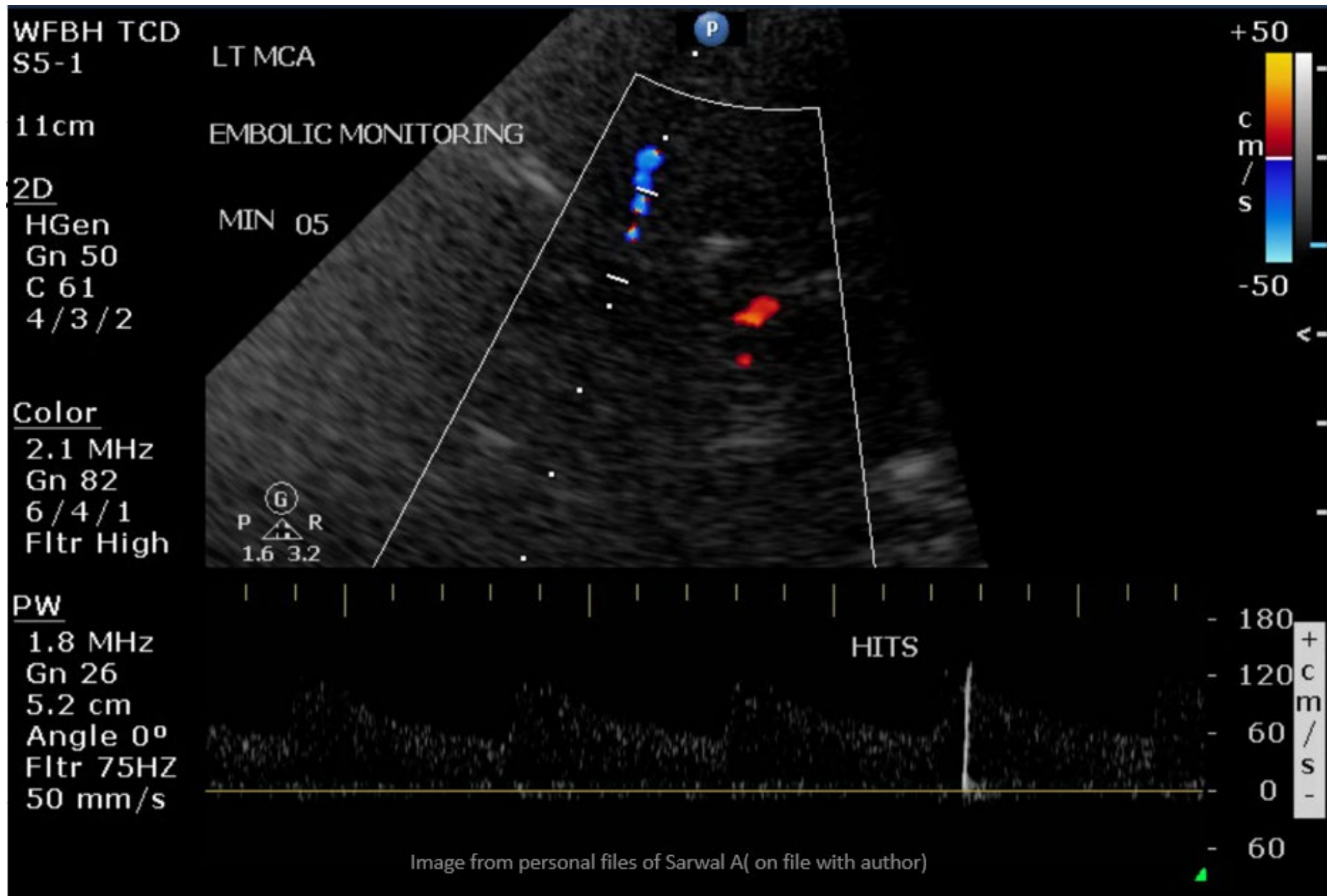
Look at those waveforms!

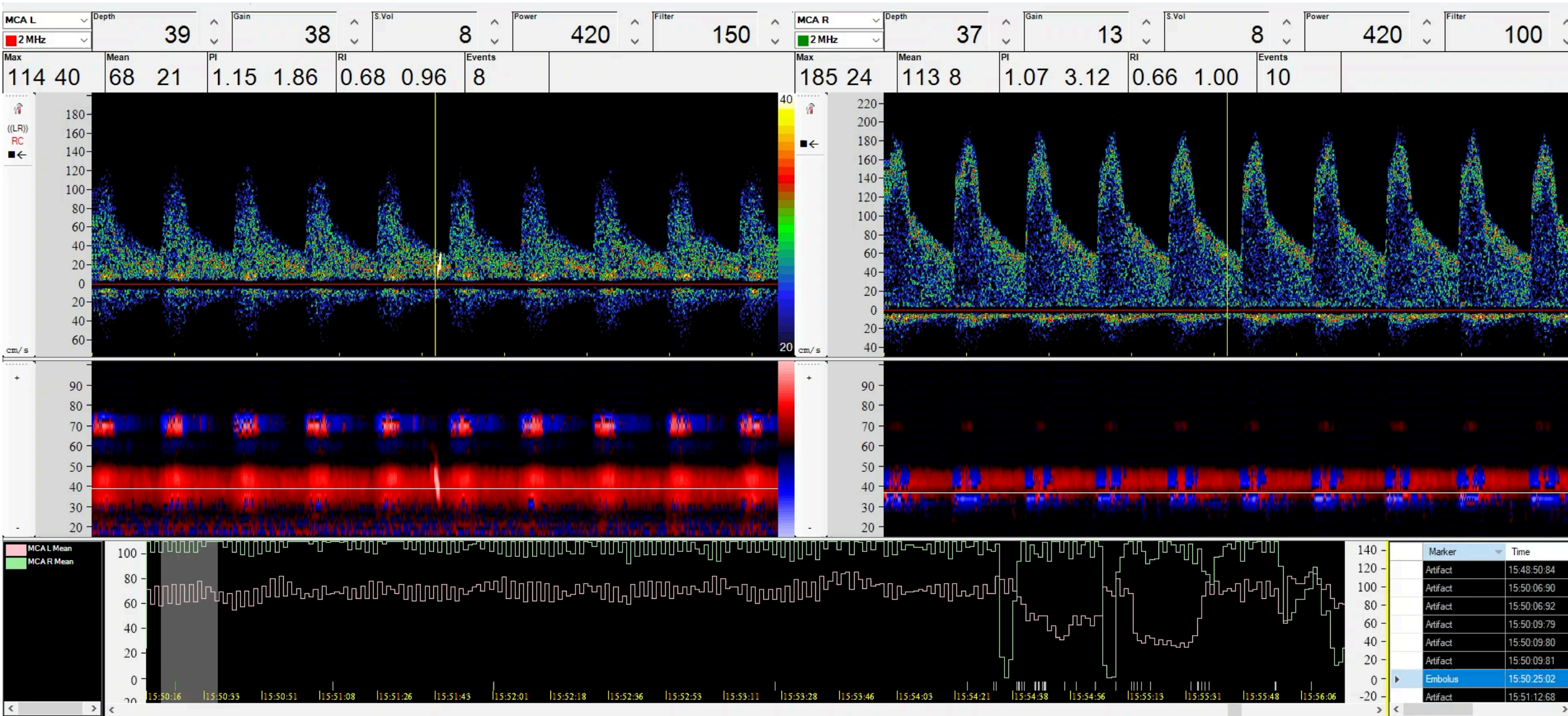


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Patient Case #2

- A 62-year-old man with past medical history of HTN and HLD was found to have acute onset aphasia and right sided weakness.
- He had a significant severe L ICA stenosis.
- He was unfortunately out of the window for thrombolytics.



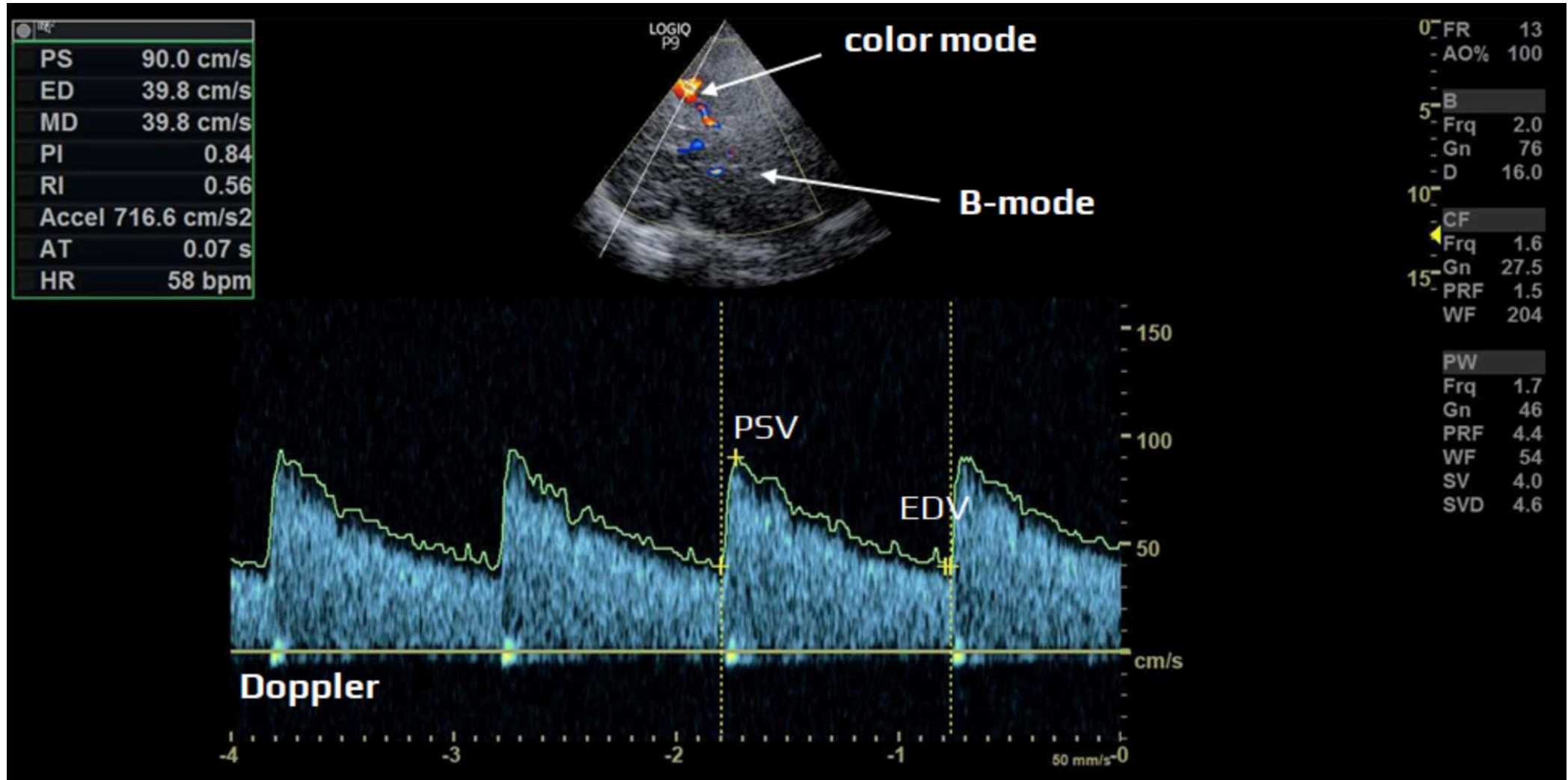


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Patient Case #3

- A 36-year-old man was in an MVC and sustained a severe TBI with significant intraparenchymal bleeding within the R hemisphere. He was intubated in the ED given a low GCS of 8 (2-2-4).
- The patient is admitted to the NSICU. The nurse calls you stating that the patient's pupil on the R is blown and he now is having extensor posturing, more on the R than the L.
- At the same time, his blood pressure becomes erratic alternating between severe hypertension and severe hypotension.

TCD obtained on admission.



<https://www.stroke-manual.com/transcranial-doppler-ultrasound/>

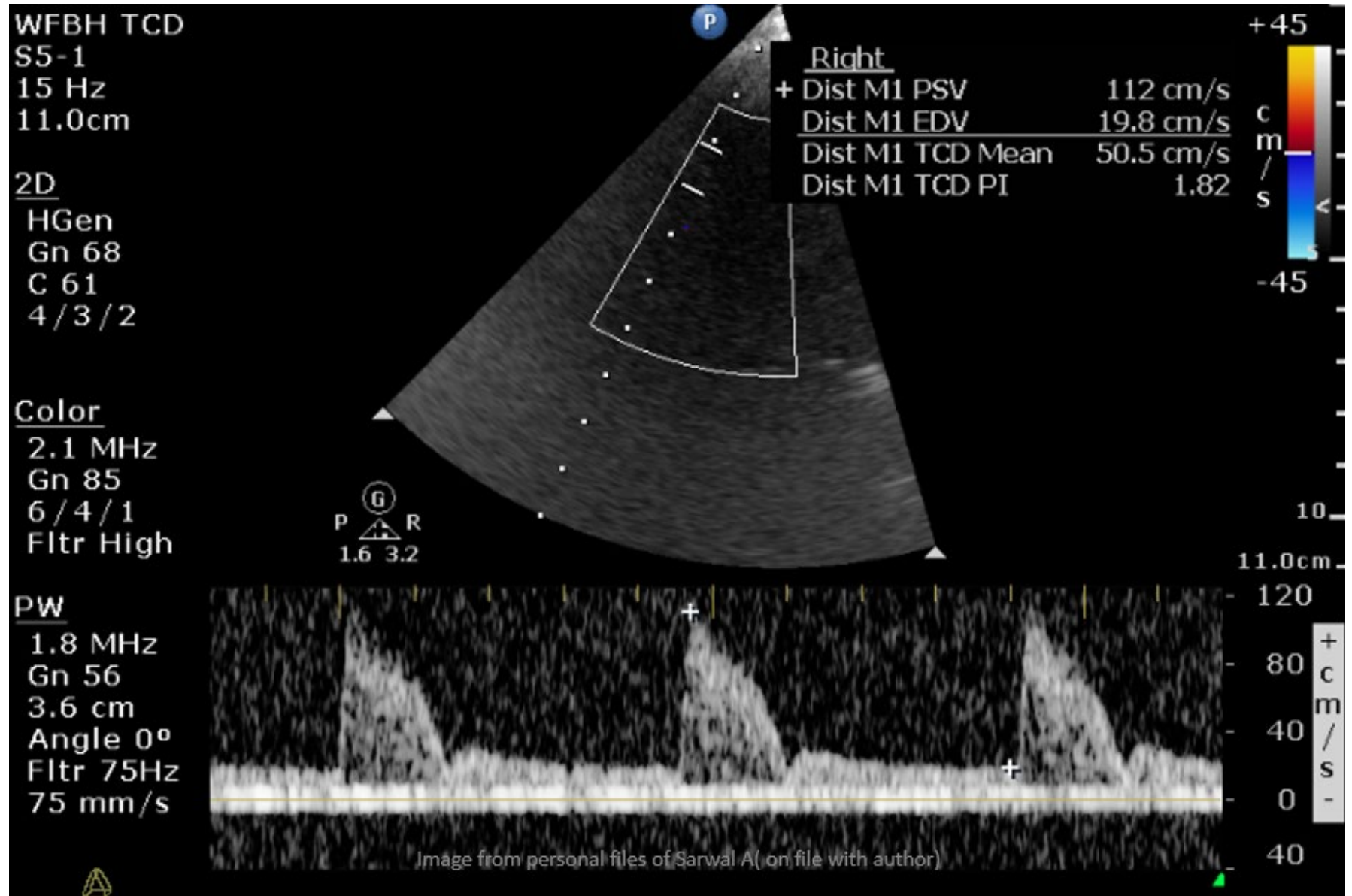
$$PI = [PSV-EDV]/MV$$

$$ICP = (10.93 \times PI) - 1.28$$

VS.

$$CPP_e = MAP \times FVd_{MCA} / FVm_{MCA} + 14$$

$$\text{Then } ICP = MAP - CPP_e$$



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Patient Case #4

- A 35-year-old woman with history of tobacco use, and contraceptive pill use comes in with left sided weakness and dysarthria after coming back from vacation to Spain.
- She had a R M2 clot, which was dissolved with TNK.

WF TCD

S5-1

17Hz

Z 1.7

2D

64%

Dyn R 60

P Low

Gen

CF

57%

1750Hz

WF 78Hz

2.0MHz

PW

70%

WF 100Hz

SV10.0mm

1.6MHz

5.6cm

TIC1.4 MI 0.4

M3 M3

+33.7



* R Mid M1

SV Depth 5.6 cm

PSV 159 cm/s

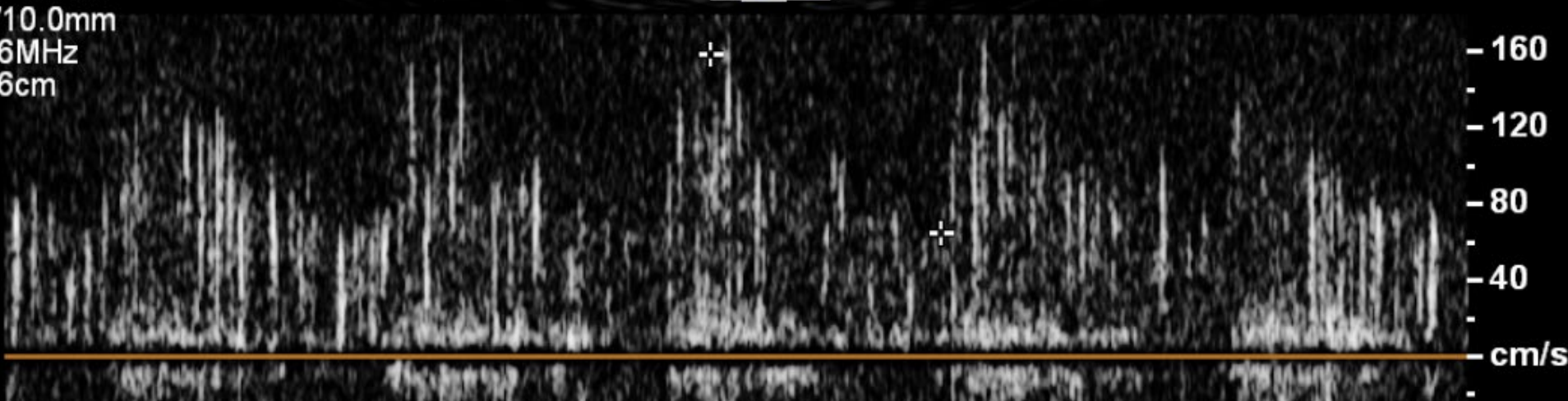
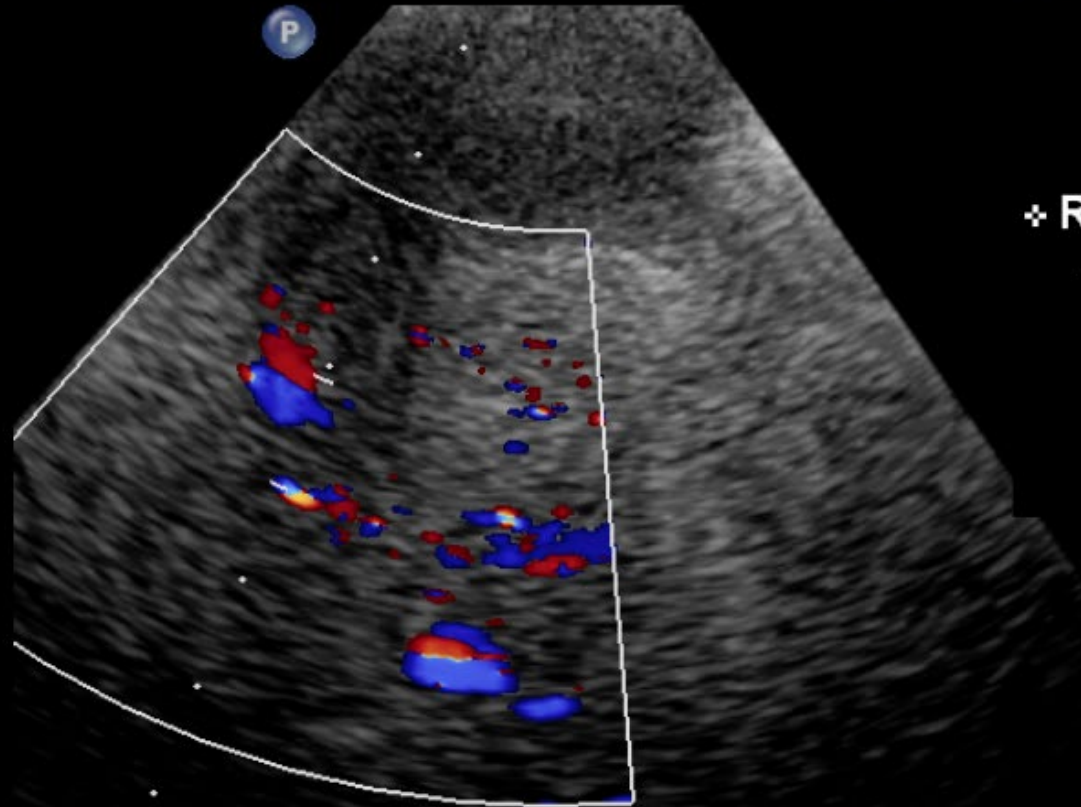
EDV 64.8 cm/s

Mean (TCD) 96 cm/s

PI (TCD) 0.98

-33.7

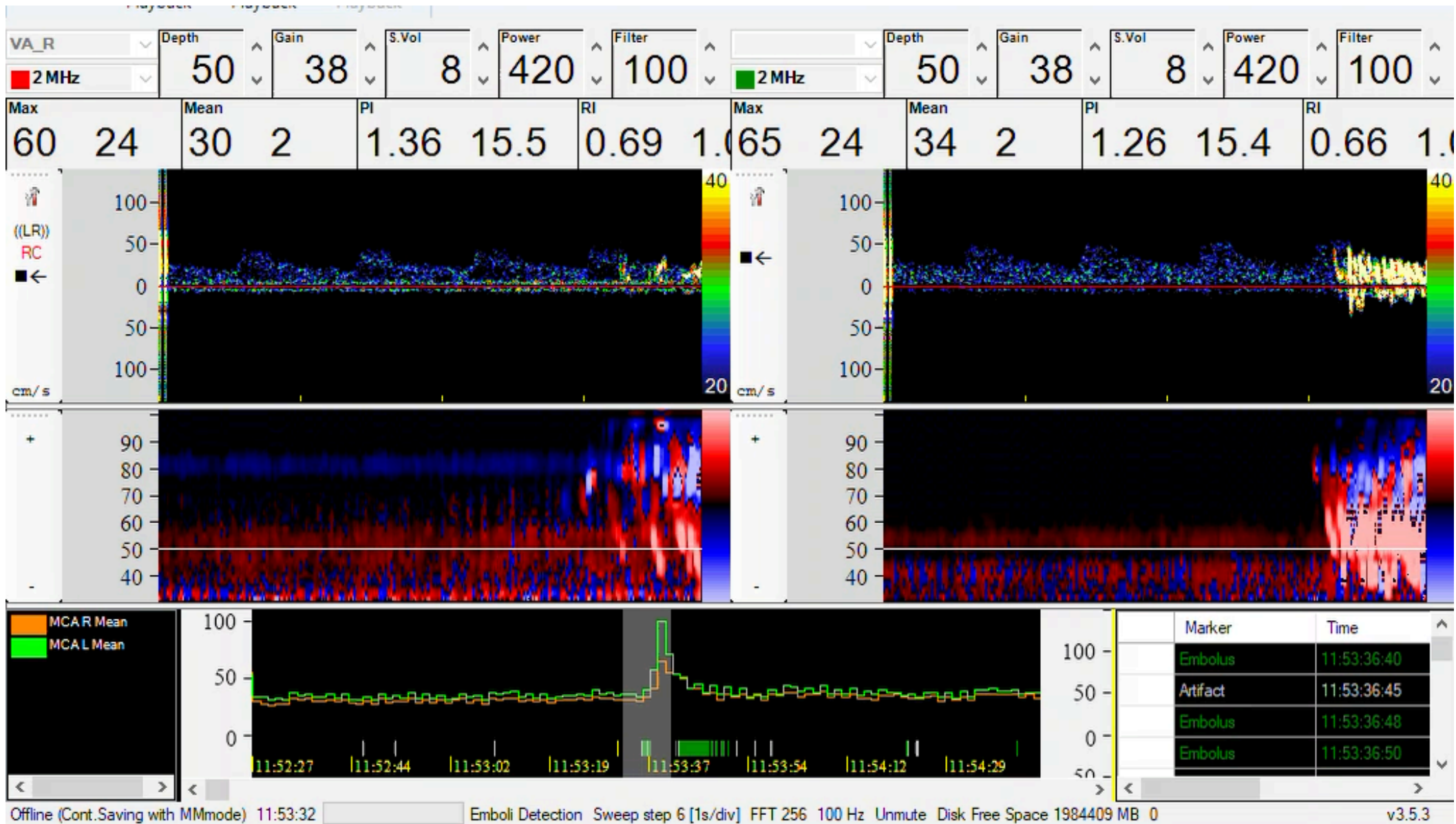
cm/s



TCD Bubble Study Sensitivity and Specificity

Table 3. Sensitivity and Specificity Rates of Transcranial Doppler.

Study	Sensitivity (%)	Specificity (%)	False Positives (%)	False Negatives (%)
Belvis et al. ²⁸	94	Not given	Not given	8
Caputi et al. ²³	97	78	8	2
Devuyst et al. ²⁷	100	Not given	21	0
Jauss et al. ³⁰	93	100	0	3



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Spencer Grade	# of Microbubbles in 3 heart beats	Size of Shunt
Grade 1	1-10 microbubbles	Small Shunt
Grade 2	11-30 microbubbles	Small Shunt
Grade 3	31-100 microbubbles	Small Shunt
Grade 4	101-300 microbubbles	Large Shunt
Grade 5	>300 microbubbles	Large Shunt



Review Questions

Review Question #1

- A patient is found to have a MFV of the L MCA being 250 cm/s with a Lindegaard Ratio of >6 . What is the diagnosis of their physiology?
 - **A.** Moderate Vasospasm
 - **B.** Severe Vasospasm
 - **C.** Hyperemia
 - **D.** Moderate Spasm + Hyperemia

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Review Question #2

- You have a patient you're worried may be having an ICP crisis with no invasive ICP monitor, but is too unstable to go to CT. You decide to use TCD. In addition to calculating the ICP, what other marker on your TCD can you use to clue you into elevated ICPs?
 - **A.** Lindegaard Ratio
 - **B.** Presence of low resistance waveforms
 - **C.** Presence of high resistance waveforms
 - **D.** Absent flow

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- In this last TCD example, what is the Spencer grade of the patient's detected shunt (more than 300 bubbles)?
 - **A.** Grade 1
 - **B.** Grade 2
 - **C.** Grade 3
 - **D.** Grade 4
 - **E.** Grade 5

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Questions?

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LCC Health™

IN SCIENCE LIVES HOPE.

THANK YOU!

References:

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