Carotid Ultrasound Update
Indications, Directions, Applications

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“Overhead Radiance”
Courtesy of Dr. Renee Healing Art

Carotid Ultrasound Update
Indications, Directions, Applications

- Indications
- Beyond standard color duplex
  - Technology/techniques
    - Small/portable/hand-held; SonoCT; 3D; Contrast; Volume flow measurements
  - Applications
    - Stents; Thyroid; Jugular/venous; IMT
- Principles in practice

Disclosures: None

CEA Specimen: ICA Plaque

Carotid Ultrasound
Clinical Imperatives

- Carotid/Vertebral disease is the most commonly identified stroke mechanism
- Carotid/Vertebral atherosclerosis/stenosis is marker of increased stroke risk
- Established surgical benefit for tight symptomatic carotid stenosis (NASCET) and tight asymptomatic stenosis (ACAS, ACST)
- Established benefit for stenting

Carotid/Vertebral Ultrasound
Clinical Decision-Making

- Carotid ultrasound now part of initial vascular evaluation for patients with Stroke or TIA, or at risk for the same.
- Safe, accurate, portable, relatively less expensive, and readily available.
- If CUS negative, usually don’t pursue
- Ideal for serial follow up for progression

Carotid/Vertebral Ultrasound
Clinical Questions to Answer

- Is any carotid stenosis present?
- If so, where, what is the distribution, how bad is it, and is it accessible?
- Most Rx decisions still made based on hemodynamic effect (% stenosis)
- Plaque features can influence decision

Carotid Ultrasound
Indications

- Stroke, TIA, Cerebral ischemia
- Bruit evaluation (Sx or Asx)
- Serial follow up of CVD
- Pre-op study, or perioperative in CEA
- Pulsatile neck masses/abnormal structures
- Many others
- High risk groups for CS or stroke/screening?

“Focus”
Courtesy of Dr. Renee Healing Art

SonoCT

- Challenge of limited width of view on B-mode imaging
- Difficult to fully appreciate the entire vessels, disease/extent of lesion (like blind man touching an elephant)
- Technology can stitch images together to provide wide views of vessels

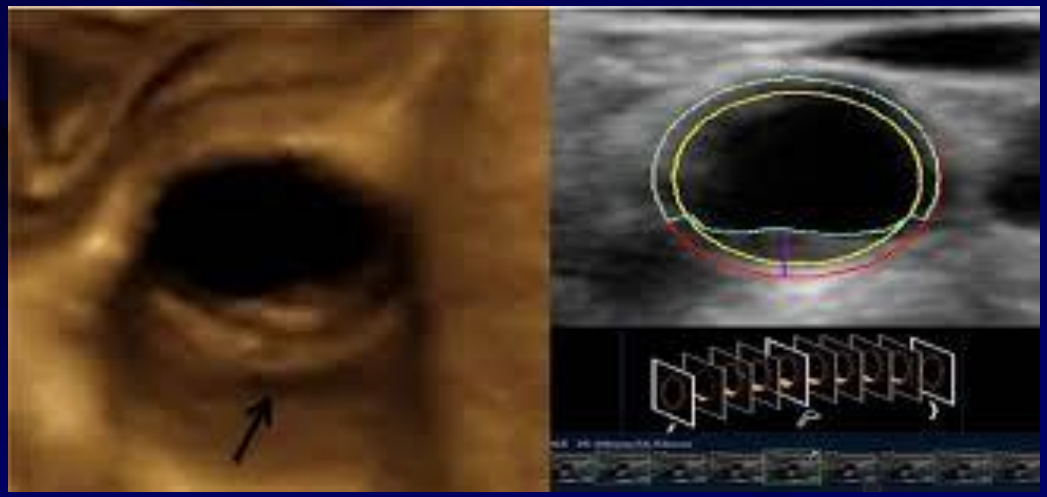
PANORANIC IMAGING OF SUPERFICIAL VEIN

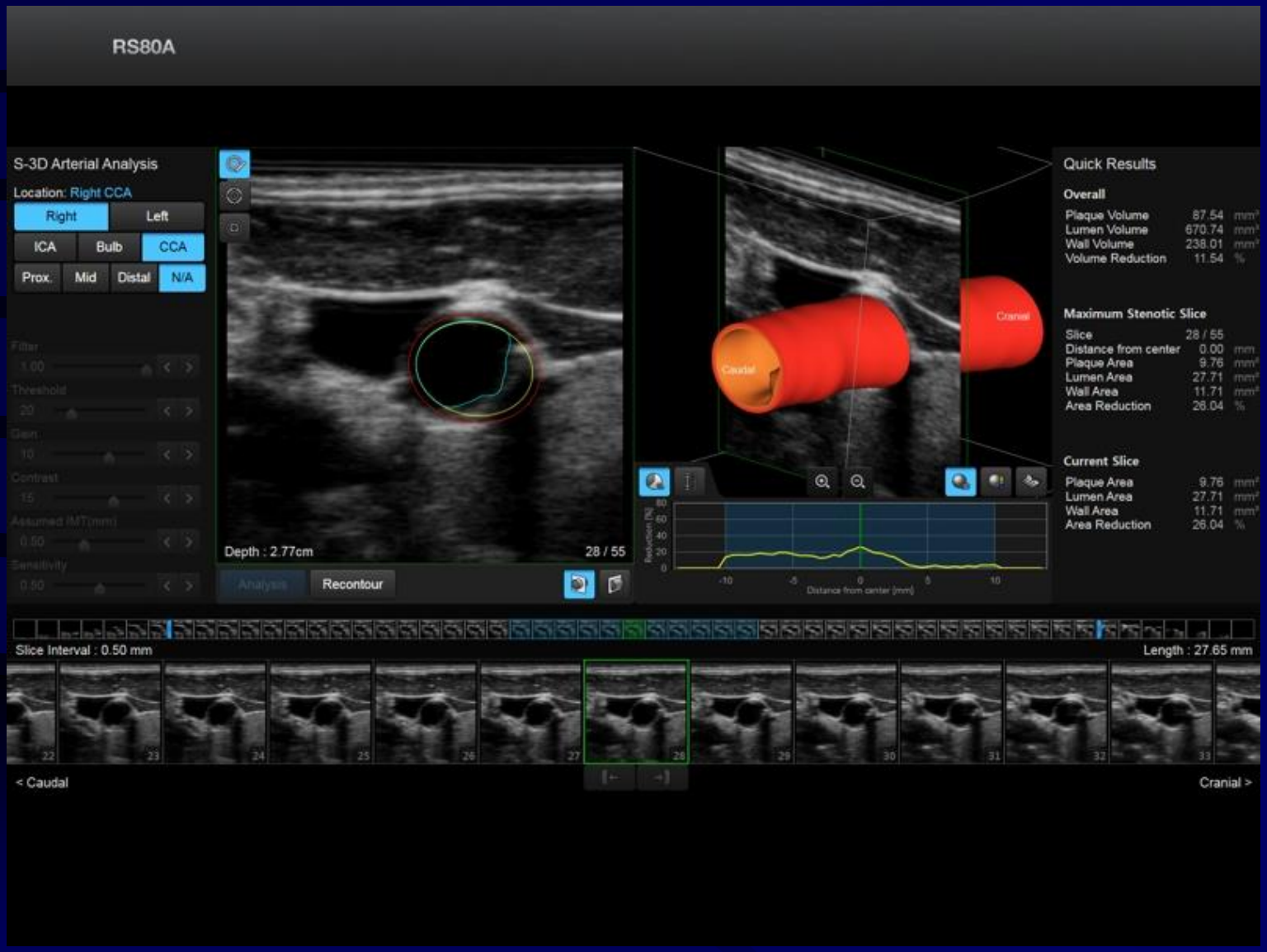
COMMON CAROTID PLAQUE
SonoCT™ IMAGING WITH XRES™ TECHNOLOGY

PROXIMAL INTERNAL CAROTID ARTERY STENT
SonoCT™ IMAGING

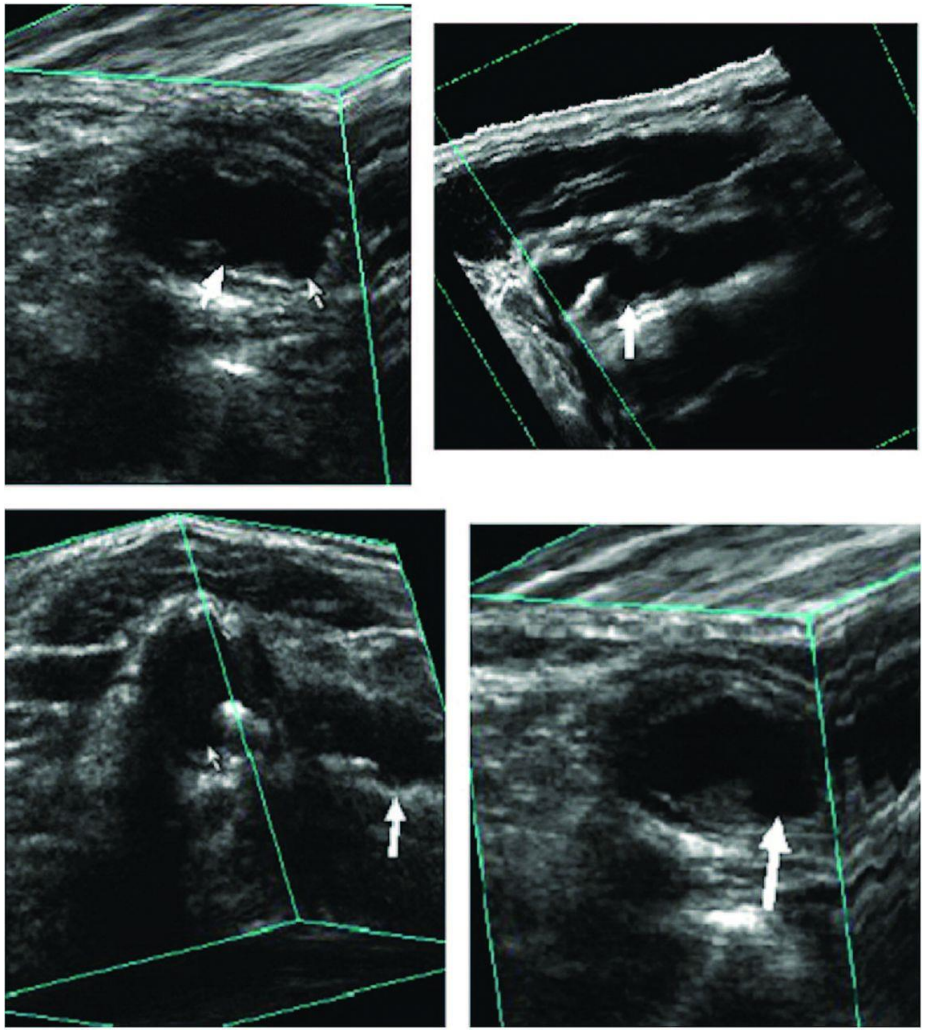
3D Carotid Ultrasound

- Of interest for decades; not practical
- More feasible with improved technology
- Potential benefits:
  - Plaque volume, better measure of progression
  - Plaque surface, ulceration
  - Surgical/IR planning
- Not widely available, not reimbursable, but established capability and great promise



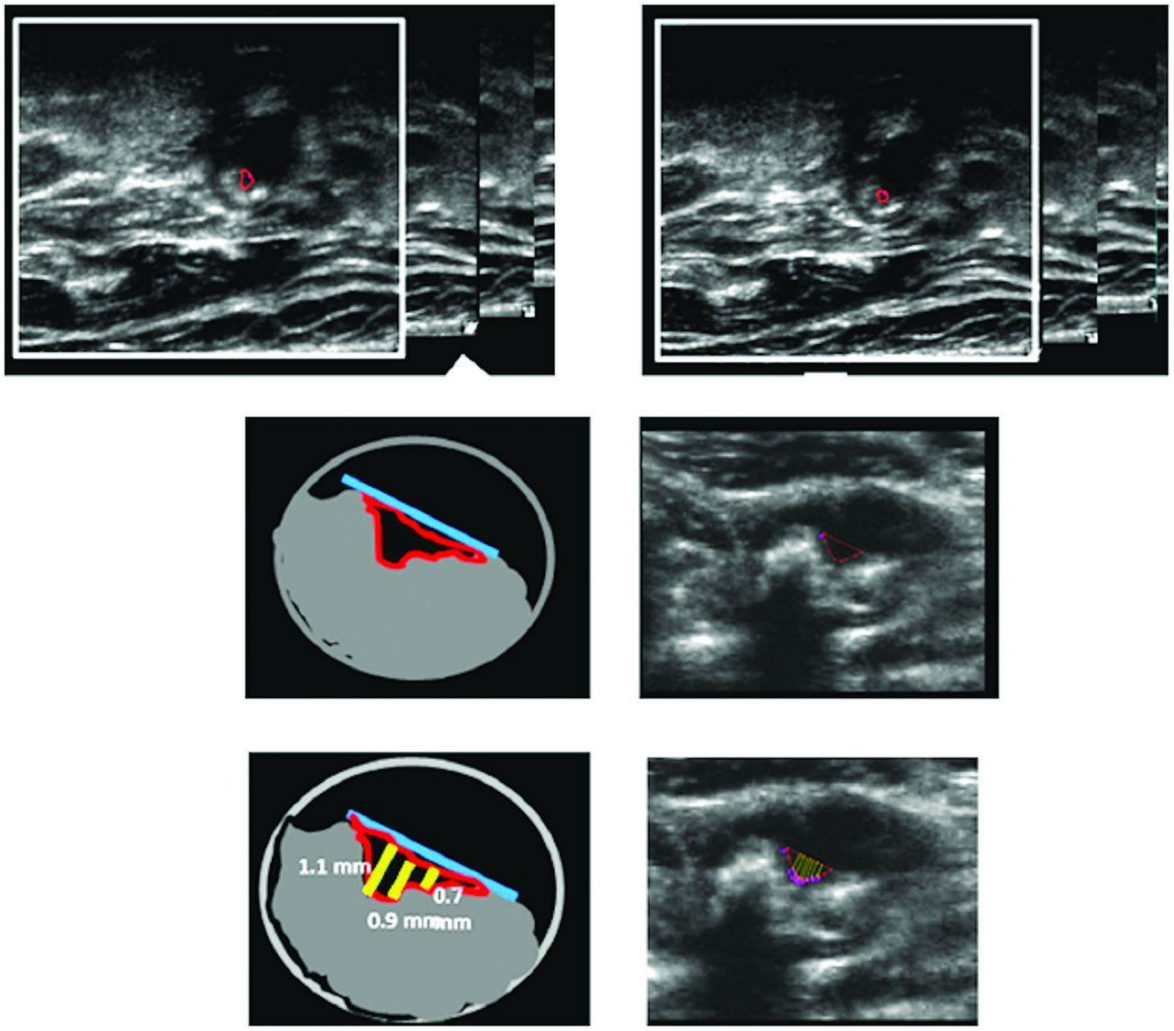

RS80A
S-3D Arterial Analysis
Location: Right CCA
Right
Left
ICA
Bulb
CCA
Prox.
Mid
Distal
N/A
Depth : 2.77cm
28 / 55
Analysis
Recontour
Caudal
Cranial
Quick Results
Overall
Plaque Volume 87.54 mm³
Lumen Volume 670.74 mm³
Wall Volume 238.01 mm³
Volume Reduction 11.54 %
Maximum Stenotic Slice
Slice 28 / 55
Distance from center 0.00 mm
Plaque Area 9.76 mm²
Lumen Area 27.71 mm²
Wall Area 11.71 mm²
Area Reduction 26.04 %
Current Slice
Plaque Area 9.76 mm²
Lumen Area 27.71 mm²
Wall Area 11.71 mm²
Area Reduction 26.04 %
Slice Interval : 0.50 mm
Length : 27.65 mm
< Caudal
Cranial >

Number of carotid ulcers.



J.D. Spence AJNR Am J Neuroradiol 2017;38:E34-E36

Measurement of ulcer volume and ulcer depth.

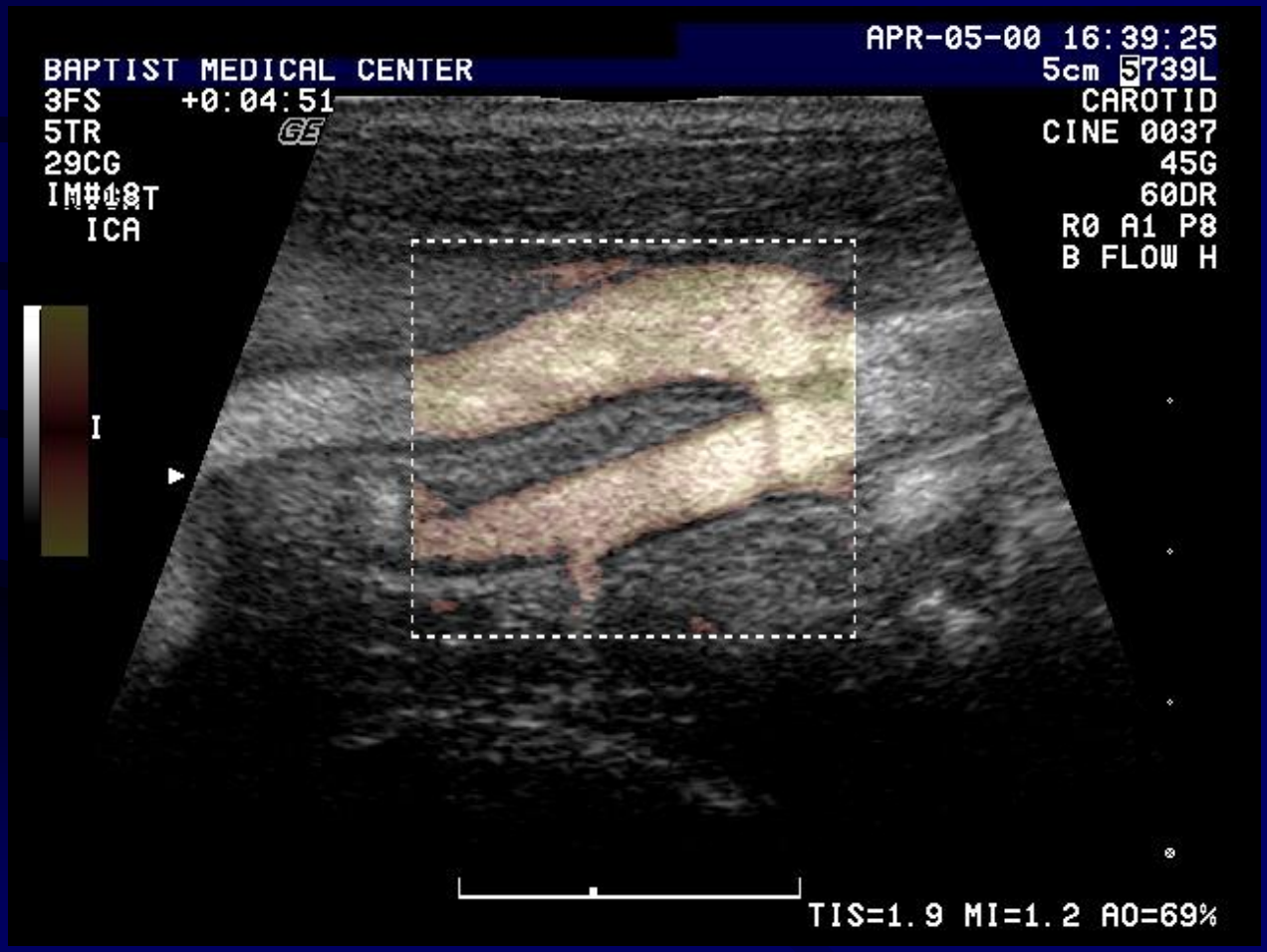


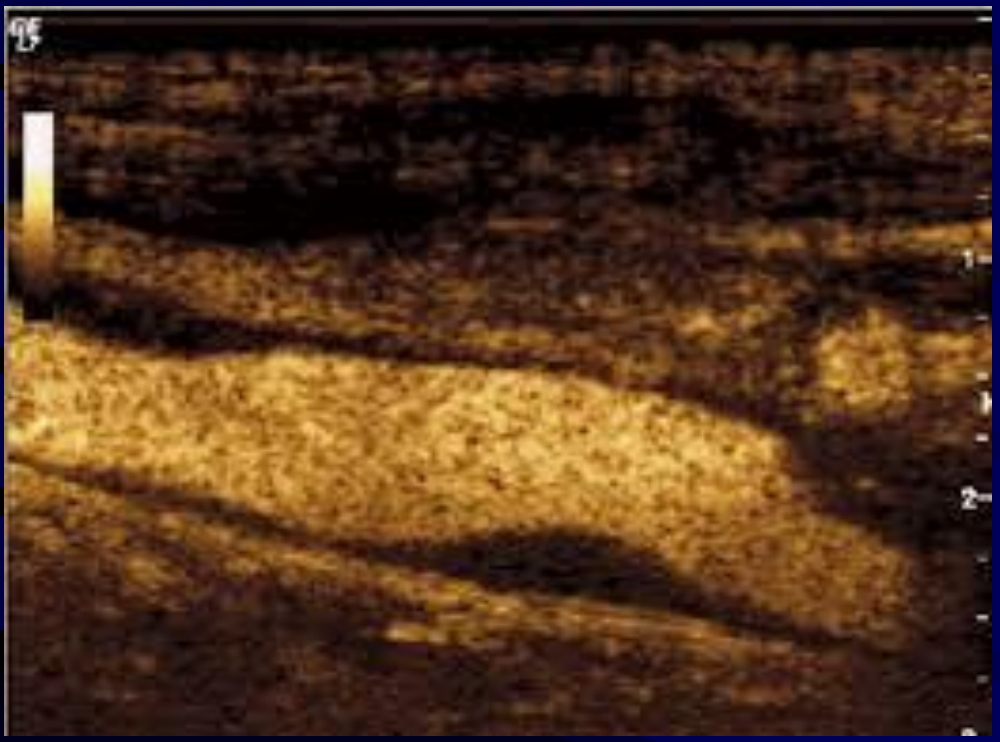
J.D. Spence AJNR Am J Neuroradiol 2017;38:E34-E36

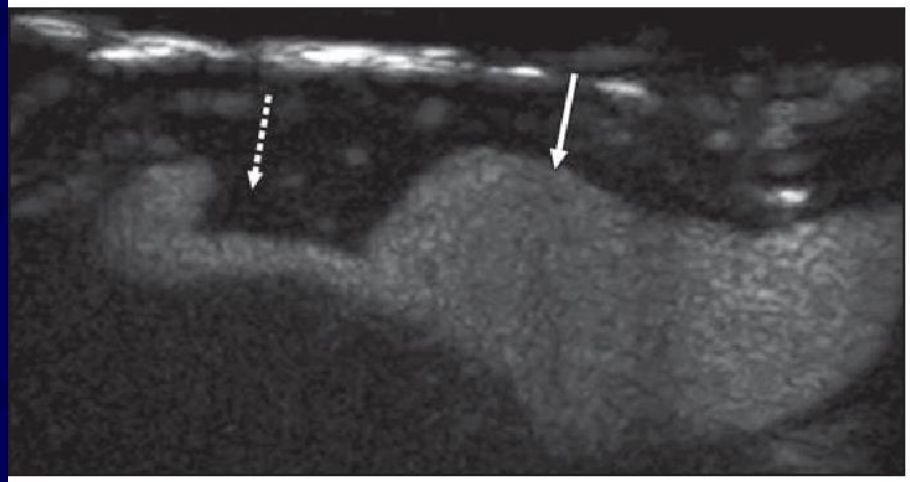
Contrast Carotid Ultrasound

- Long anticipated
- Commercially available (not agitated saline)
- Improved visualization
  - Defining structures
  - Surface features
  - Plaque blood supply/vulnerability
- Not reimbursable, not yet widely used, but great potential to identify highest risk, vulnerable plaques

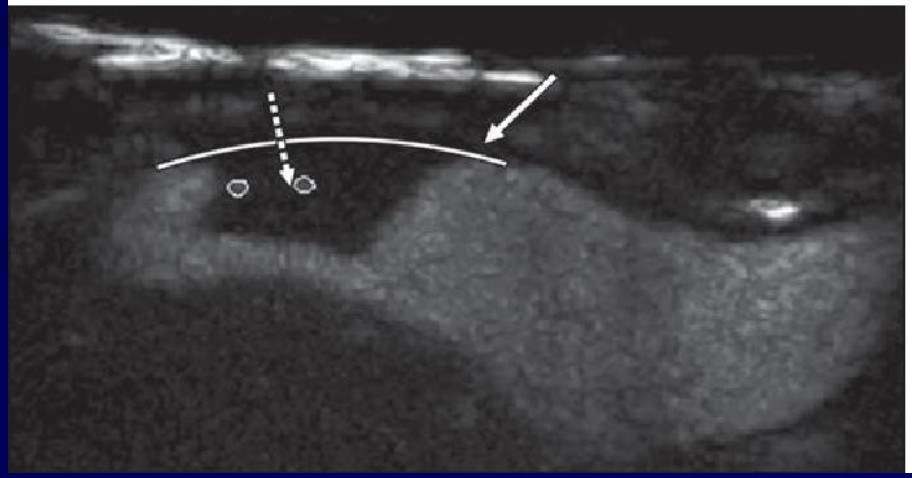
B-Flow Imaging

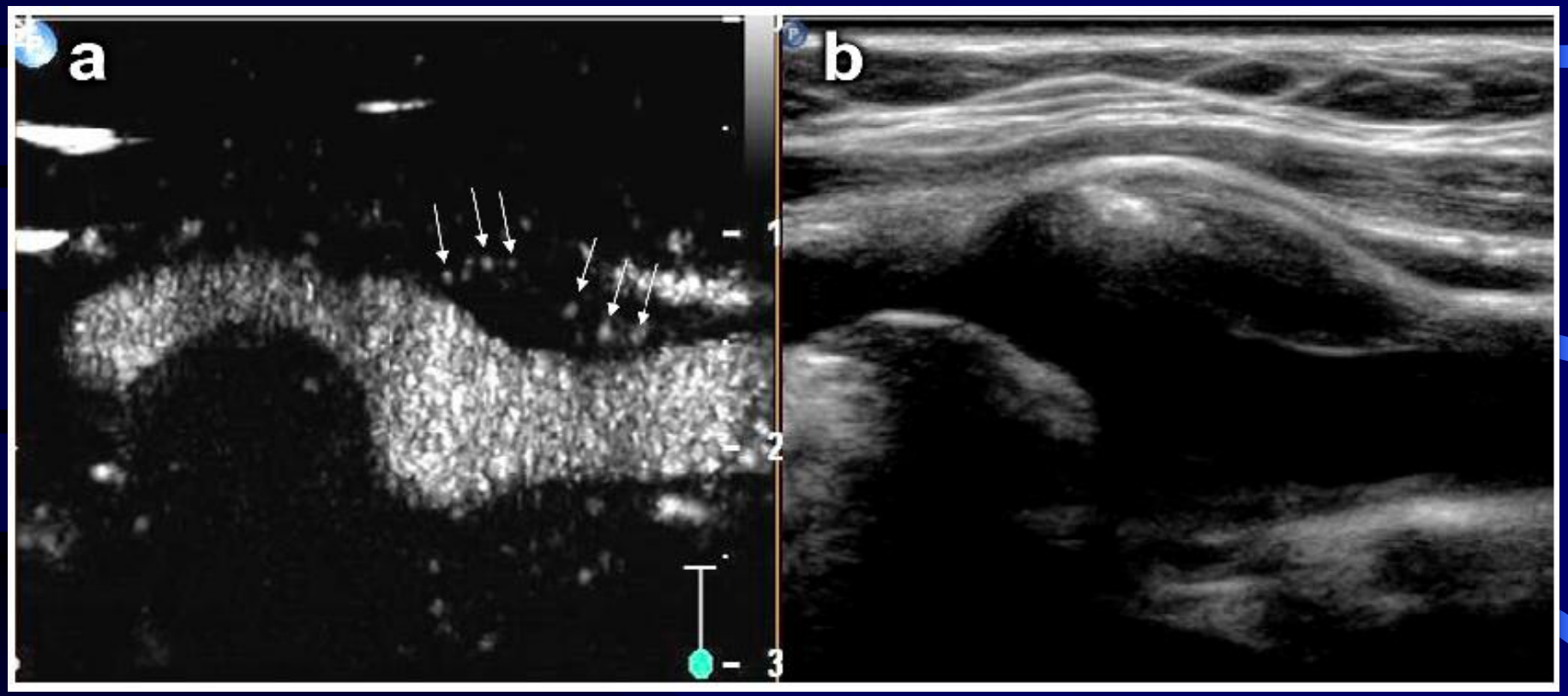


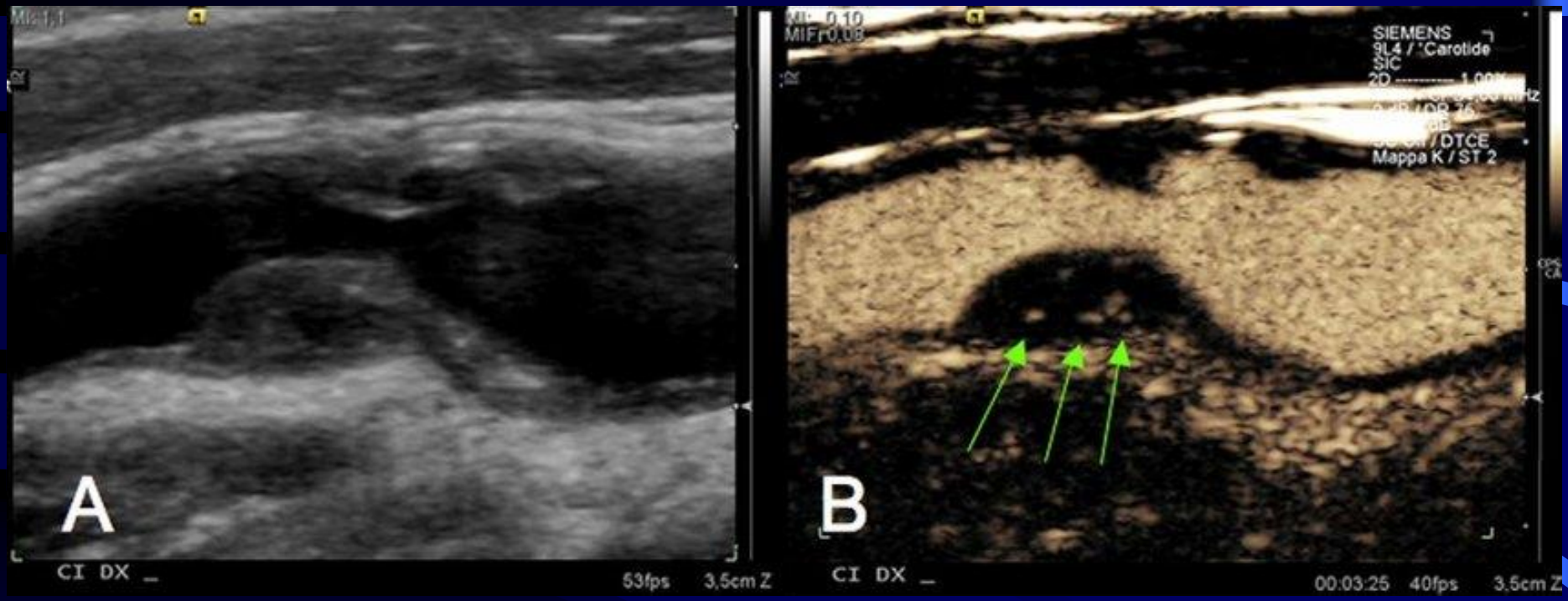


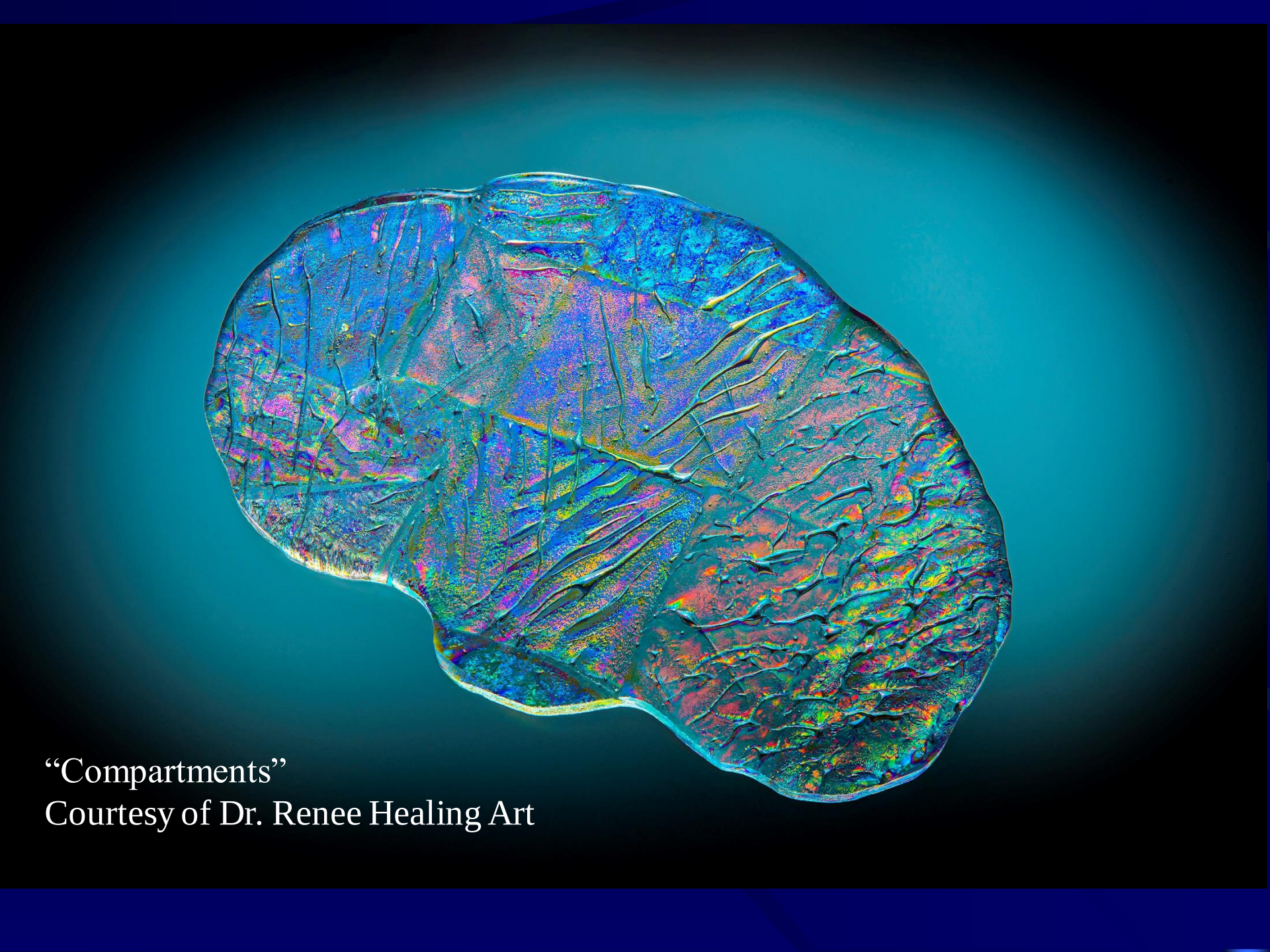


A




a
b
1
2
3


A
CI DX _
53fps 3,5cm Z
SIEMENS
9L4 / 'Carotide
DTCE
Mappa K / ST 2
B
CI DX _
00:03:25 40fps 3,5cm Z



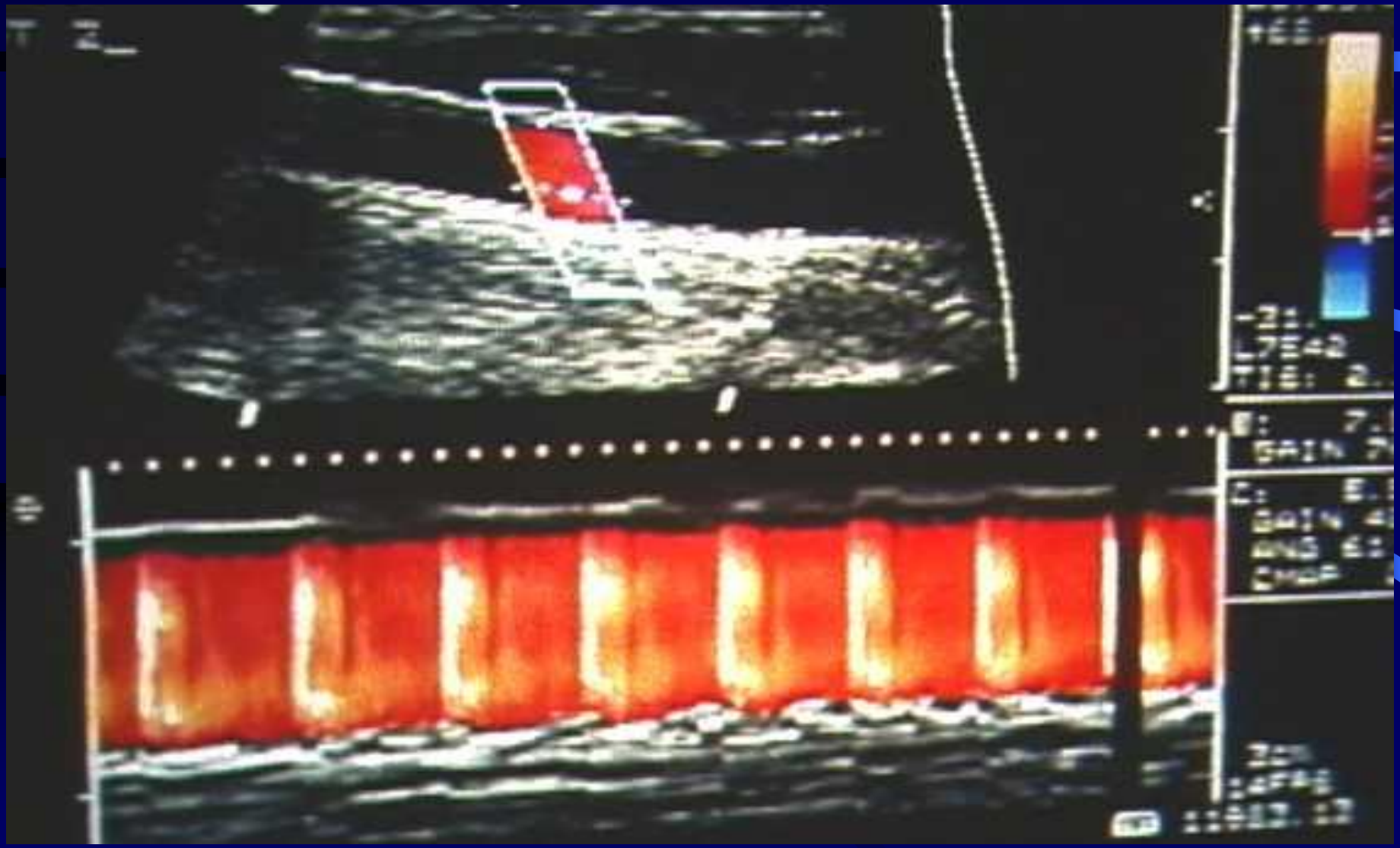
“Compartments”
Courtesy of Dr. Renee Healing Art

Carotid Protocol & Techniques

Ancillary Methods – Volume Flow

- Velocities alone can be deceiving
- Volume flow key to hemodynamic view
- Early work with Color Velocity Imaging Quantification, Philips Ultrasound Int.
- Time domain processing, m-mode display, velocity profile, and flow lumen over time.
- Doppler-based volume flow now available on most instruments

CCA VFR with CVI-Q

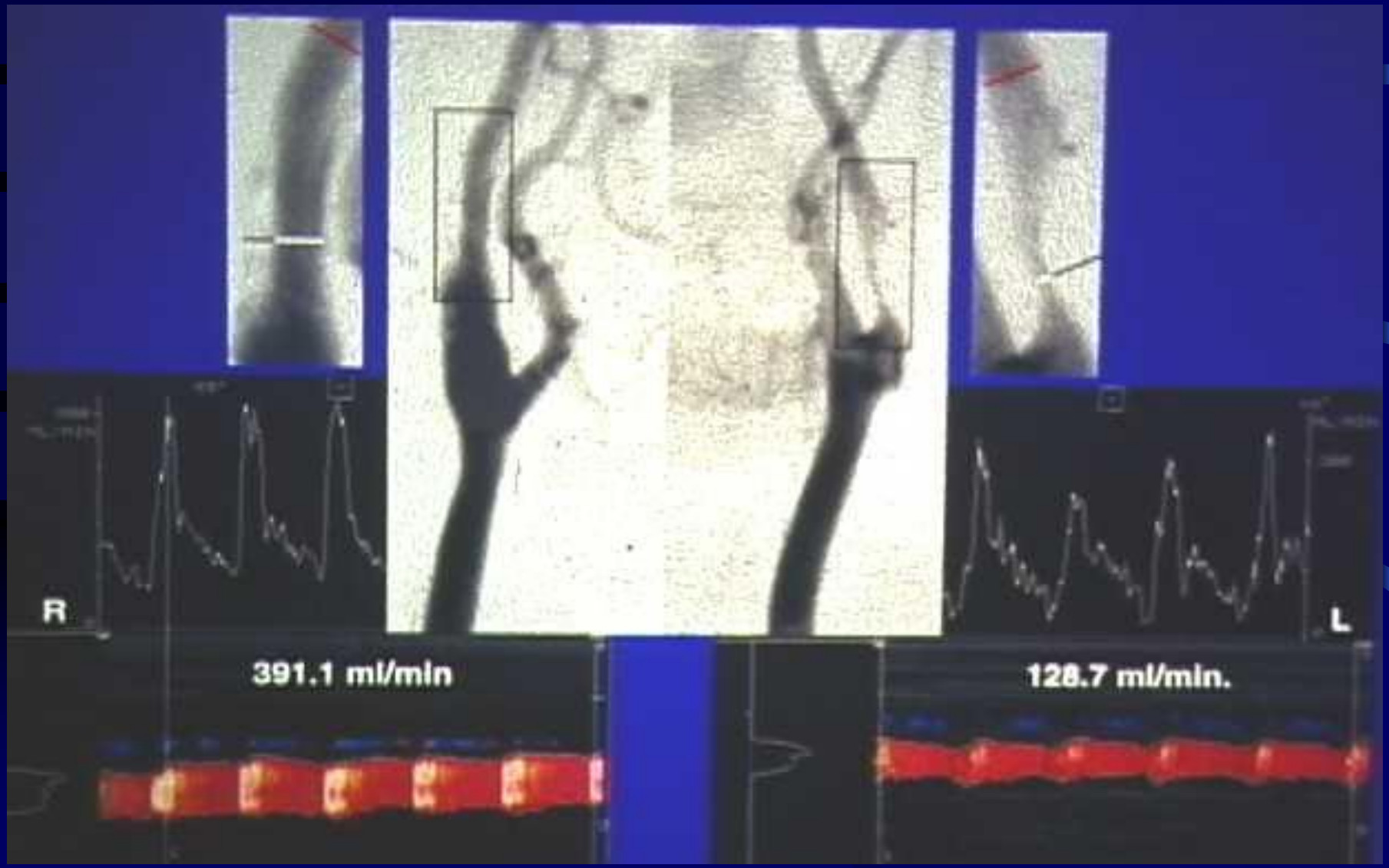


Carotid Protocol & Techniques

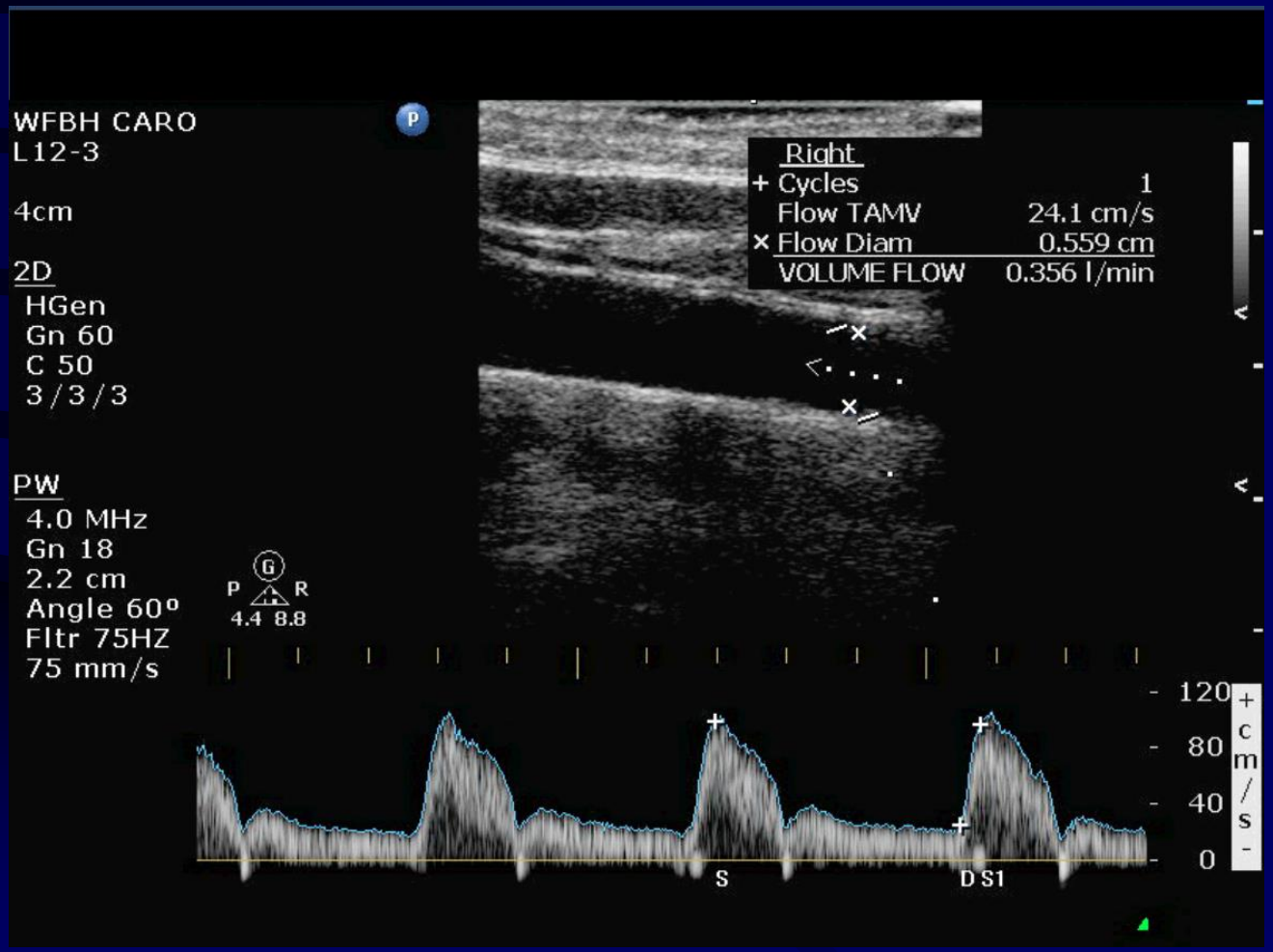
Ancillary Methods – Volume Flow

- Best access and accuracy for CCA, less for ICA, and even less for vertebral
- Predictable changes with both ipsilateral and contralateral stenosis/occlusion.
- VFR drops with severe ipsilateral distal disease, increases contralateral (if disease not bilateral), if intracranial collaterals normal

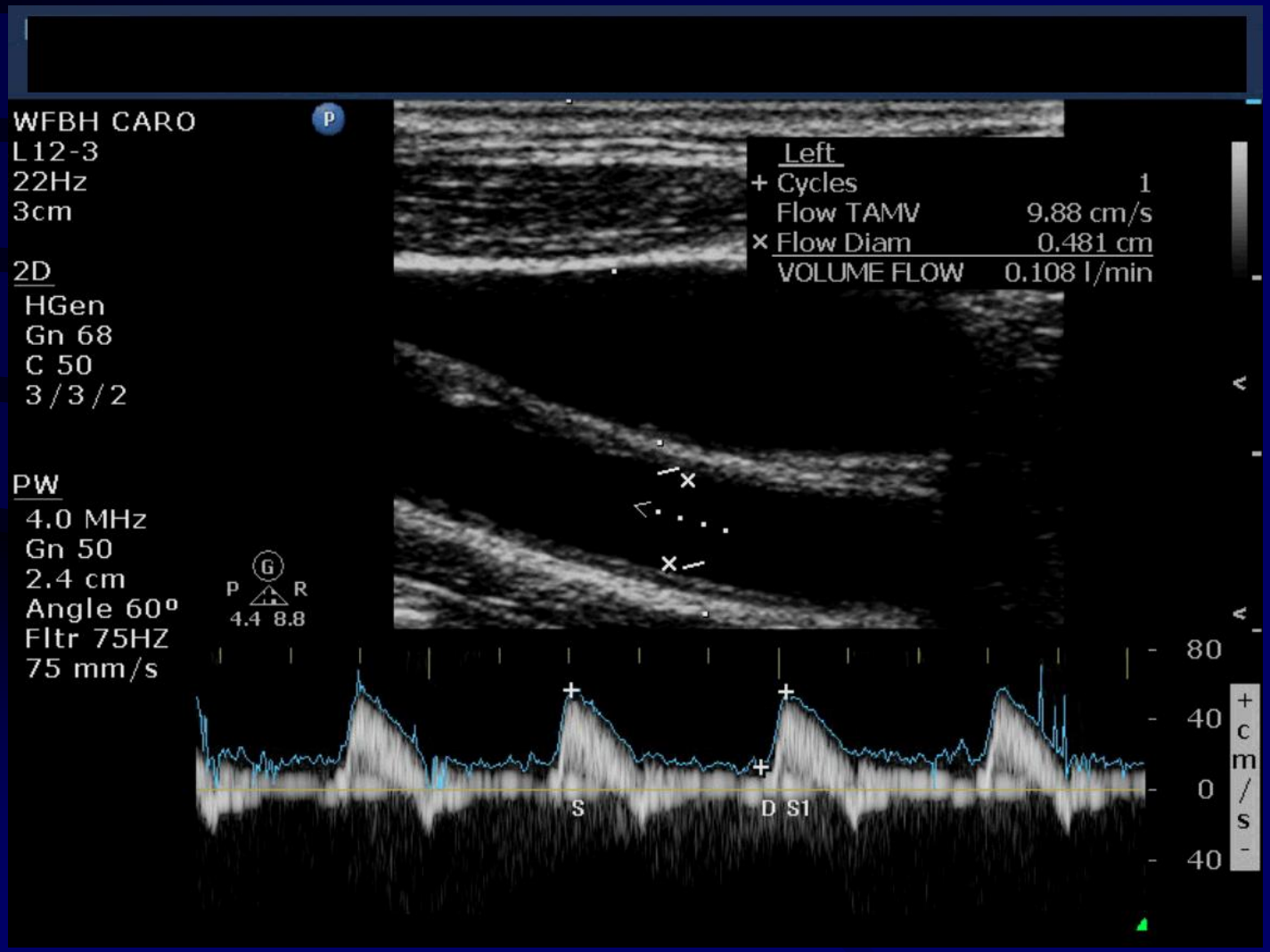
Carotid Stenosis & VFR



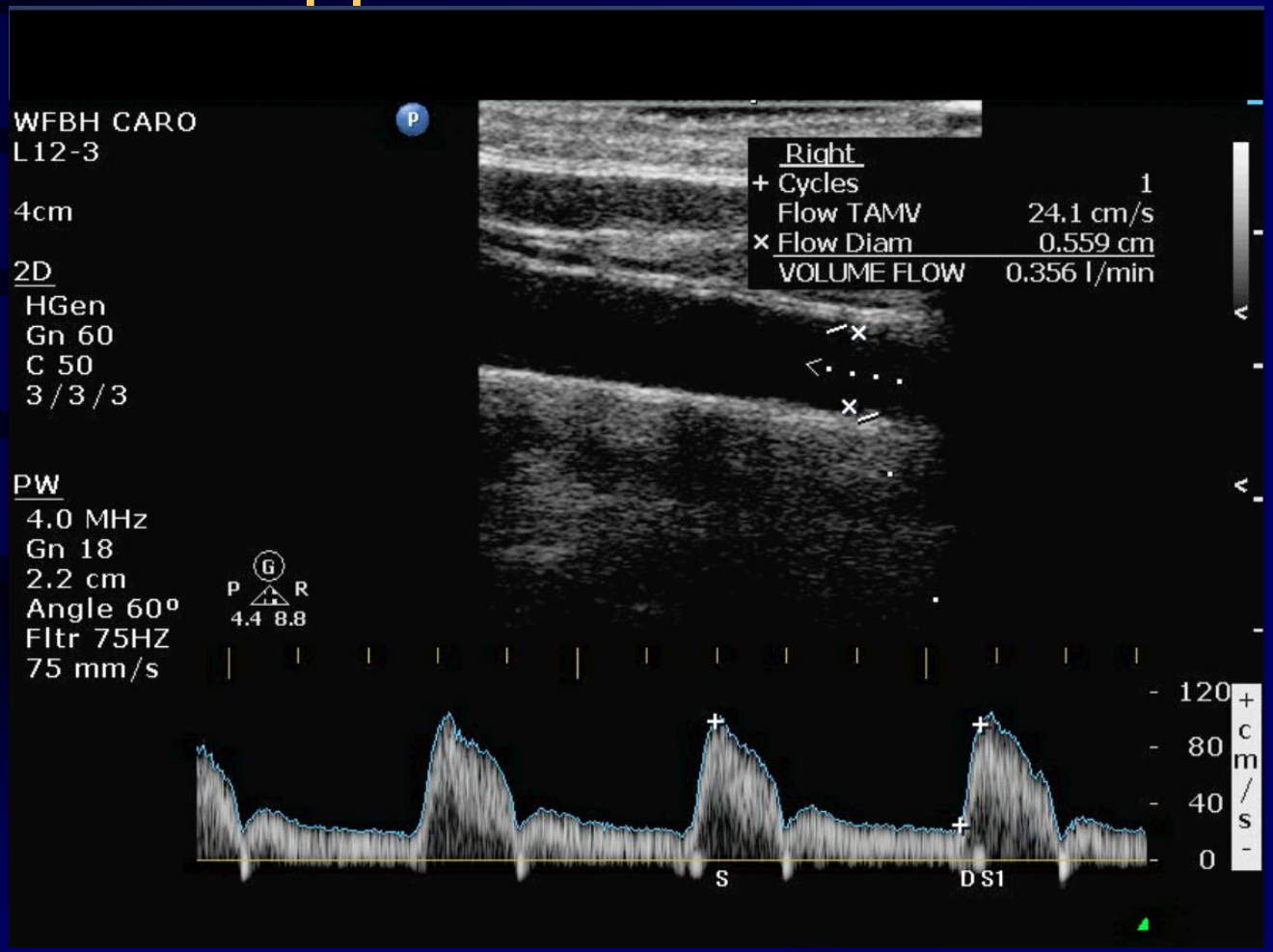
Volume Flow Measurements



CCA Volume Flow
Distal Occlusion

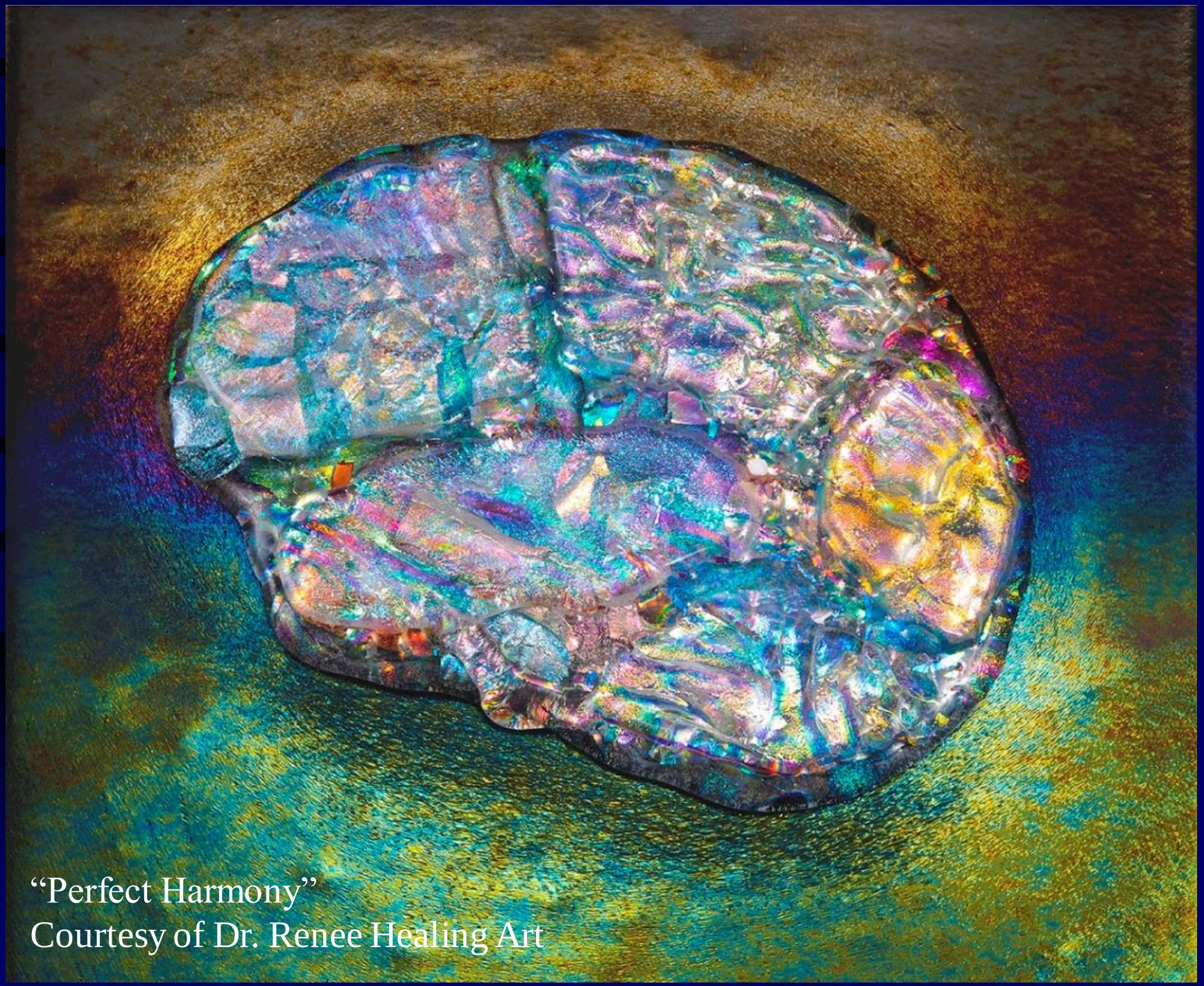


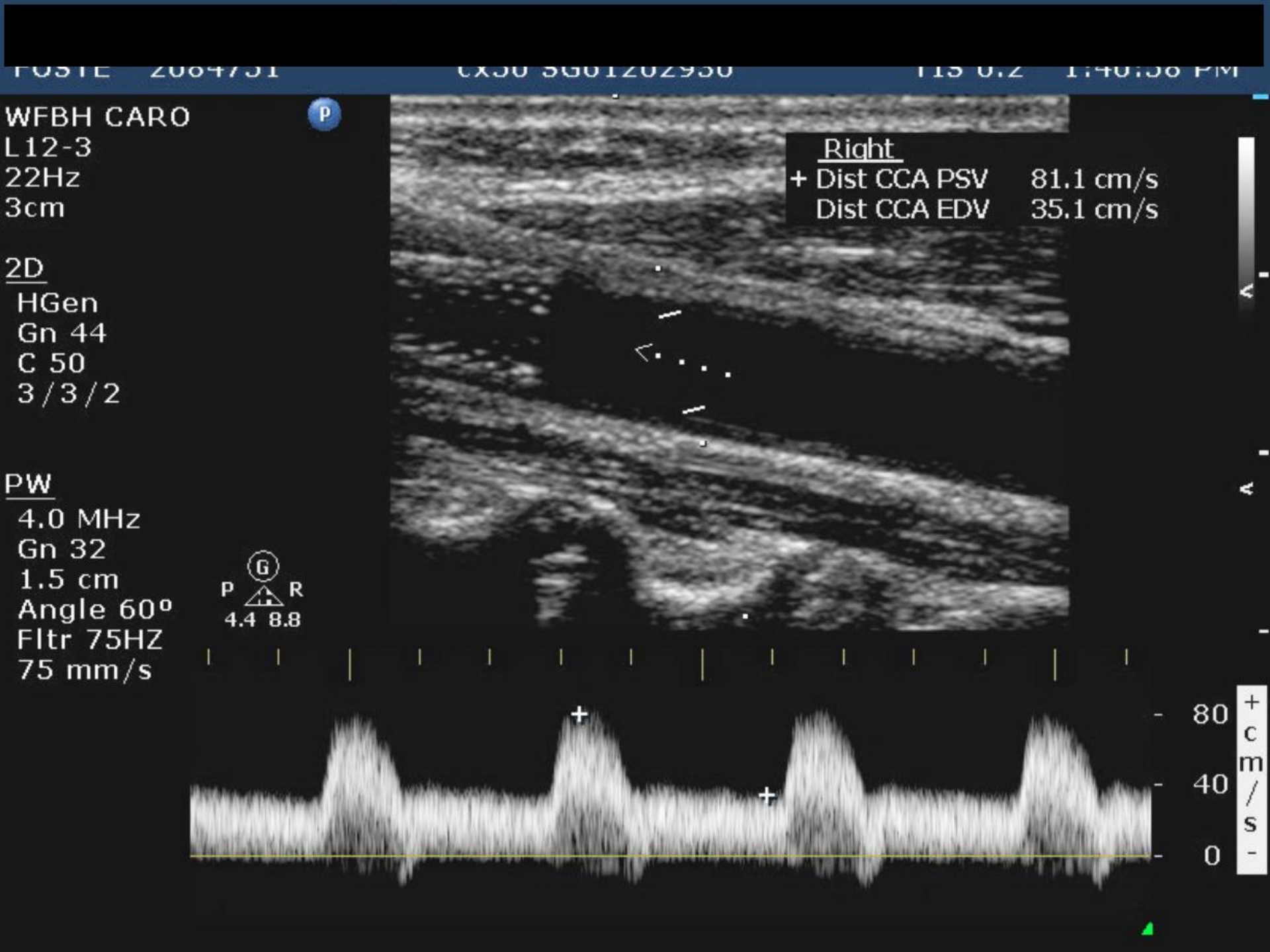
CCA Volume Flow
Opposite to Occlusion



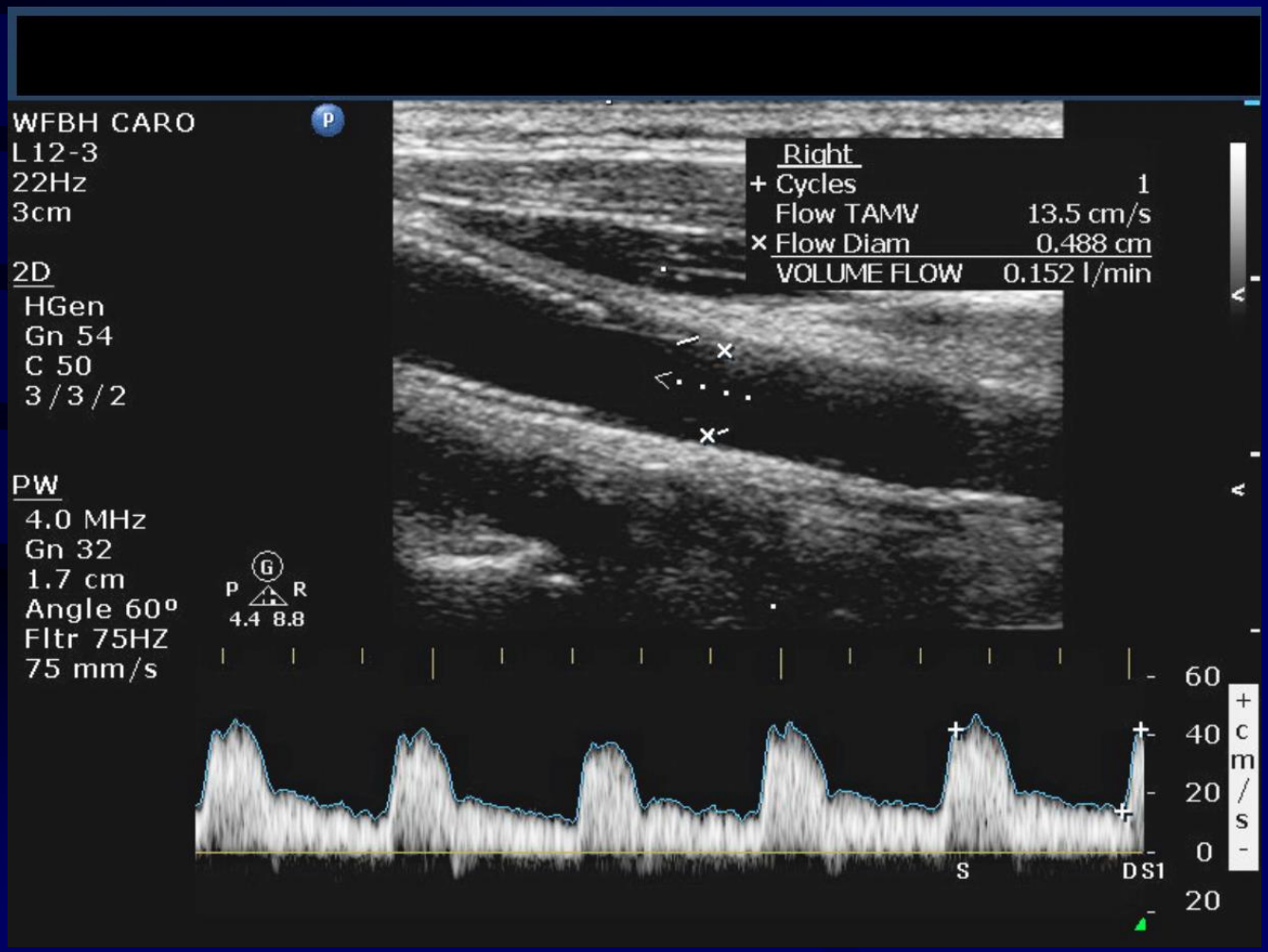
Volume Flow Measurments
Use at WFSM

- CCA VFR done if 70% or greater stenosis
- If spectral changes of distal/prox sten/occl
- Bilateral high or low velocities
- Waveform suggestive of an AVM
- Assess collateral function and avoid error contralateral to stenosis or occlusion
- To follow progression of stenosis

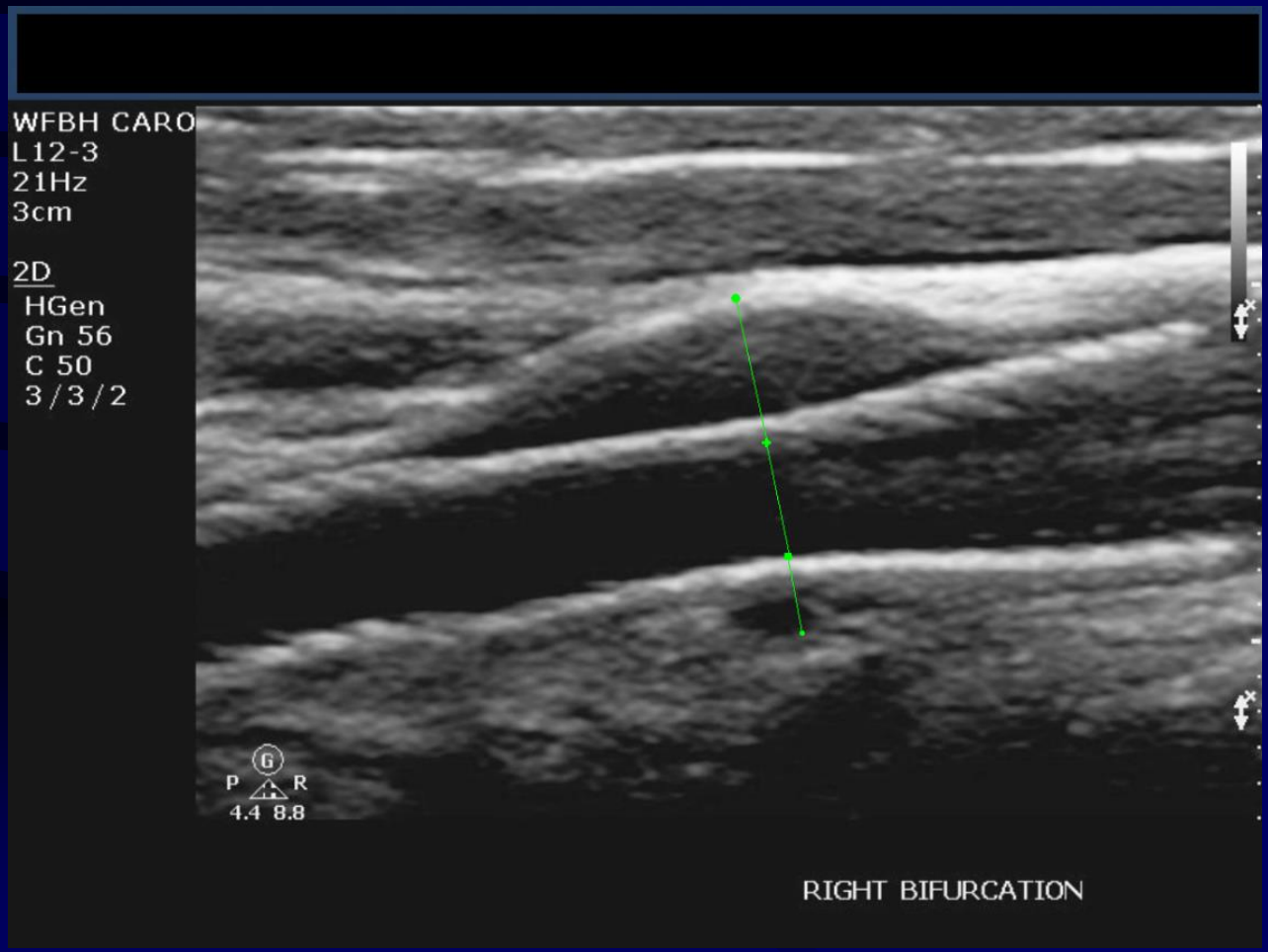

“Perfect Harmony”
Courtesy of Dr. Renee Healing Art

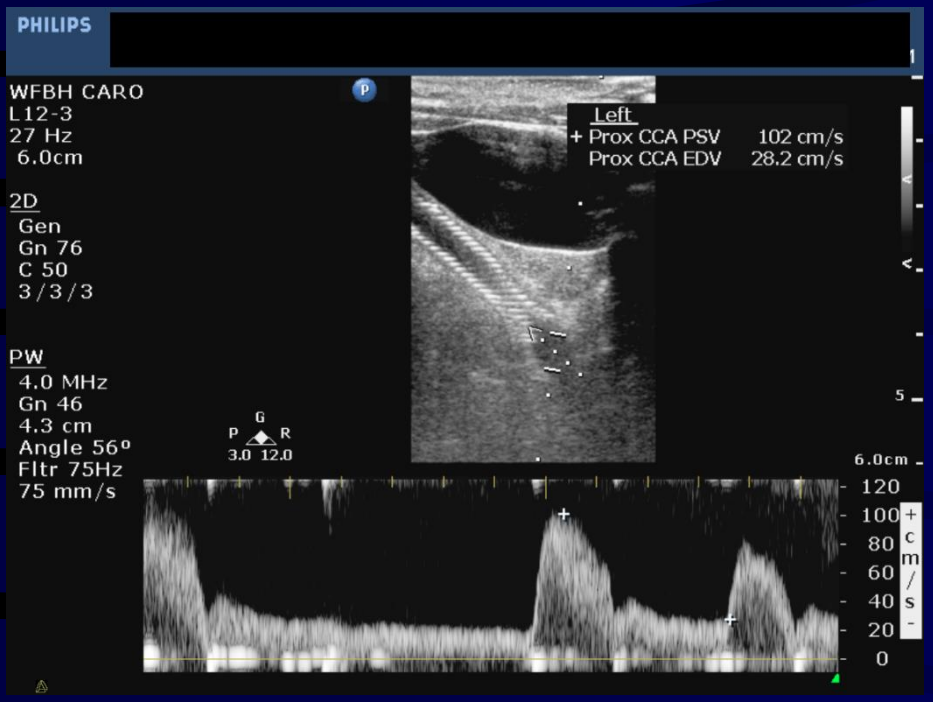

WFBH CARO
L12-3
22Hz
3cm
2D
HGen
Gn 44
C 50
3/3/2
PW
4.0 MHz
Gn 32
1.5 cm
Angle 60°
Fltr 75HZ
75 mm/s
Right
+ Dist CCA PSV 81.1 cm/s
Dist CCA EDV 35.1 cm/s
P
R
4.4 8.8
80
40
0
cm/s

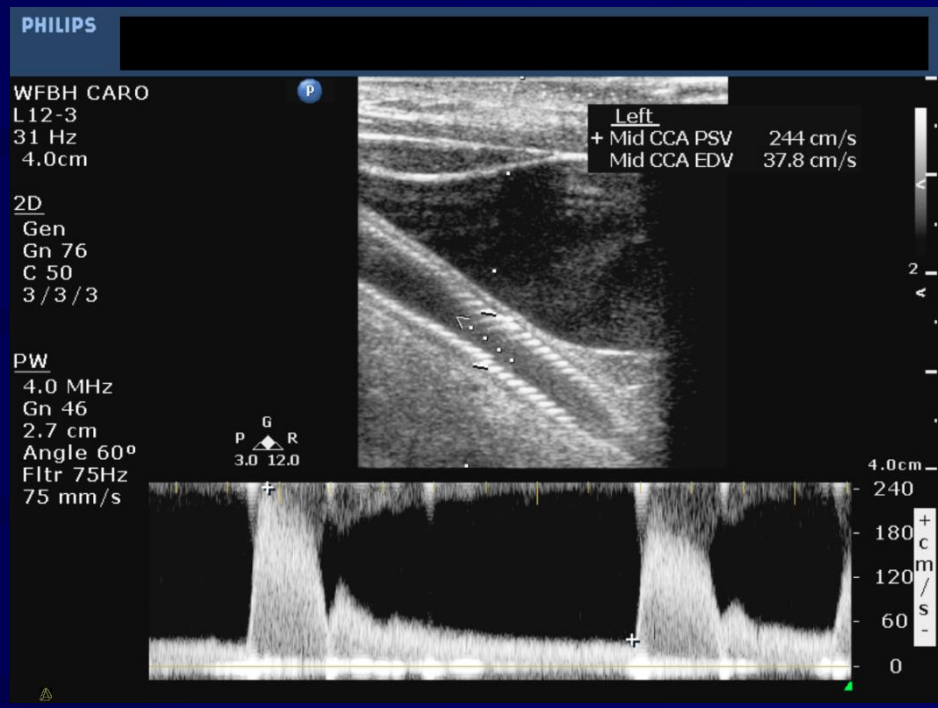
CCA Volume Flow Proximal to Stent

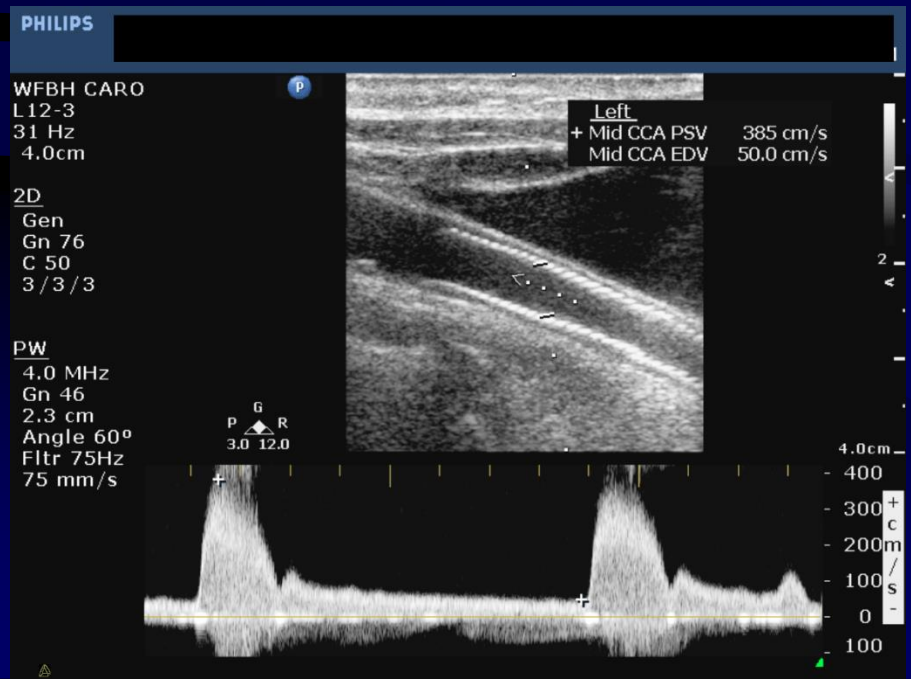


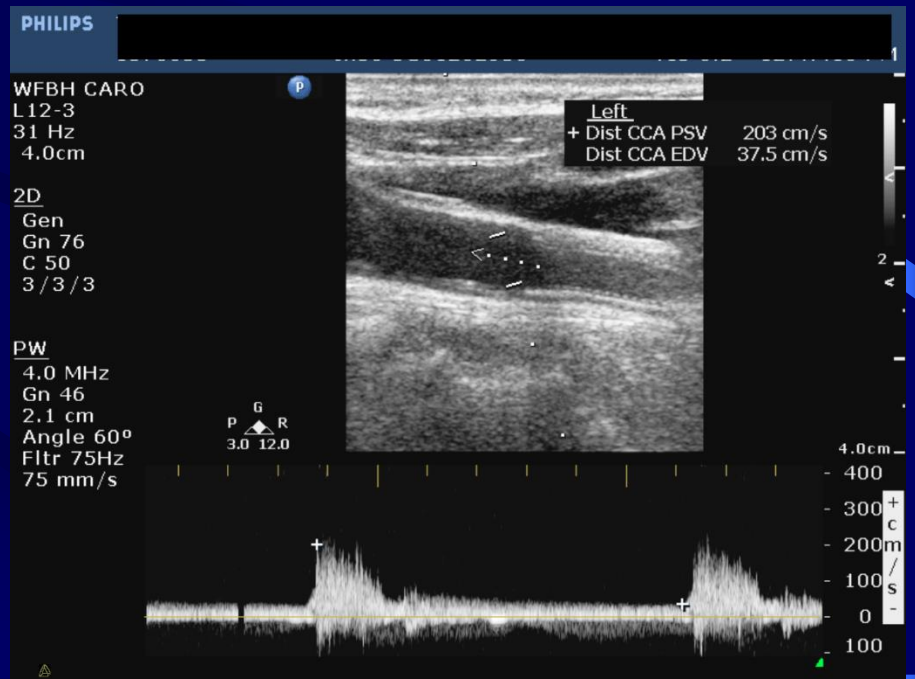
Lumen Measurement



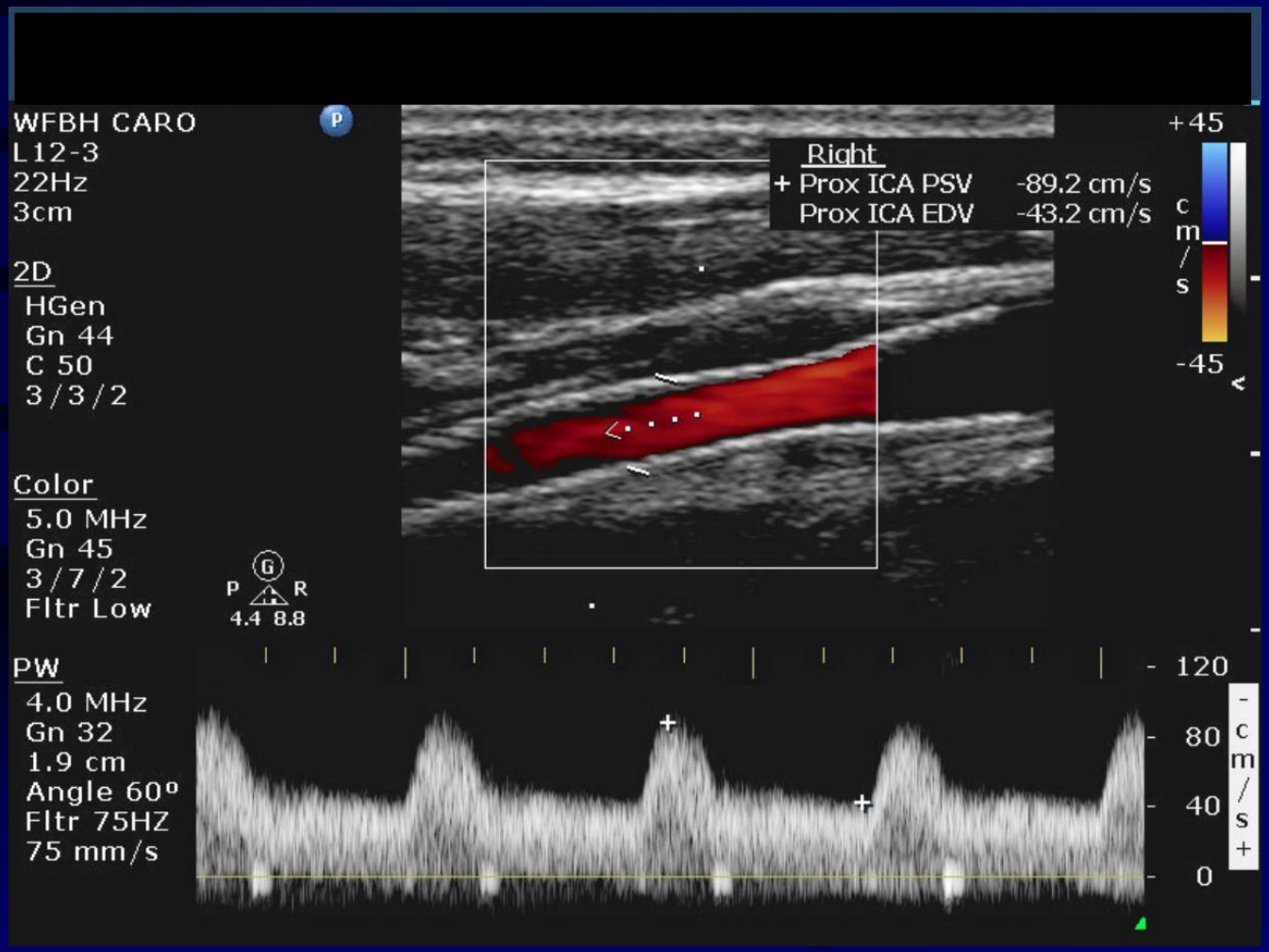

PHILIPS
WFBH CARO
L12-3
27 Hz
6.0cm
2D
Gen
Gn 76
C 50
3/3/3
PW
4.0 MHz
Gn 46
4.3 cm
Angle 56°
Fltr 75Hz
75 mm/s
Left
+ Prox CCA PSV 102 cm/s
Prox CCA EDV 28.2 cm/s
3.0 12.0
6.0cm
120
100
80
60
40
20
0
cm/s


PHILIPS
WFBH CARO
L12-3
31 Hz
4.0cm
2D
Gen
Gn 76
C 50
3/3/3
PW
4.0 MHz
Gn 46
2.7 cm
Angle 60°
Fltr 75Hz
75 mm/s
Left
+ Mid CCA PSV 244 cm/s
Mid CCA EDV 37.8 cm/s
3.0 12.0
4.0cm
240
180
120
60
0
cm/s

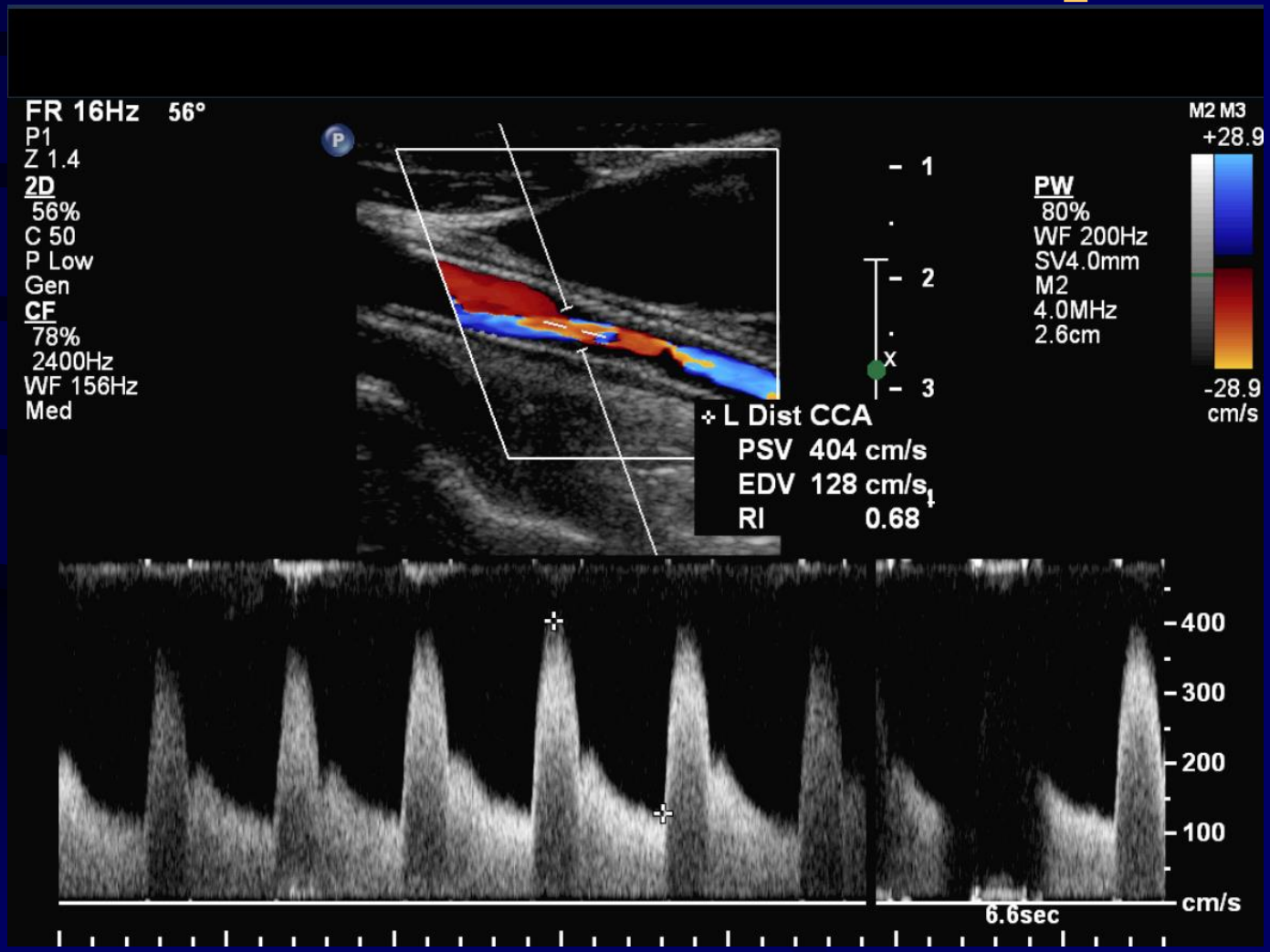

PHILIPS
WFBH CARO
L12-3
31 Hz
4.0cm
2D
Gen
Gn 76
C 50
3/3/3
PW
4.0 MHz
Gn 46
2.3 cm
Angle 60°
Fltr 75Hz
75 mm/s
Left
+ Mid CCA PSV 385 cm/s
Mid CCA EDV 50.0 cm/s
3.0 12.0
4.0cm
400
300
200
100
0
100
cm/s


PHILIPS
WFBH CARO
L12-3
31 Hz
4.0cm
2D
Gen
Gn 76
C 50
3/3/3
PW
4.0 MHz
Gn 46
2.1 cm
Angle 60°
Fltr 75Hz
75 mm/s
Left
+ Dist CCA PSV 203 cm/s
Dist CCA EDV 37.5 cm/s
3.0 12.0
4.0cm
400
300
200
100
0
100
cm/s

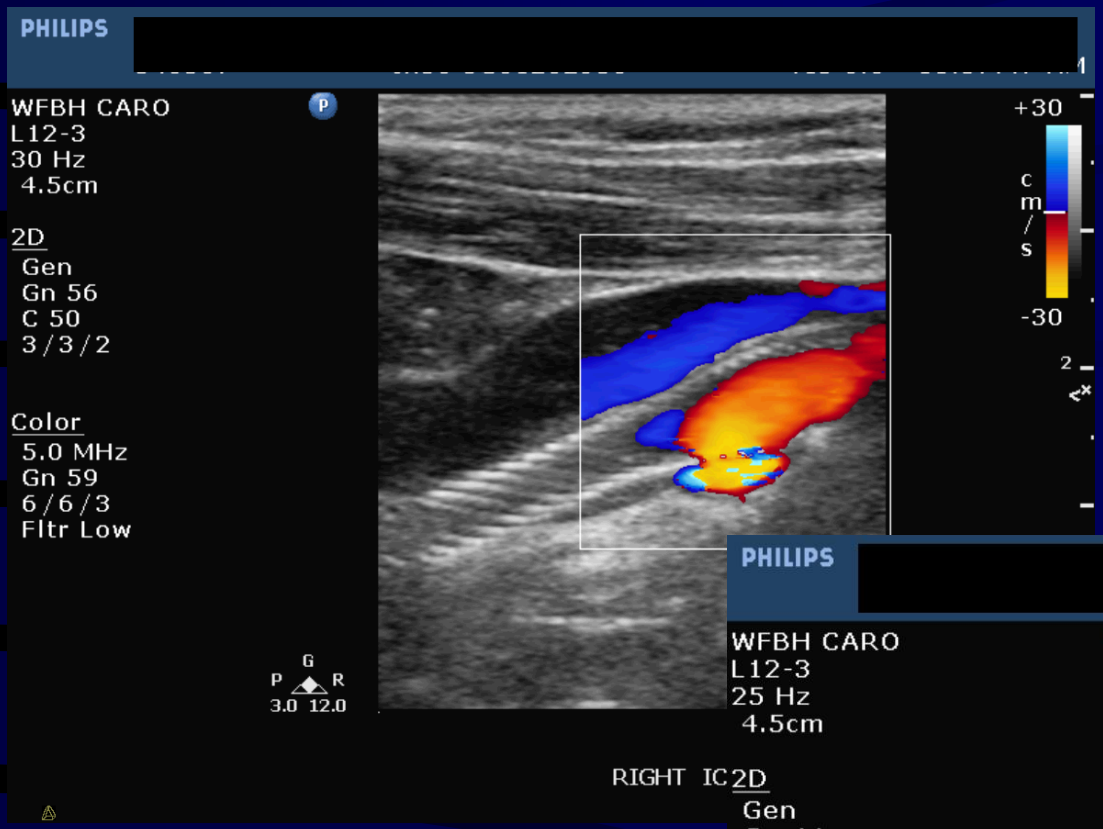
Stent: Color Flow

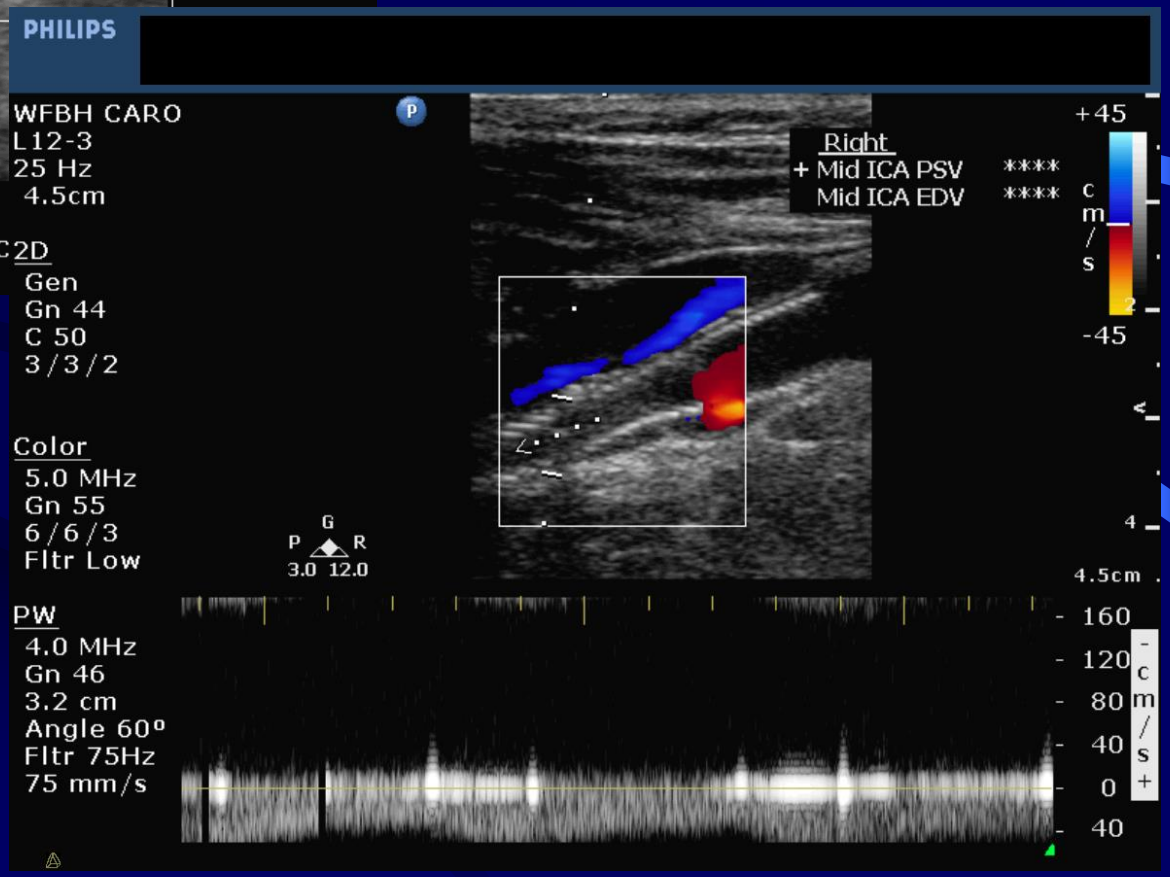


Stent Stenosis Color Duplex



Post-Stenotic Turbulence


PHILIPS
WFBH CARO
L12-3
30 Hz
4.5cm
2D
Gen
Gn 56
C 50
3/3/2
Color
5.0 MHz
Gn 59
6/6/3
Fltr Low
+30
cm/s
-30
G
P R
3.0 12.0


PHILIPS
WFBH CARO
L12-3
25 Hz
4.5cm
RIGHT IC
2D
Gen
Gn 44
C 50
3/3/2
Color
5.0 MHz
Gn 55
6/6/3
Fltr Low
G
P R
3.0 12.0
Right
+ Mid ICA PSV ****
Mid ICA EDV ****
+45
cm/s
-45
4.5cm
PW
4.0 MHz
Gn 46
3.2 cm
Angle 60°
Fltr 75Hz
75 mm/s
160
120
80
40
0
40
cm/s

Stent Re-Stenosis Used at WFBMC

- Stent is stiff and not distensible
- Velocities are higher
- Ratio helpful to identify severe re-stenosis

% Stenosis	Peak Systolic Velocity	End Diastolic Velocity	ICA:CCA ratio
50-69%	175-299 cm/s	----	----
≥ 70%	≥300	≥140	≥3.8

Setacci C, et al., Stroke, 2008;39:1189-96

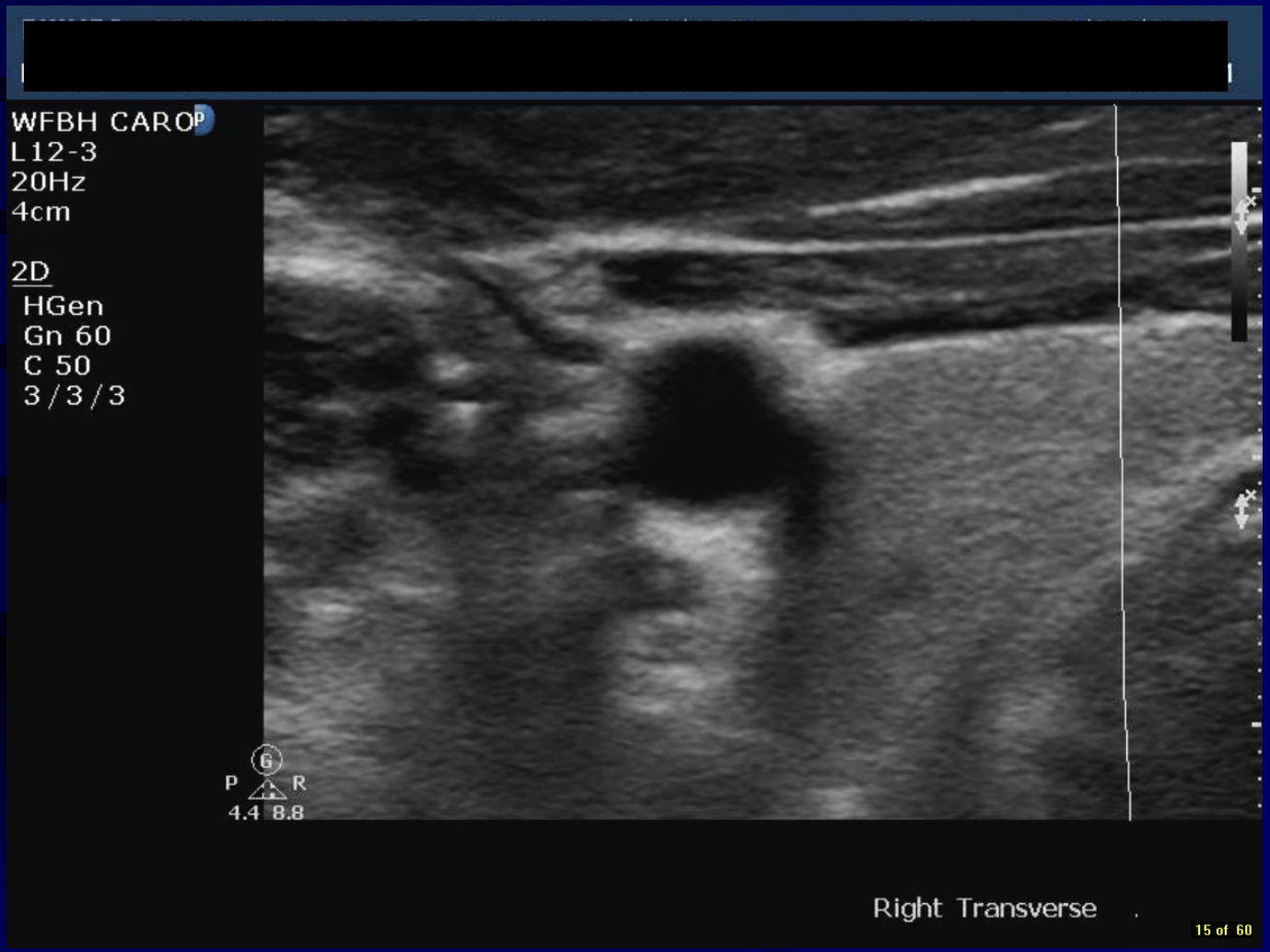
Thyroid

- Routinely observed as part of carotid exam
- Typically uniform, ground glass appearance
- Often see abnormalities:
  - Size (enlarged, mass effect, vessel compression
  - Hypervascular on color flow
  - Cysts (if ≥ 1 cm, need to report)
- Reported as incidental findings

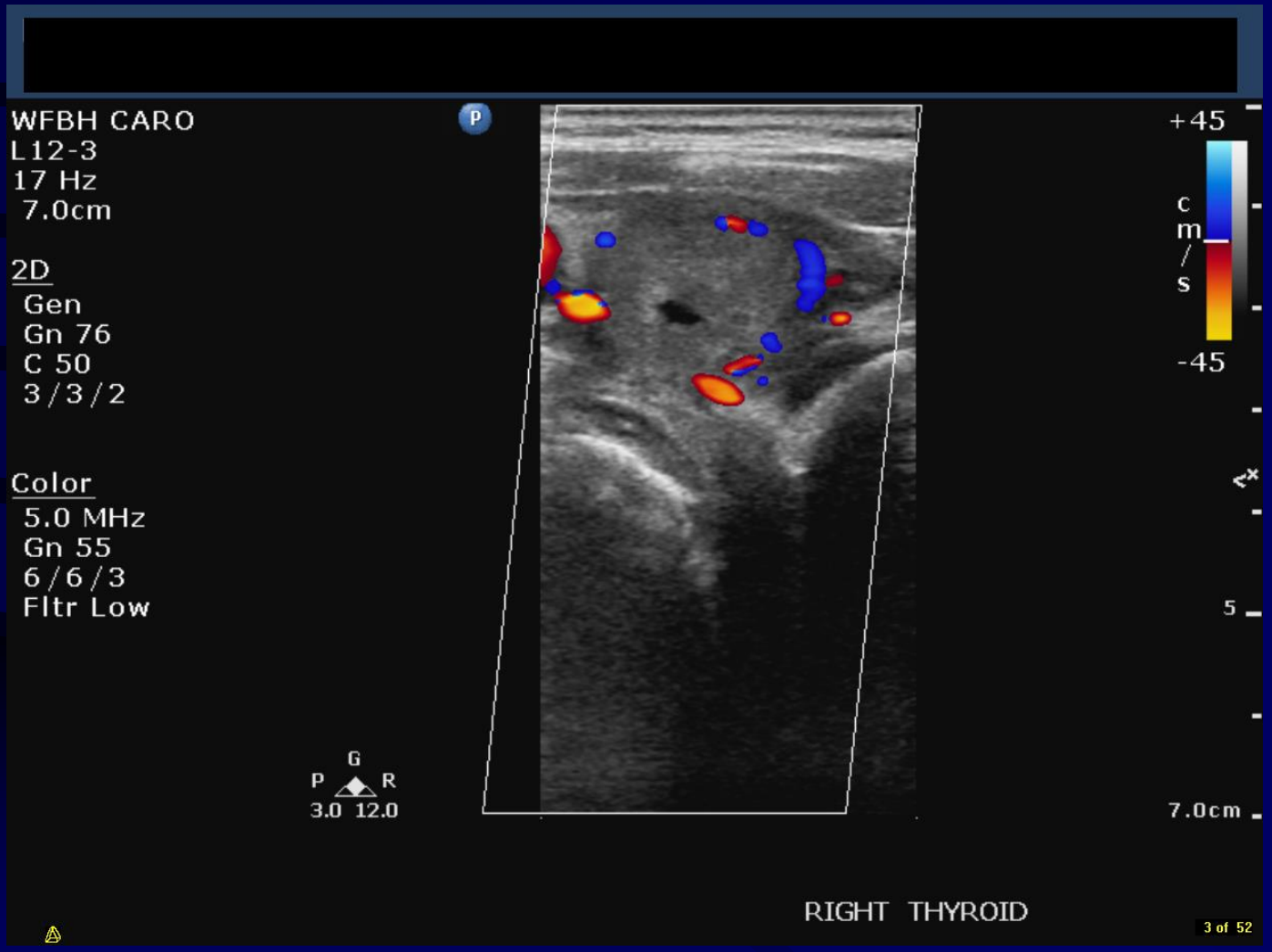
Structures of the Neck

1.Thyroid gland
2.Trachea
3.Brachiocephalic artery
4.Common carotid artery
5.Internal jugular vein
6.Superior vena cava

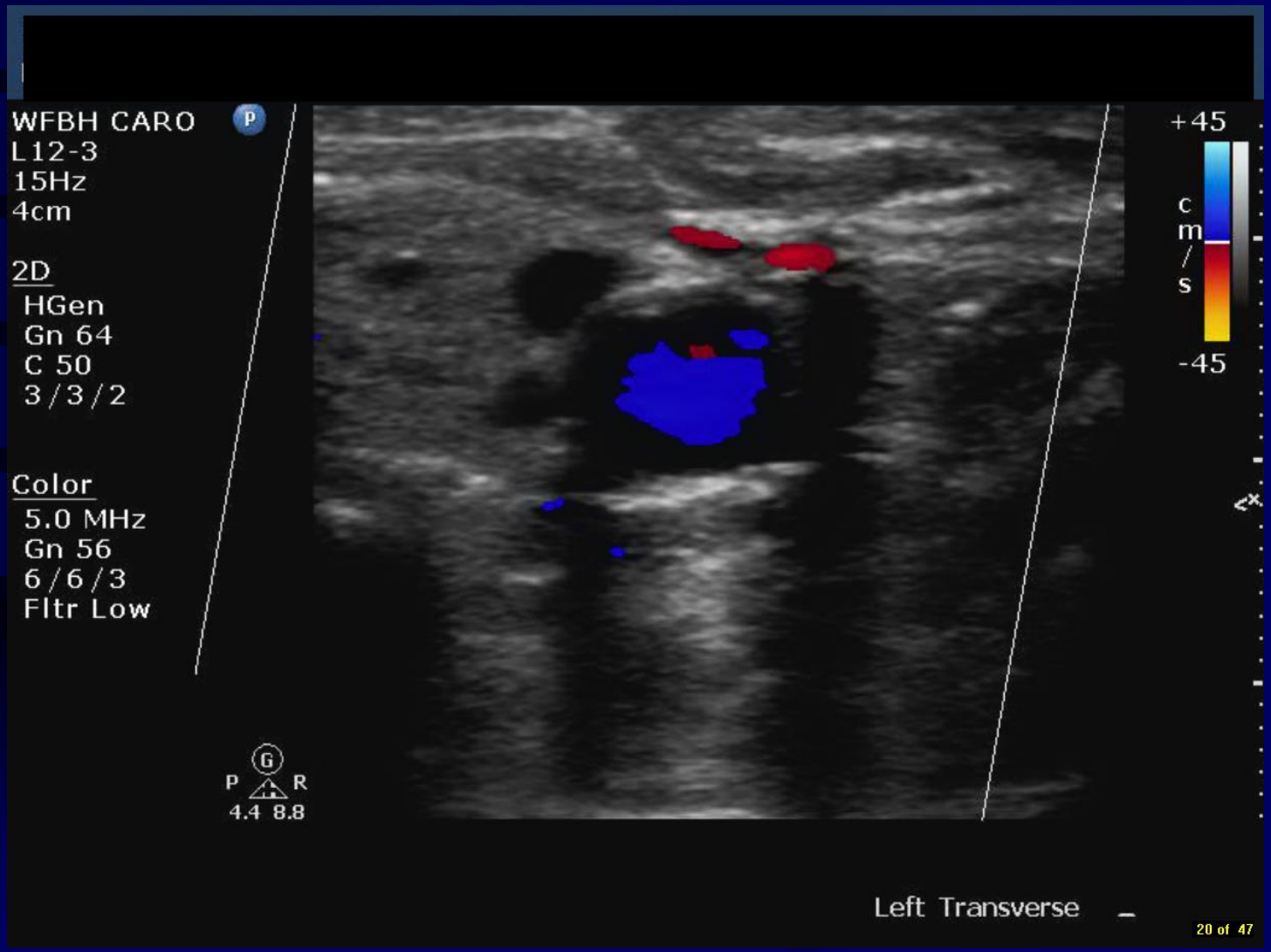
Normal Appearing Thyroid - Right



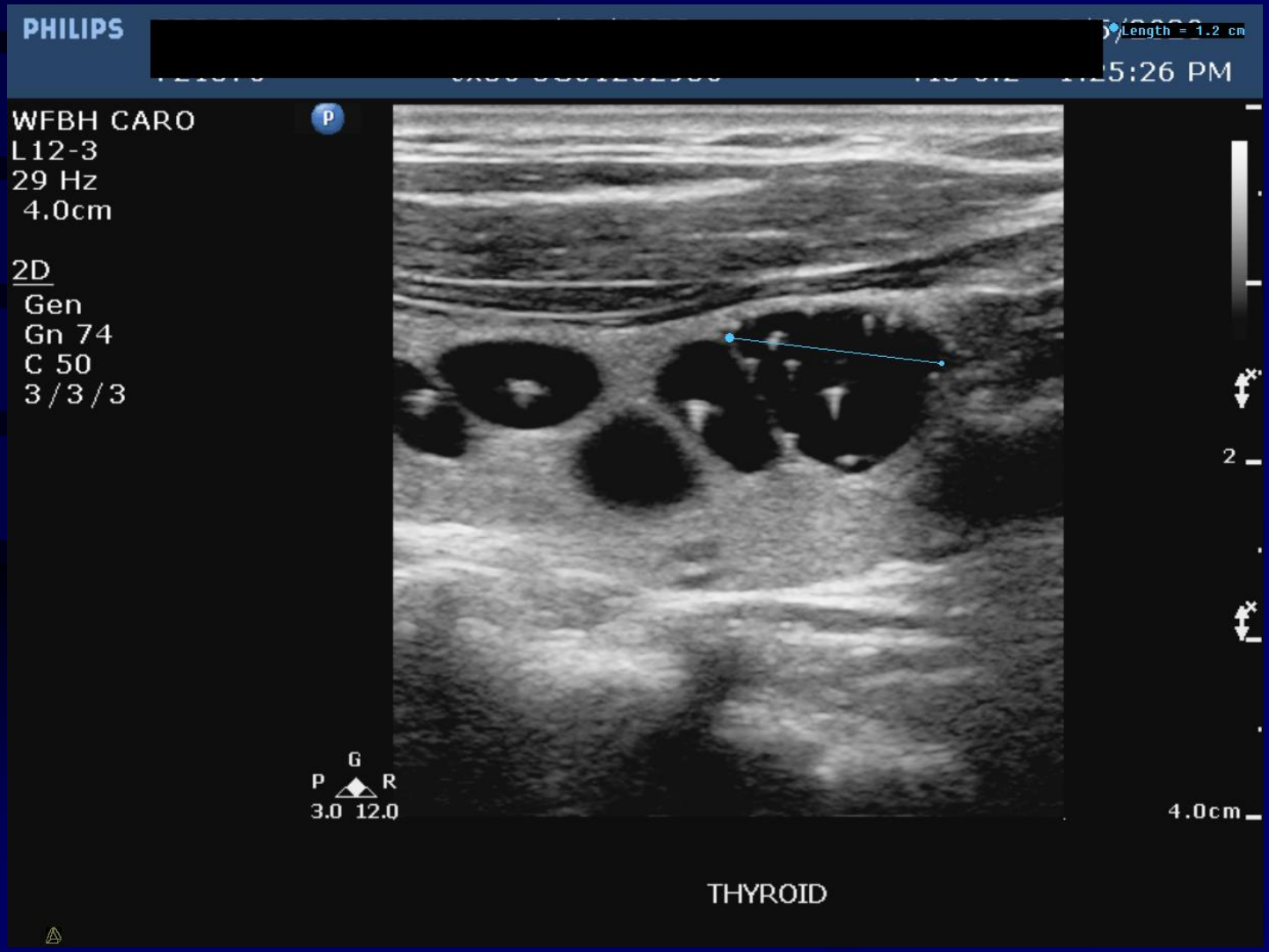
Thyroid – Increased Vascularity, Small Cyst



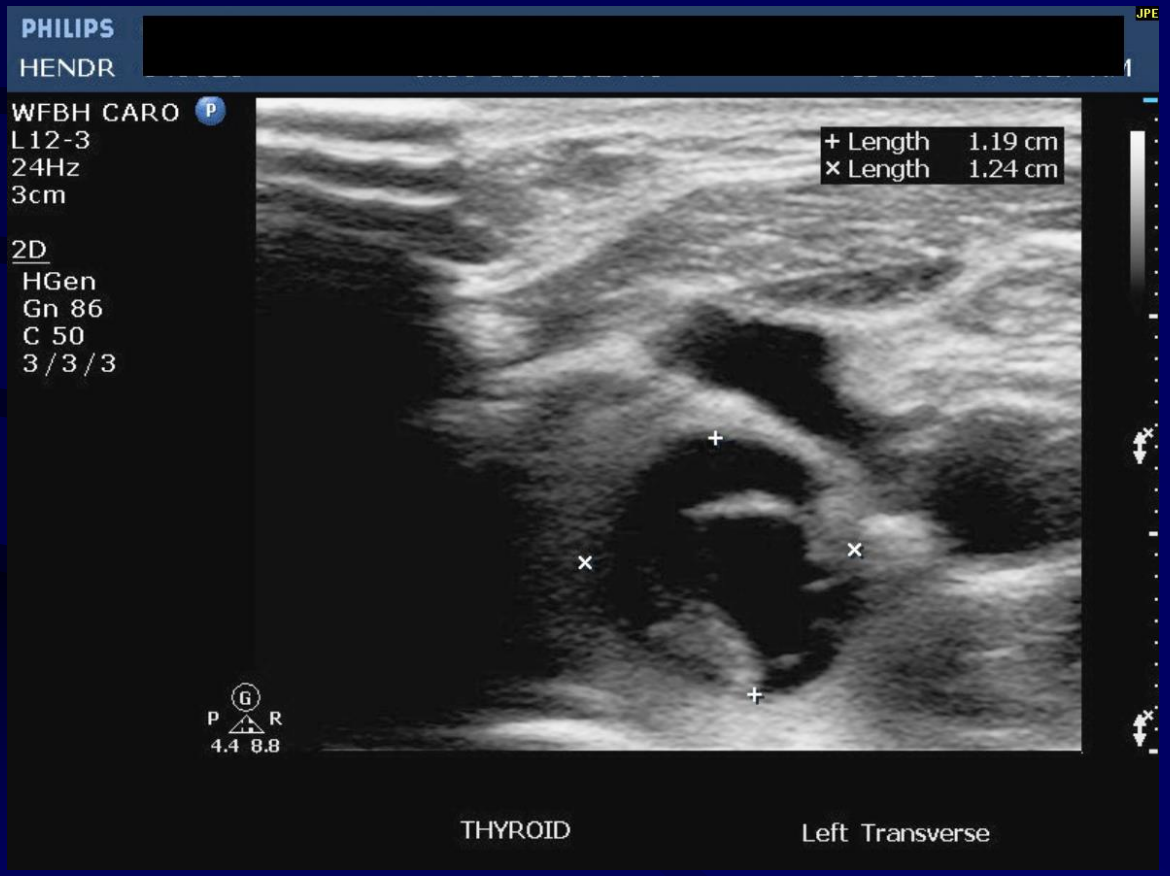
Multiple Small Thyroid Cysts



Cystic Thyroid



Thyroid Cyst with Debris

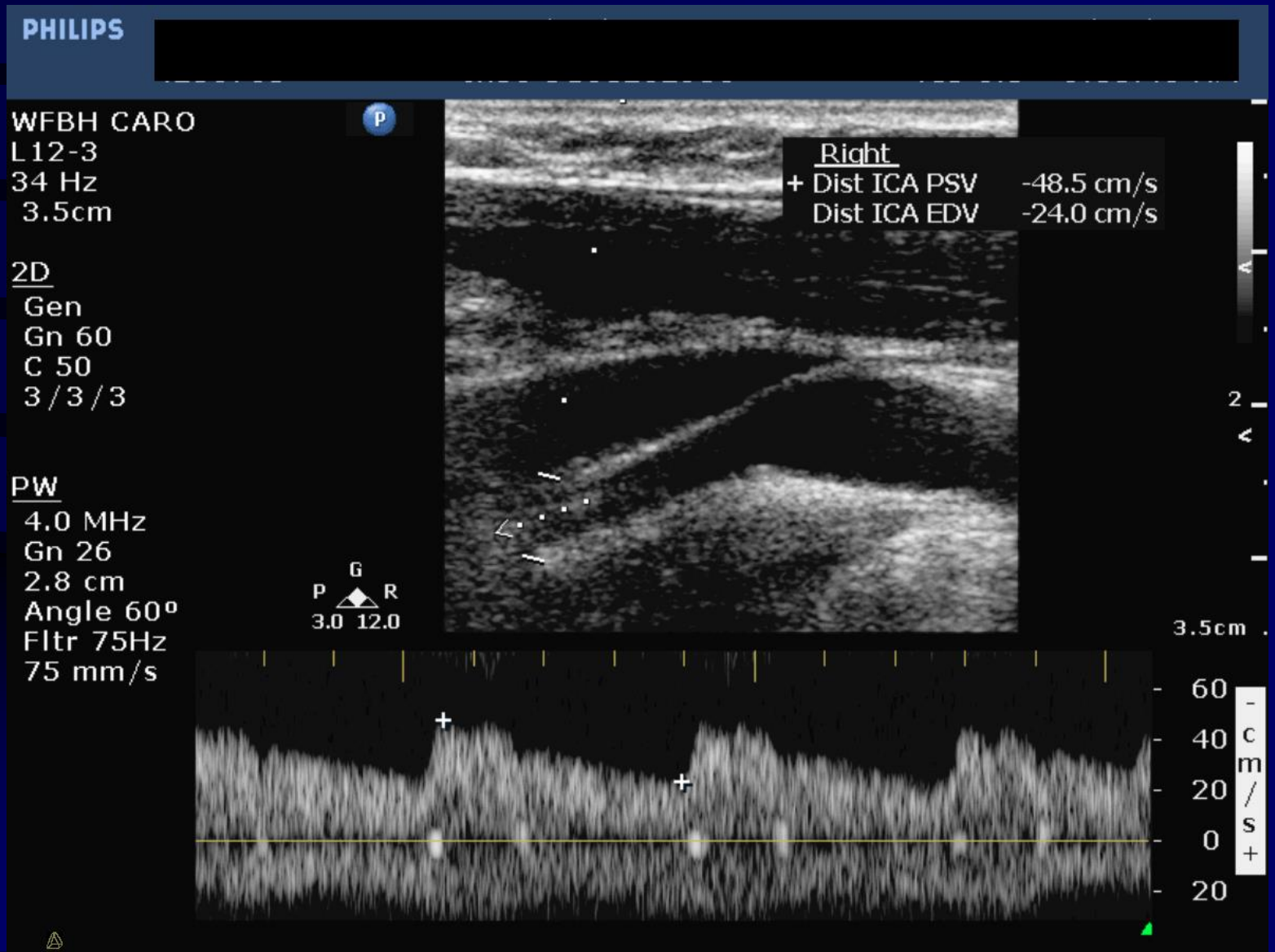


Courtesy of Dr. Renee Healing Art

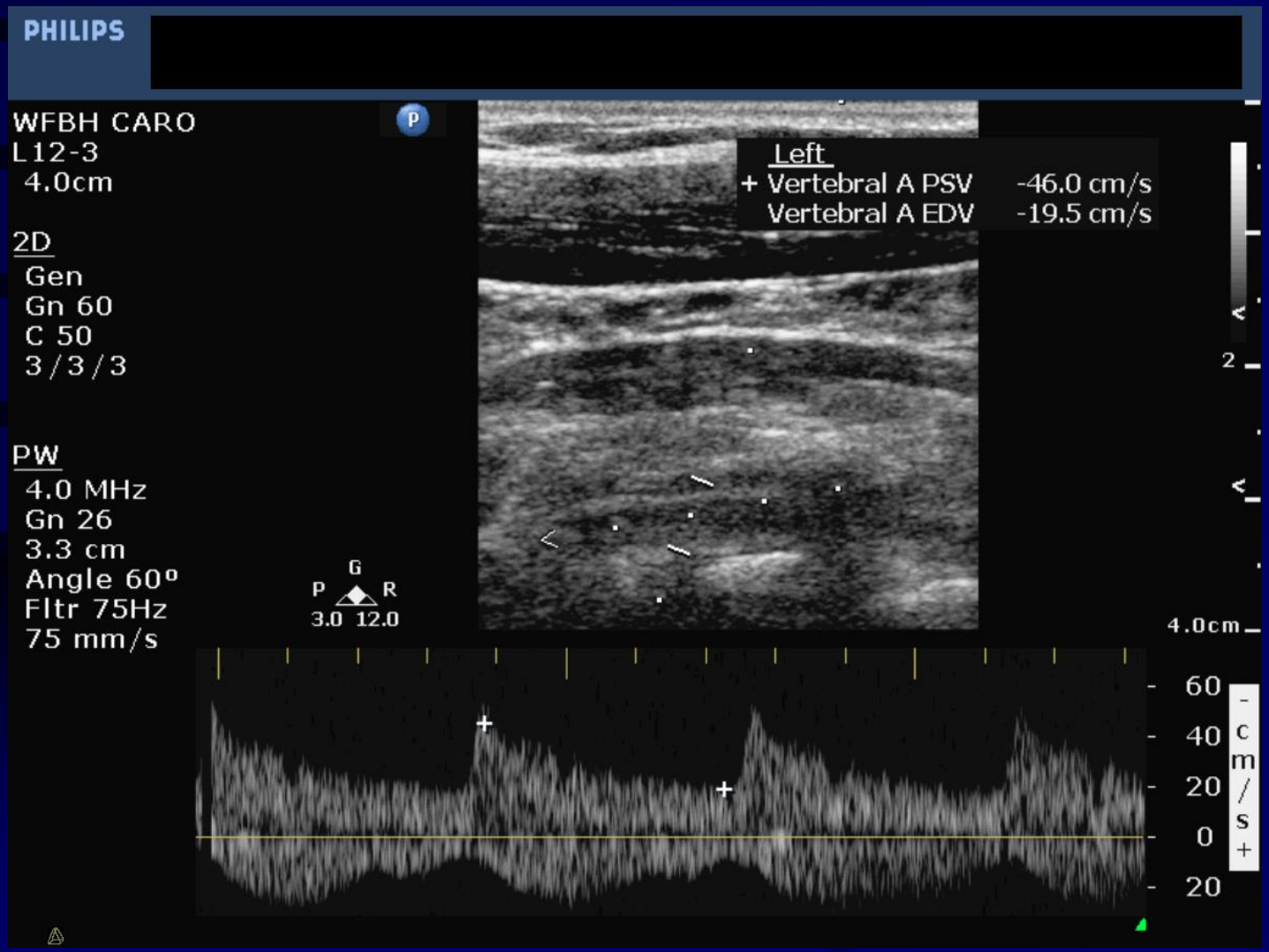
Jugular Veins

- Integral part of routine carotid exam
- May actually improve resolution for carotid
- Velocity hard to measure, or artifact
- Often see spontaneous echo contrast
- Few clinical implications/relevance
- Jugular valve may be important
- Must look for thrombus
- Venous side of brain circulation offers great potential for future advances/understandings

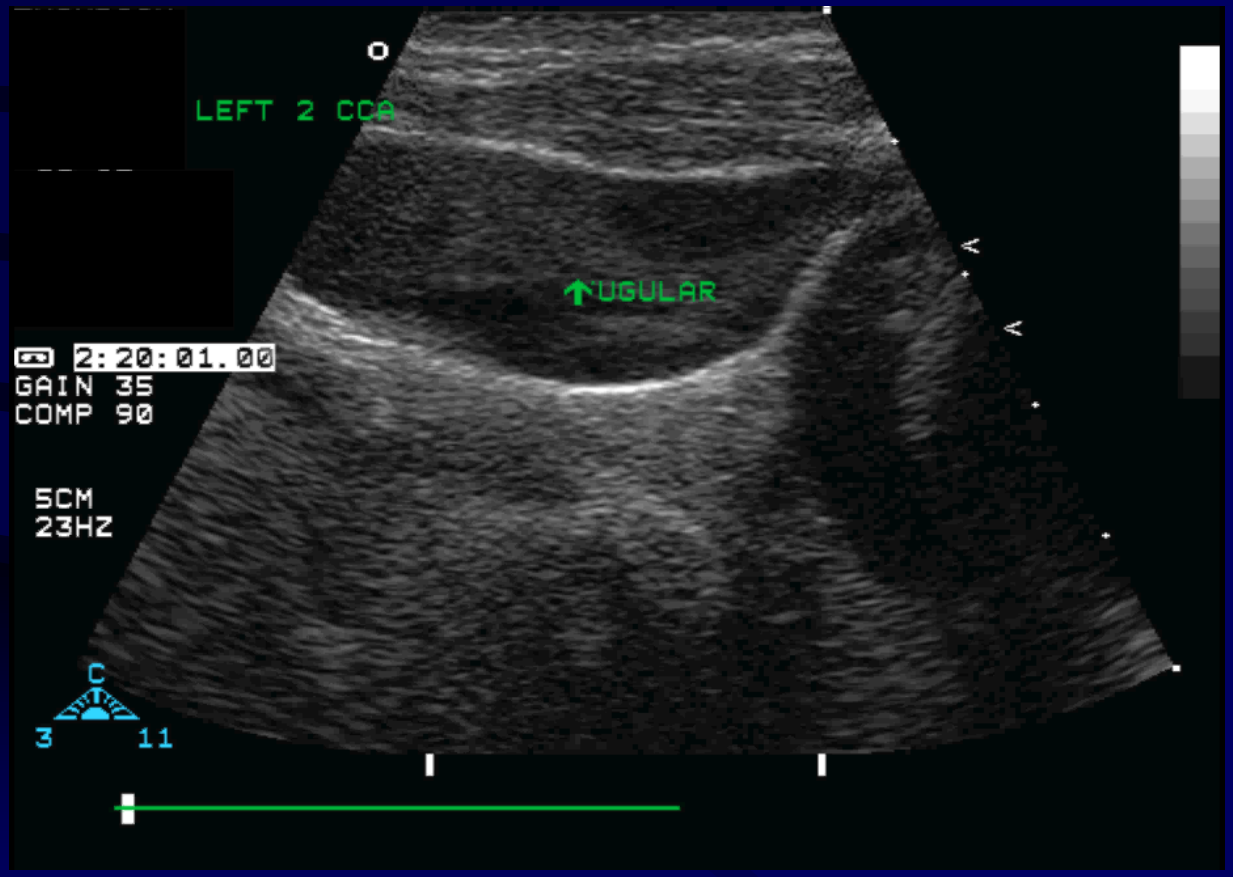
Venous Signal with ICA



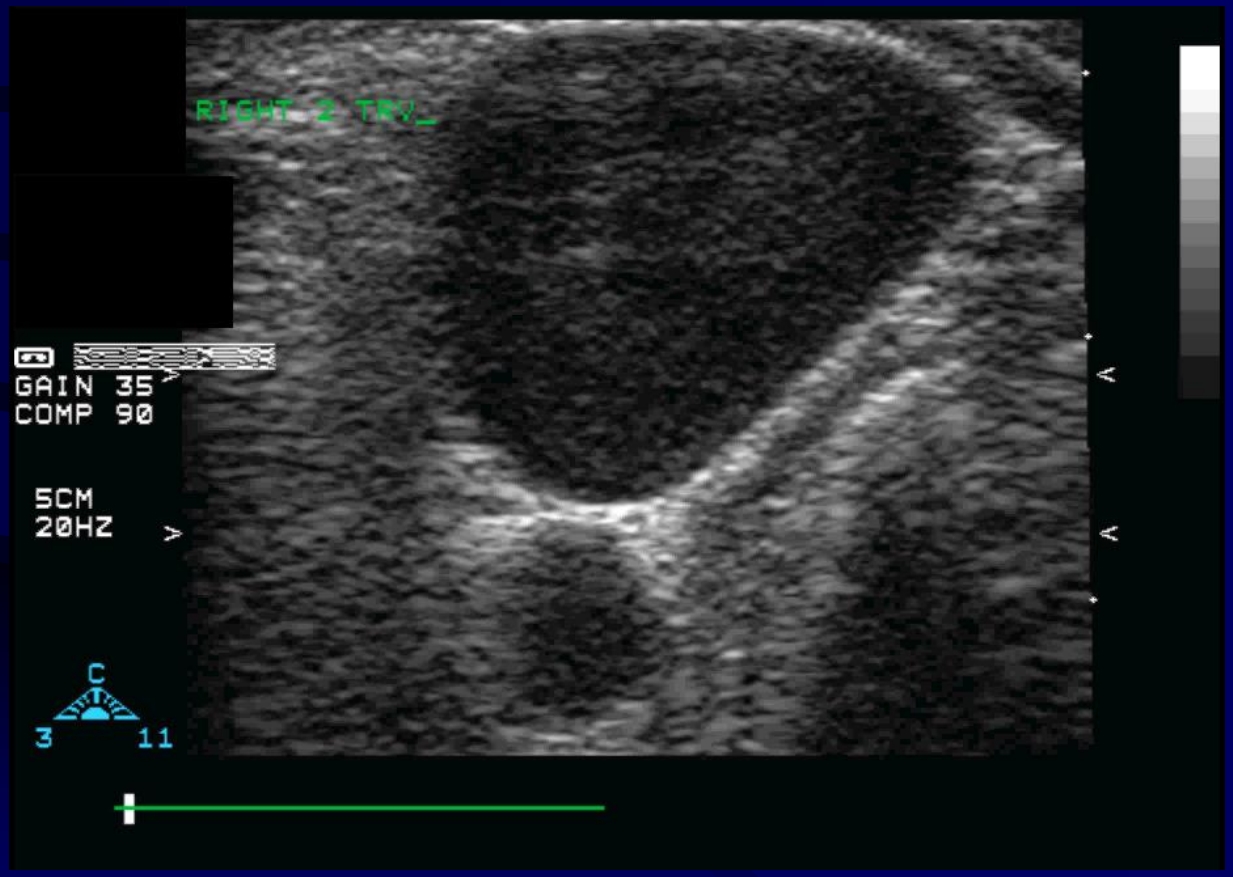
Venous Signal with VA



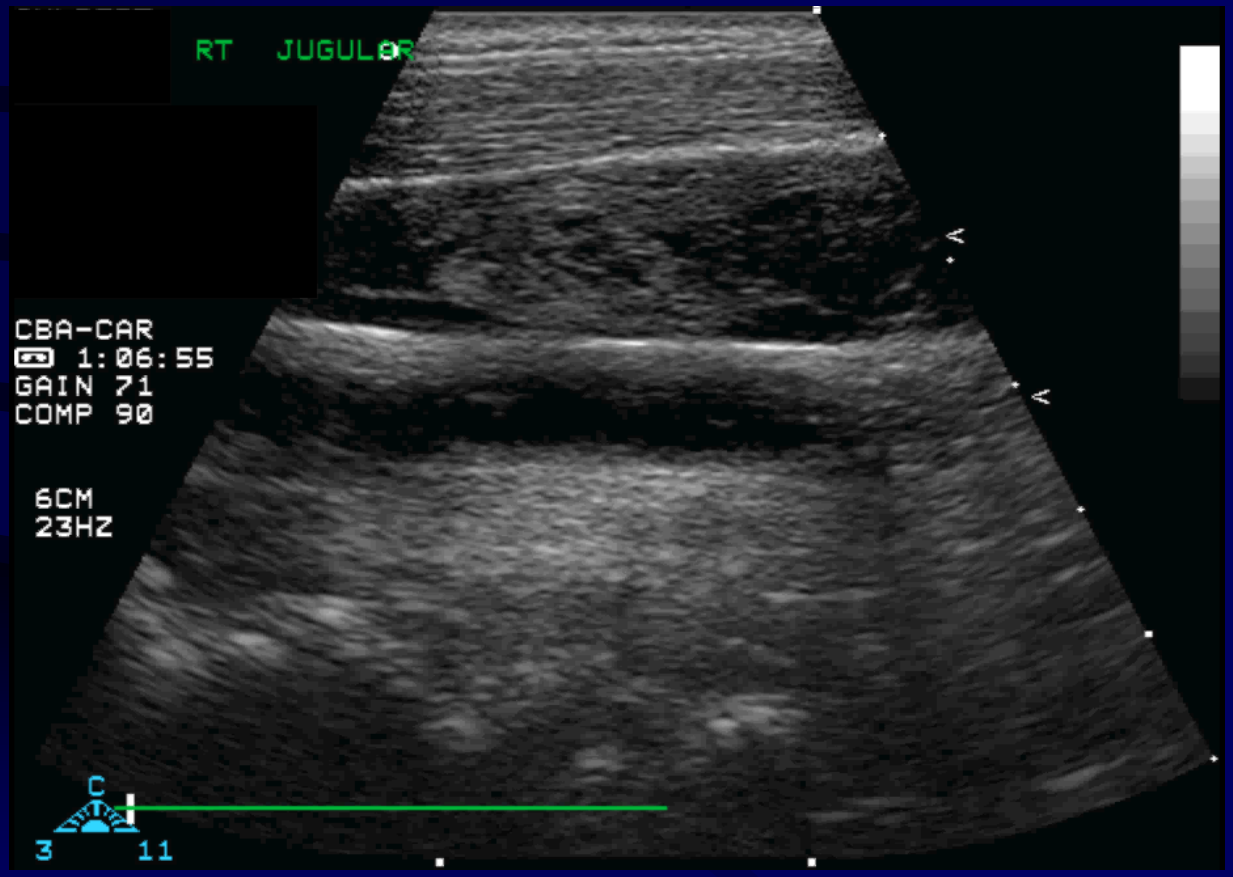
Internal Jugular
Spontaneous Echo Contrast



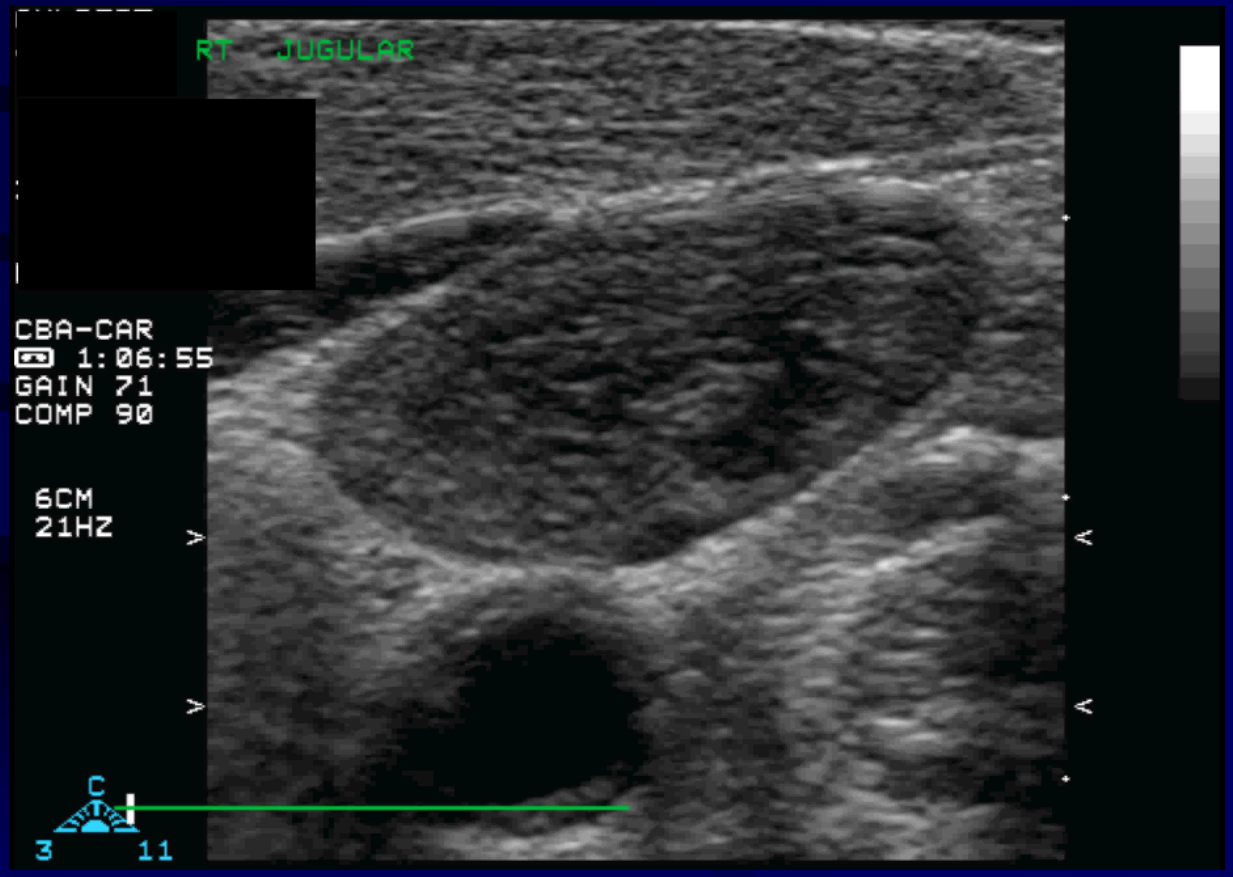
Internal Jugular Transverse Spontaneous Echo Contrast

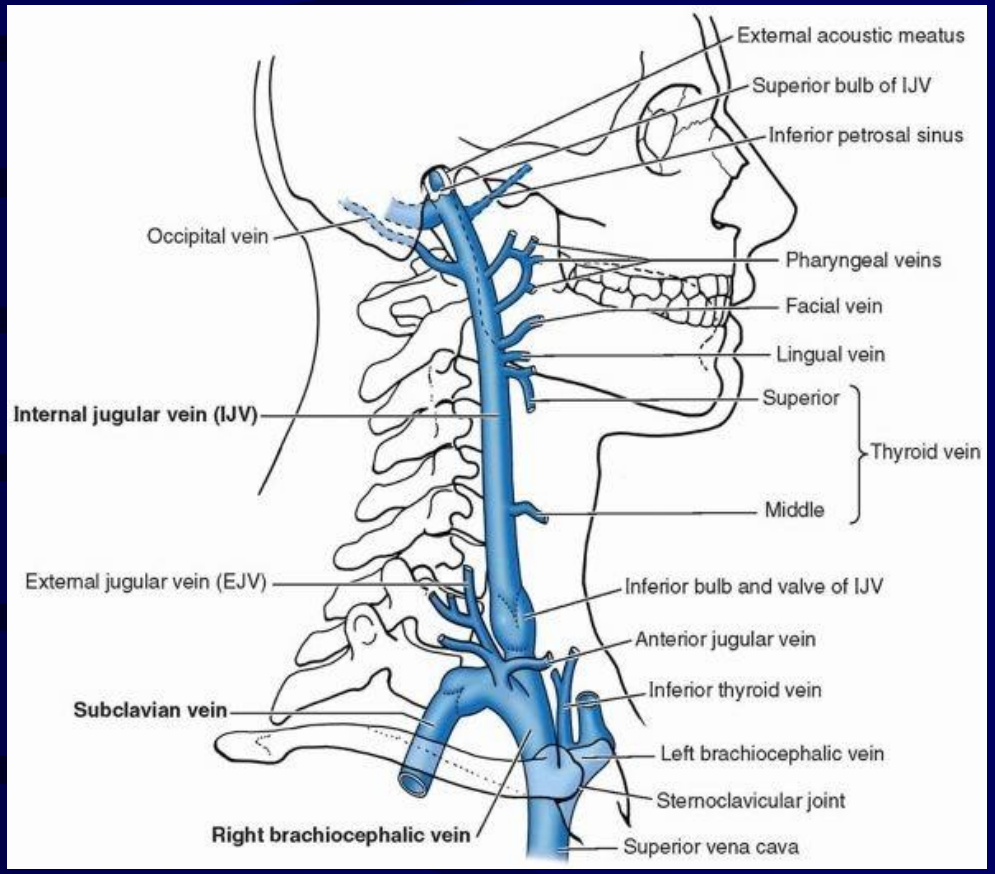


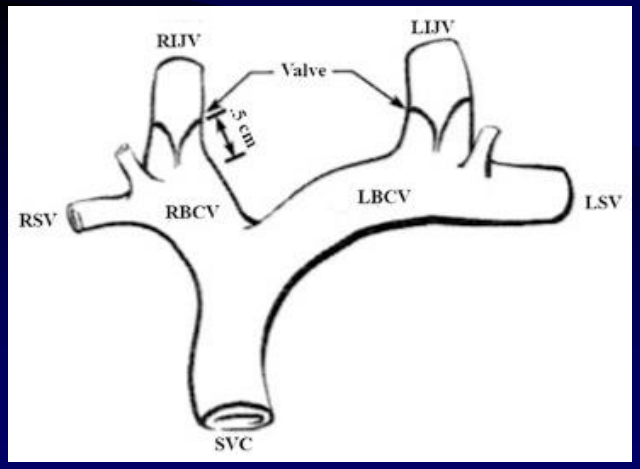
Internal Jugular Thrombosis

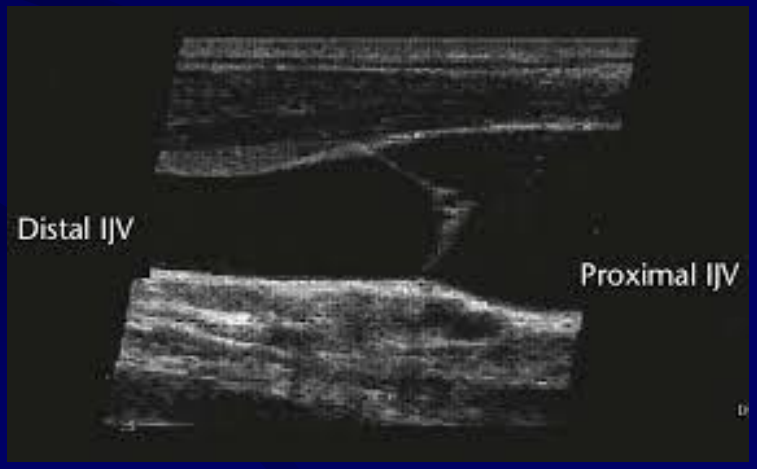


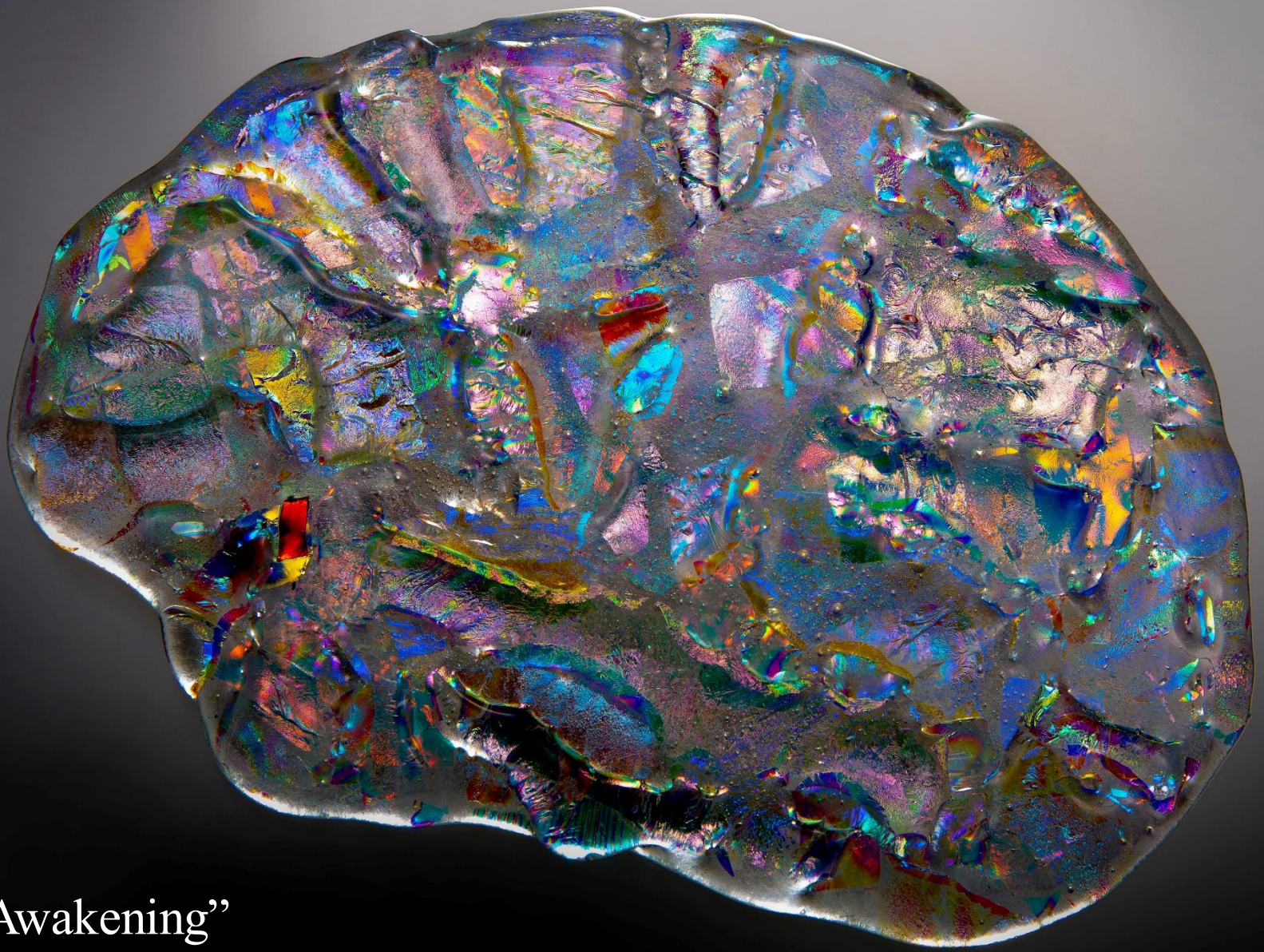
Internal Jugular Thombosis




External acoustic meatus
Superior bulb of IJV
Inferior petrosal sinus
Occipital vein
Pharyngeal veins
Facial vein
Lingual vein
Internal jugular vein (IJV)
Superior
Thyroid vein
Middle
External jugular vein (EJV)
Inferior bulb and valve of IJV
Anterior jugular vein
Inferior thyroid vein
Subclavian vein
Left brachiocephalic vein
Sternoclavicular joint
Right brachiocephalic vein
Superior vena cava


RIJV
LIJV
Valve
.5 cm
RSV
RBCV
LBCV
LSV
SVC

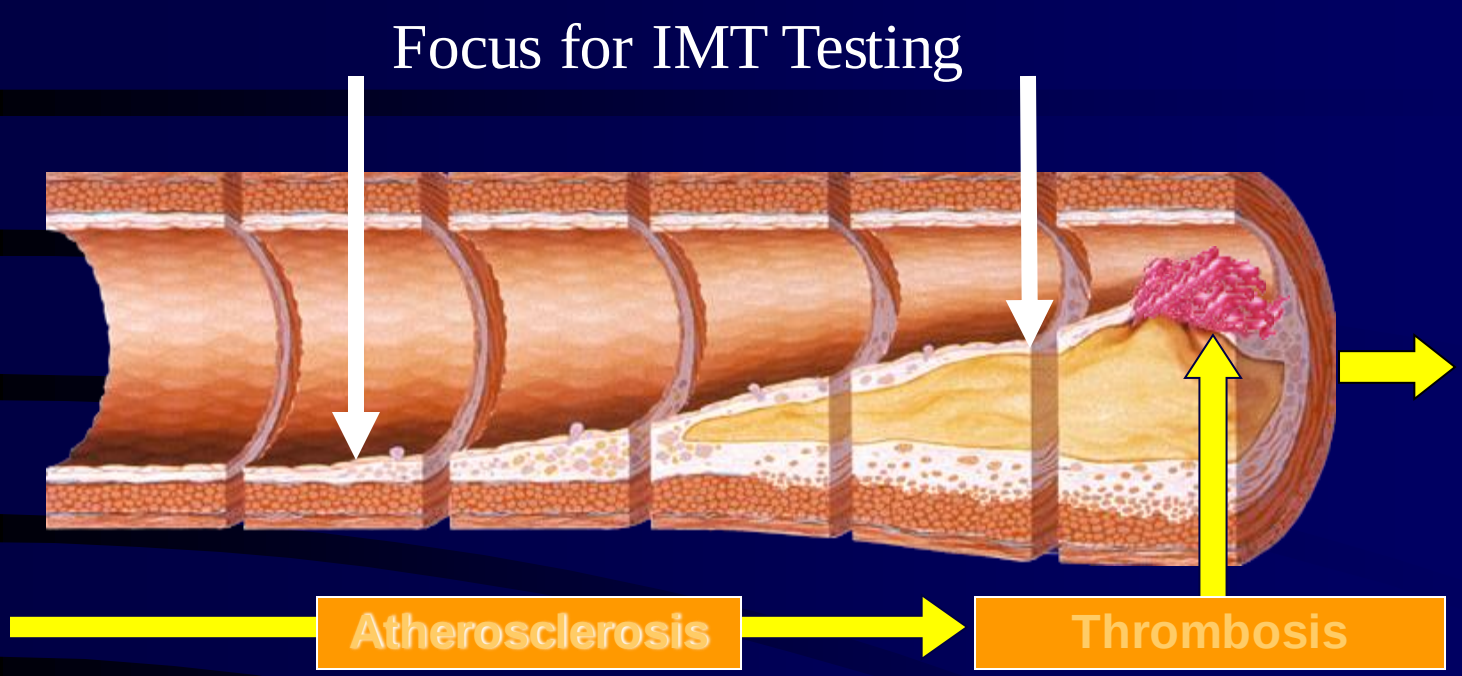

Distal IJV
Proximal IJV



“Awakening”

Progression of Atherosclerosis

Spectrum of Disease

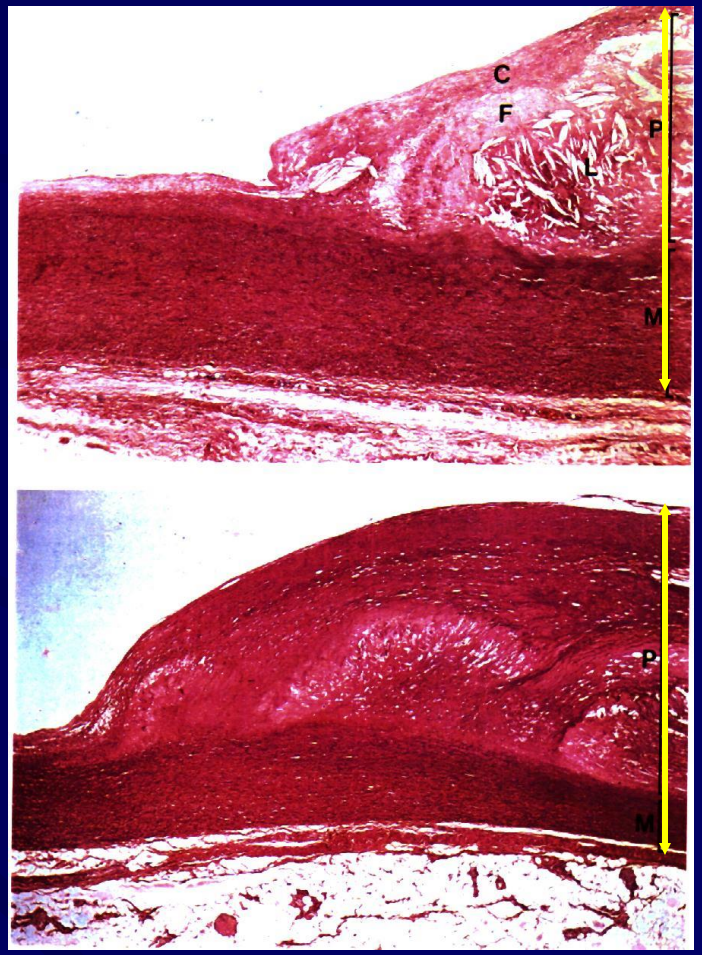


Adapted from Stary HC et al. *Circulation*. 1995;92:1355-1374 and Fuster V. *Vasc Med*. 1998;3:231-239.

Carotid IMT Definition (Cont')

Anatomic Basis for IMT

- **Histological slices show the intimal and medial layers of two atherosclerotic arteries with *B-mode Carotid IMT Definition* (different plaque characteristics).**
- **The maximum IMT of each wall is indicated by the vertical yellow line.**
- **This thickness includes that of both the media (M) and the plaque (P). The plaques affect both the intima and the media.**

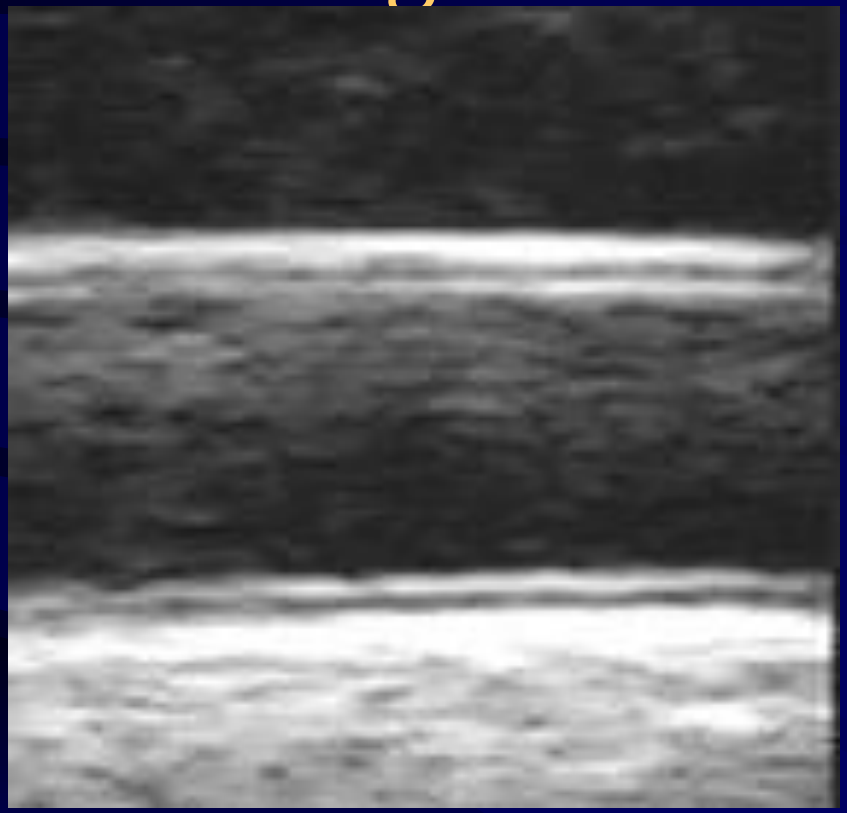


B-Mode Image – CCA Longitudinal

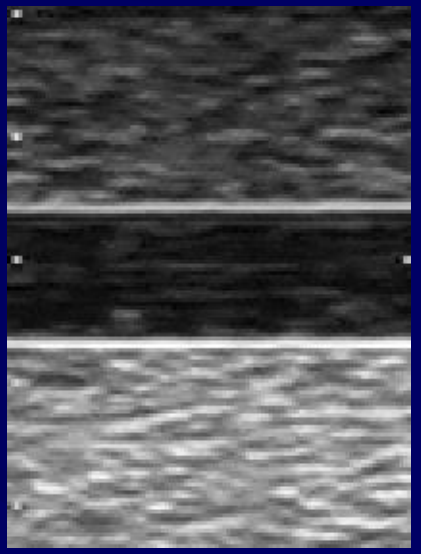
near

lumen

far



cylinder

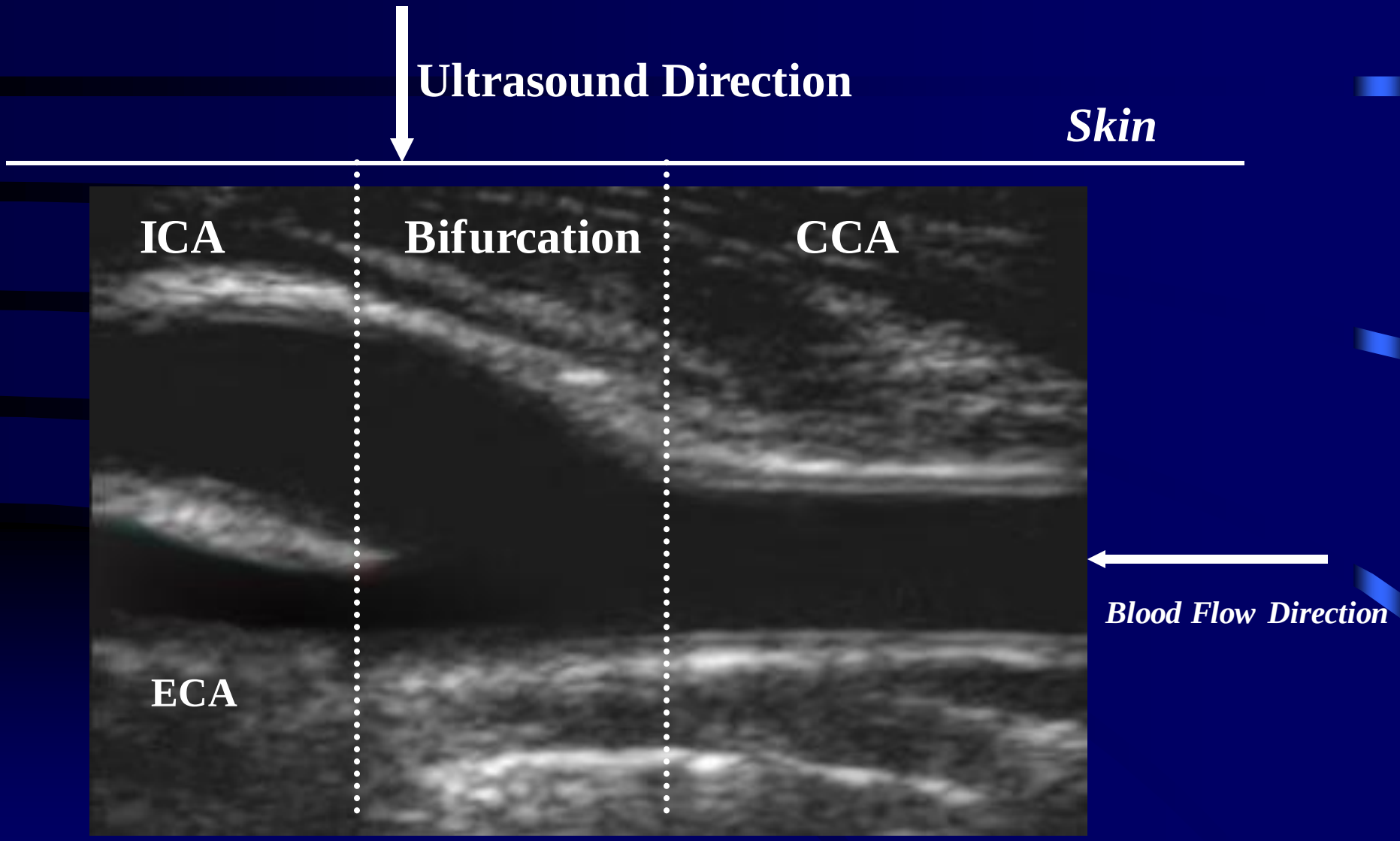


Measurement of CIMT

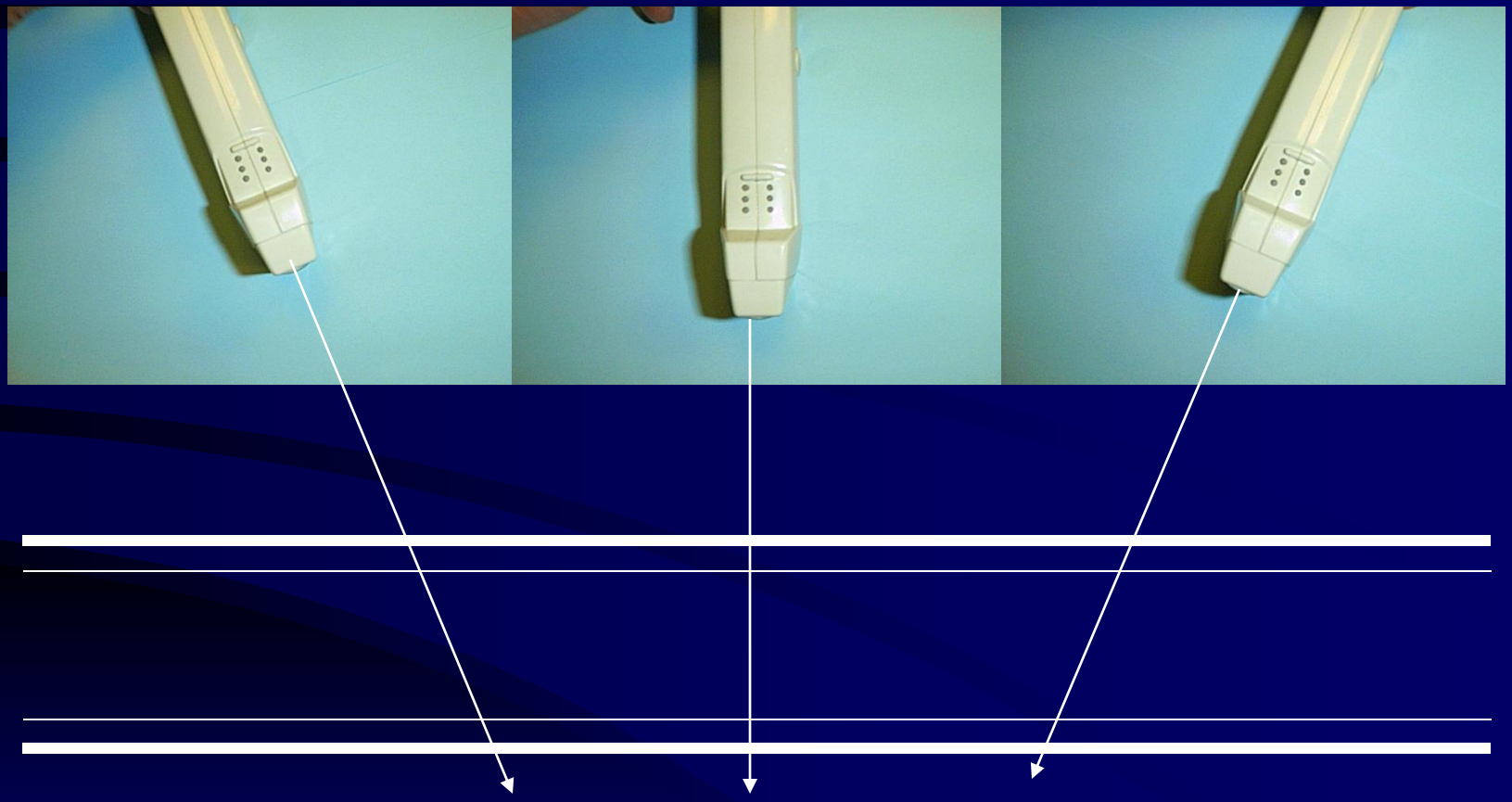
Pulse duration

Pulse duration

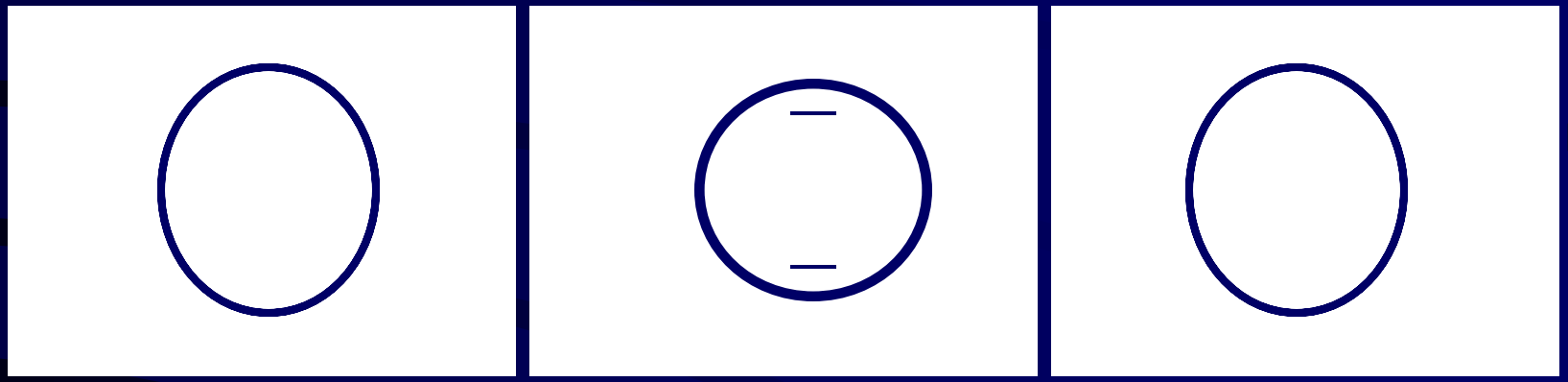
Carotid IMT Protocols



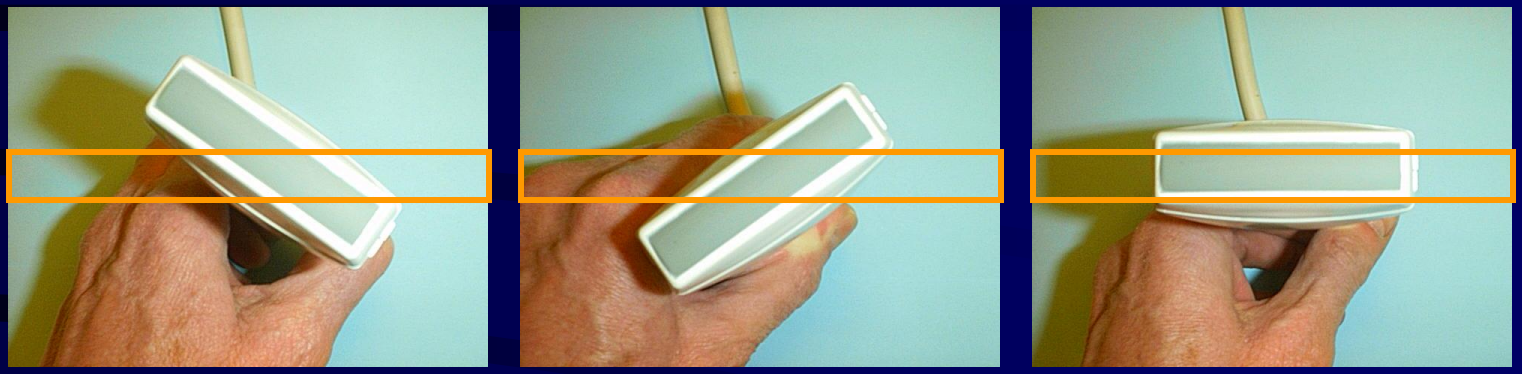
Effect of Transducer Angulation

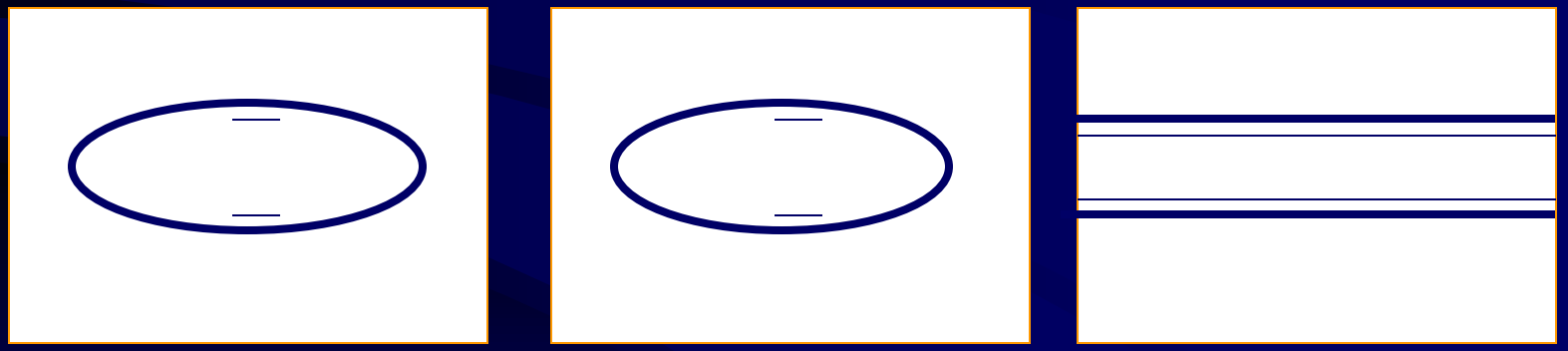


B-mode Images

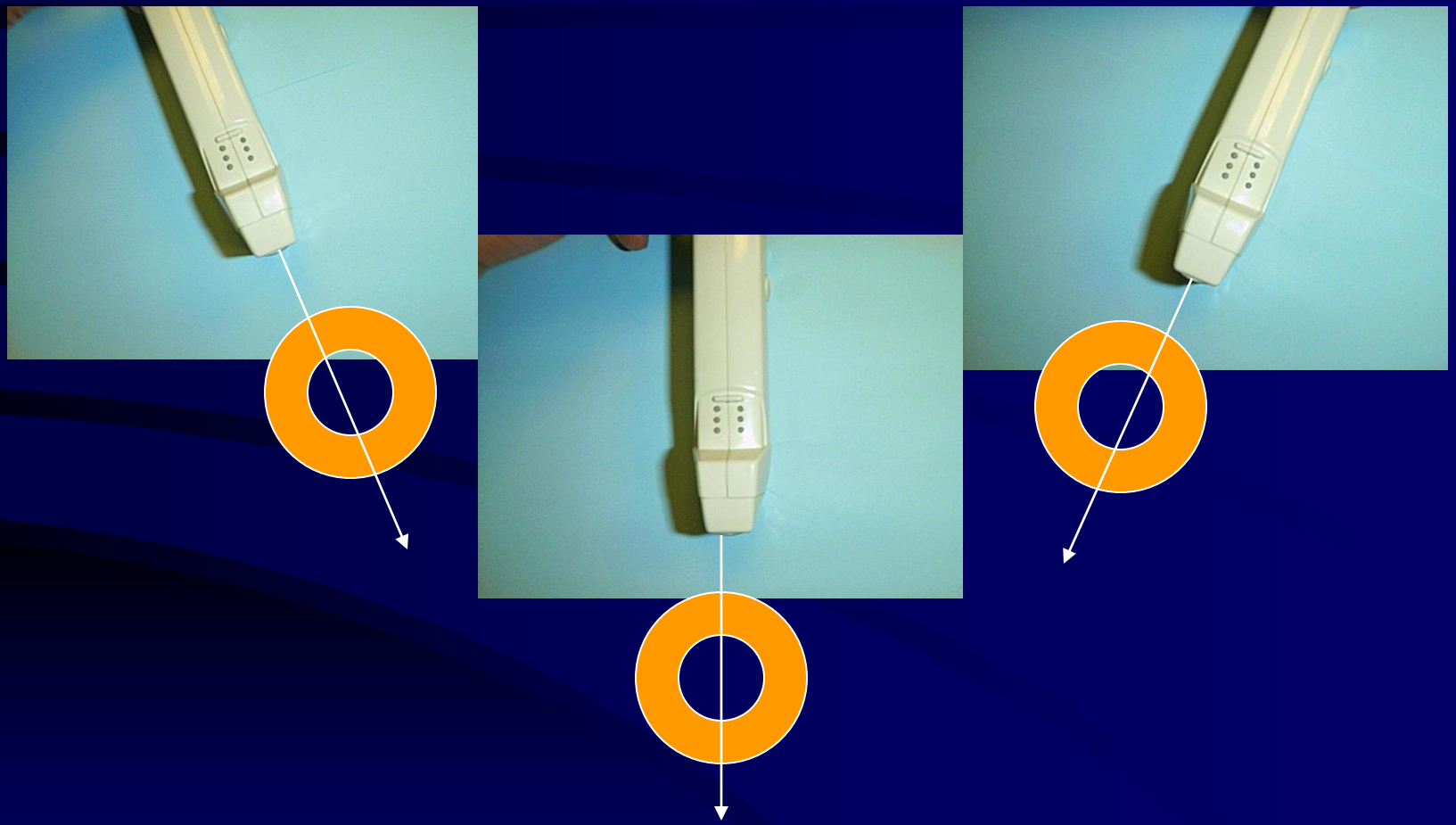


Rotating scan head

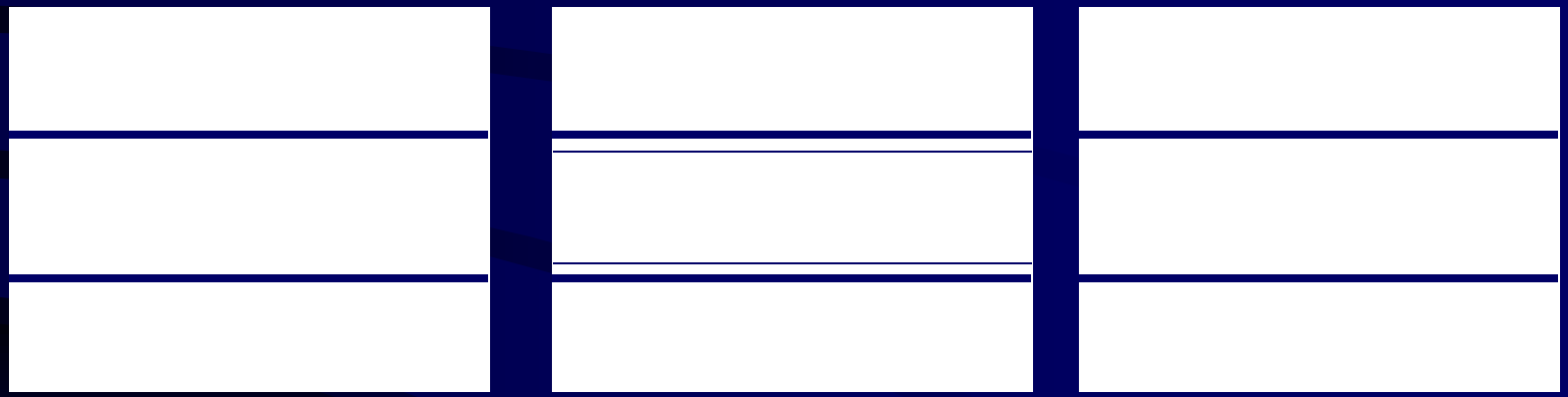




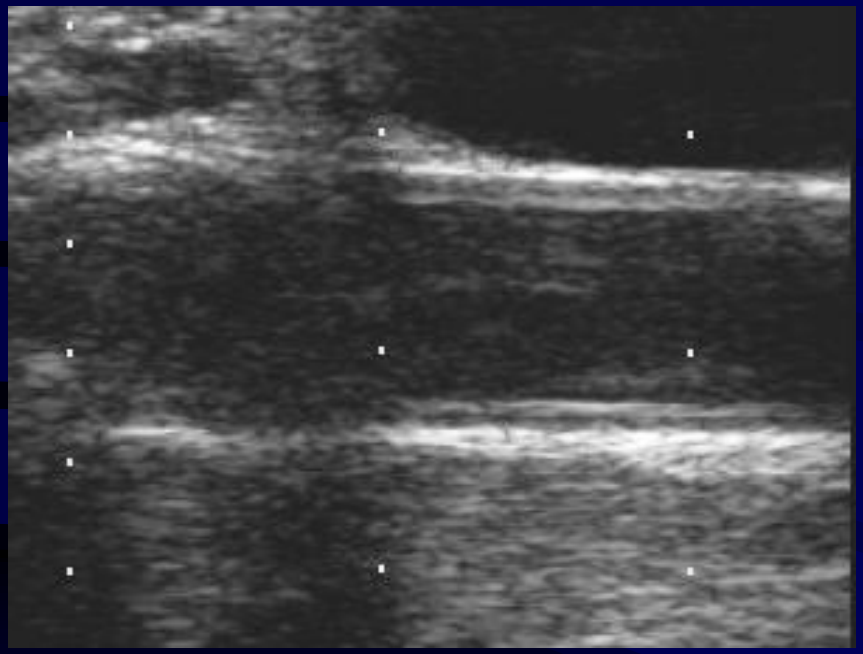
Off Axis

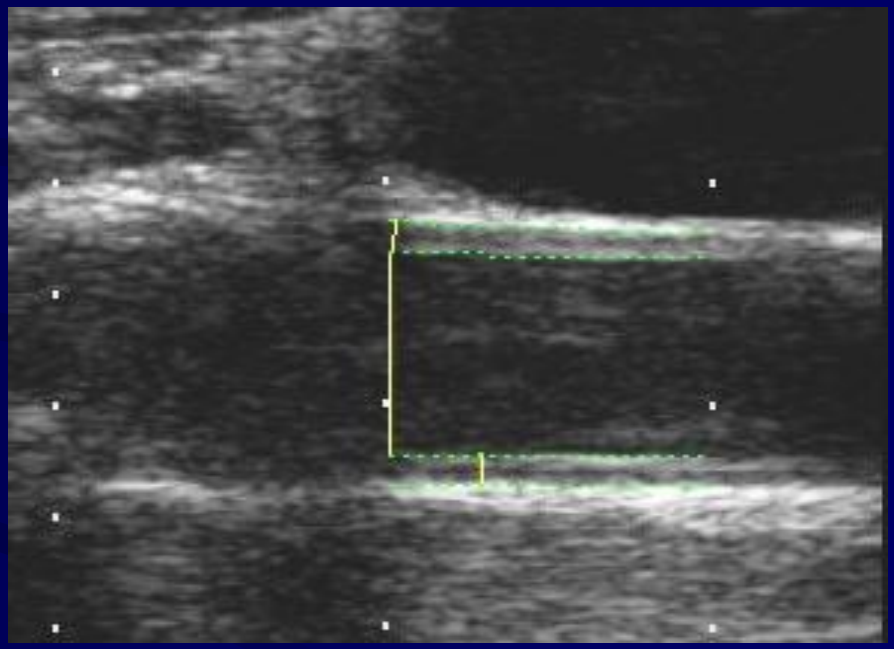


B-Mode Image Examples



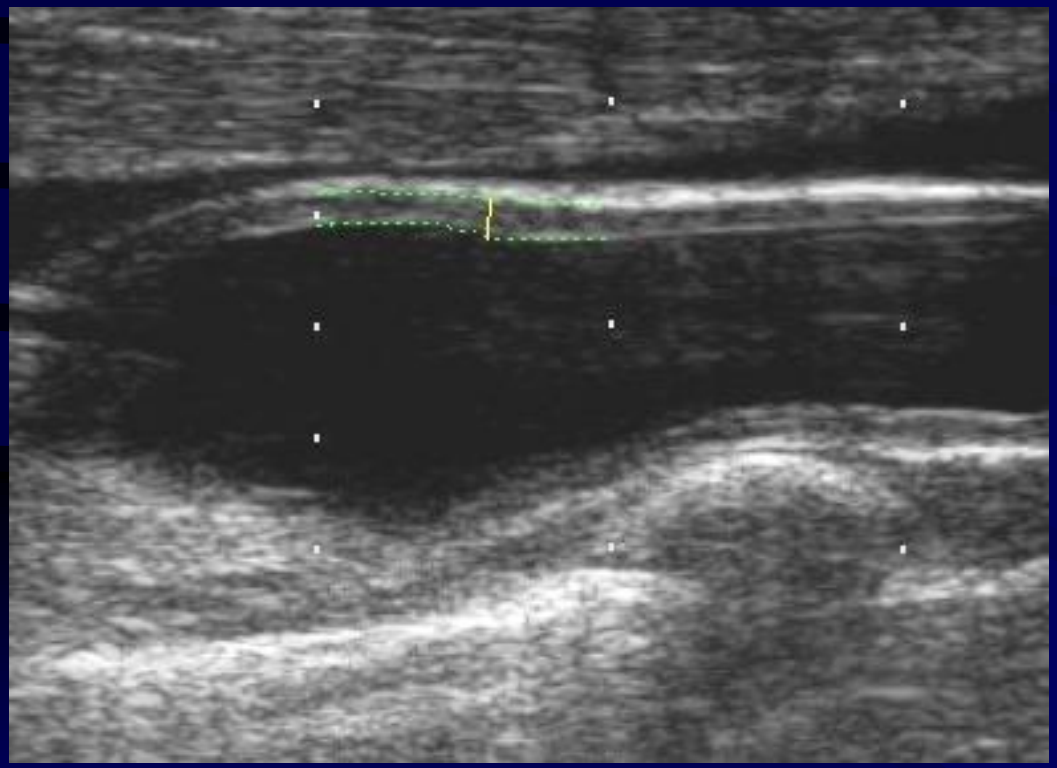
IMT Measurement by Automated Edge Detection IMT Software





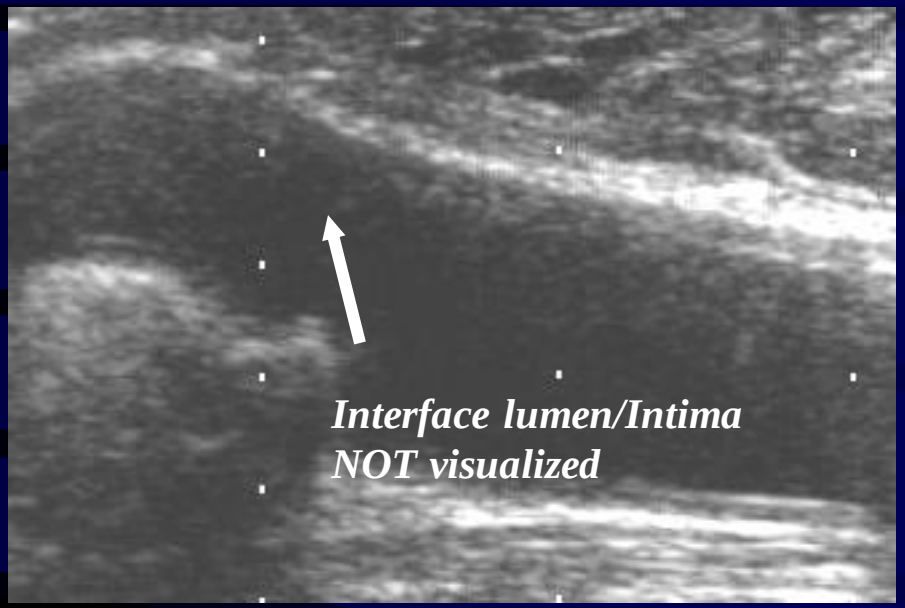
1. **Sharp interfaces.**
2. **Correct edge detection.**
3. **Valid IMT measurement.**

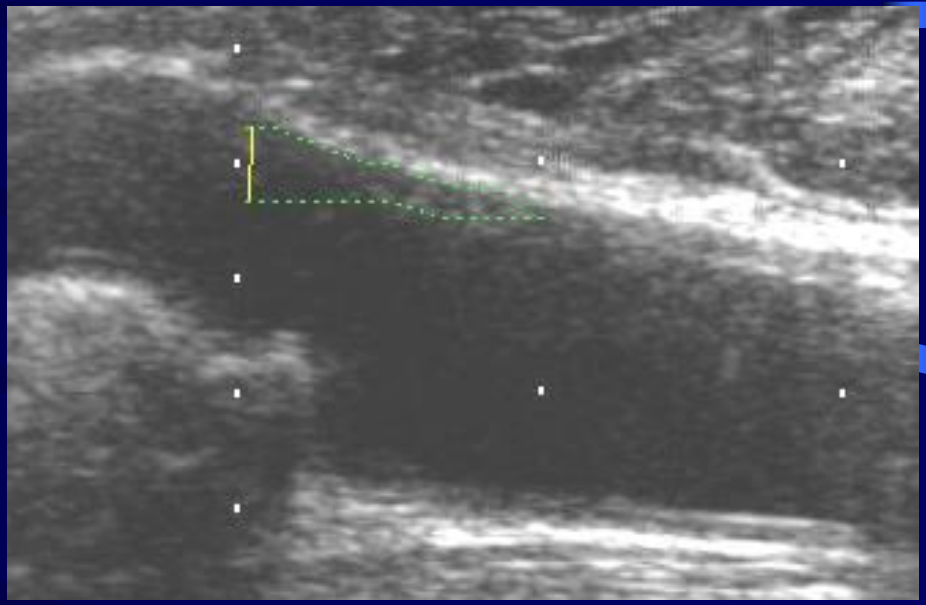
IMT Measurement by Automated Edge Detection IMT Software (Cont')



- **Sharp interfaces**
- **Artifact not present**
- **Correct edge detection**
- **Perpendicular to wall**
- **Valid IMT measurement**

IMT Measurement by Automated Edge Detection IMT Software (Cont')





1. **False edge detection.**
2. **Measurement line oblique to wall.**
3. **Invalid IMT measurement!**

Operator editing is required for a valid IMT measurement!

Clinical Value of Carotid IMT (Cont')

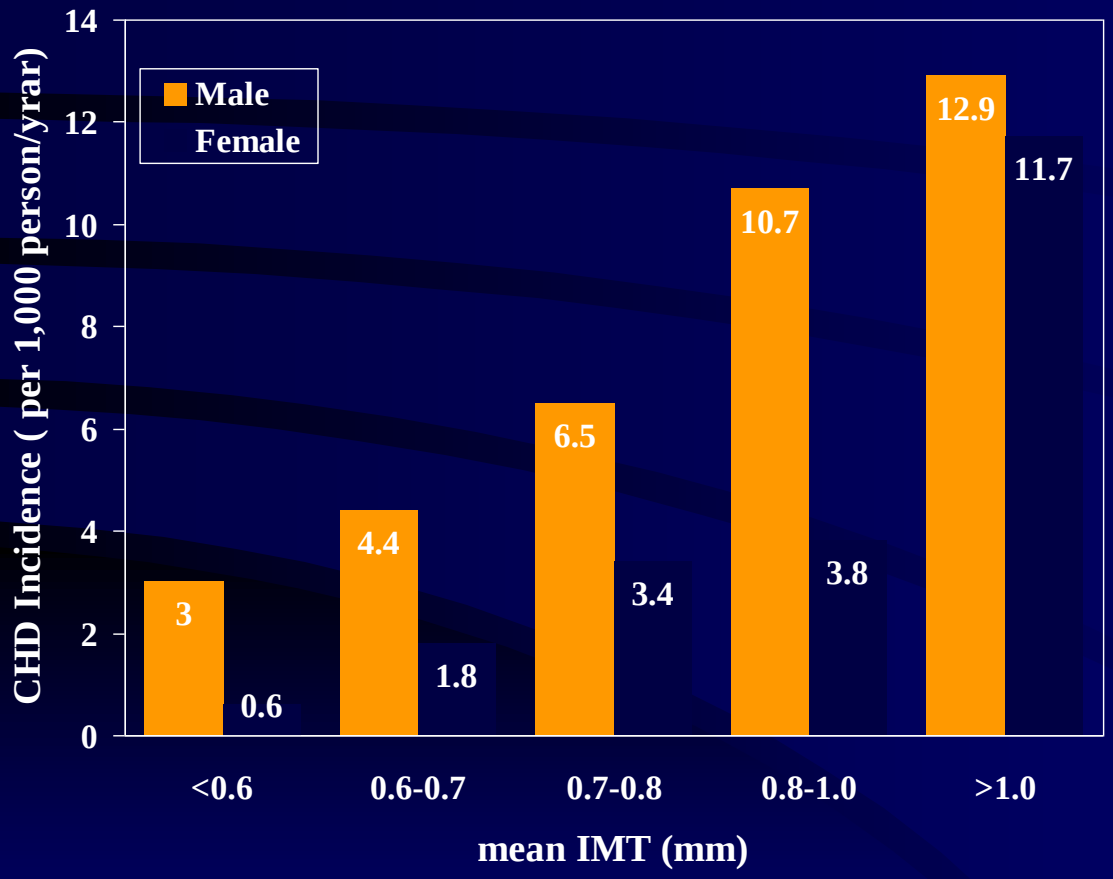
- **Carotid IMT is an independent predictor of cardiovascular events in general populations after adjustment for traditional risk factors**

- **Observational studies have found that for an absolute carotid IMT difference of 0.1 mm, the future risk of MI increases by 10% to 15%, and the stroke risk increases by 13% to 18%**

Adapted from Lorenz MW, et al. Circulation 2007;115

Absolute IMT and Risk of CHD

Atherosclerosis Risk in Communities (ARIC)

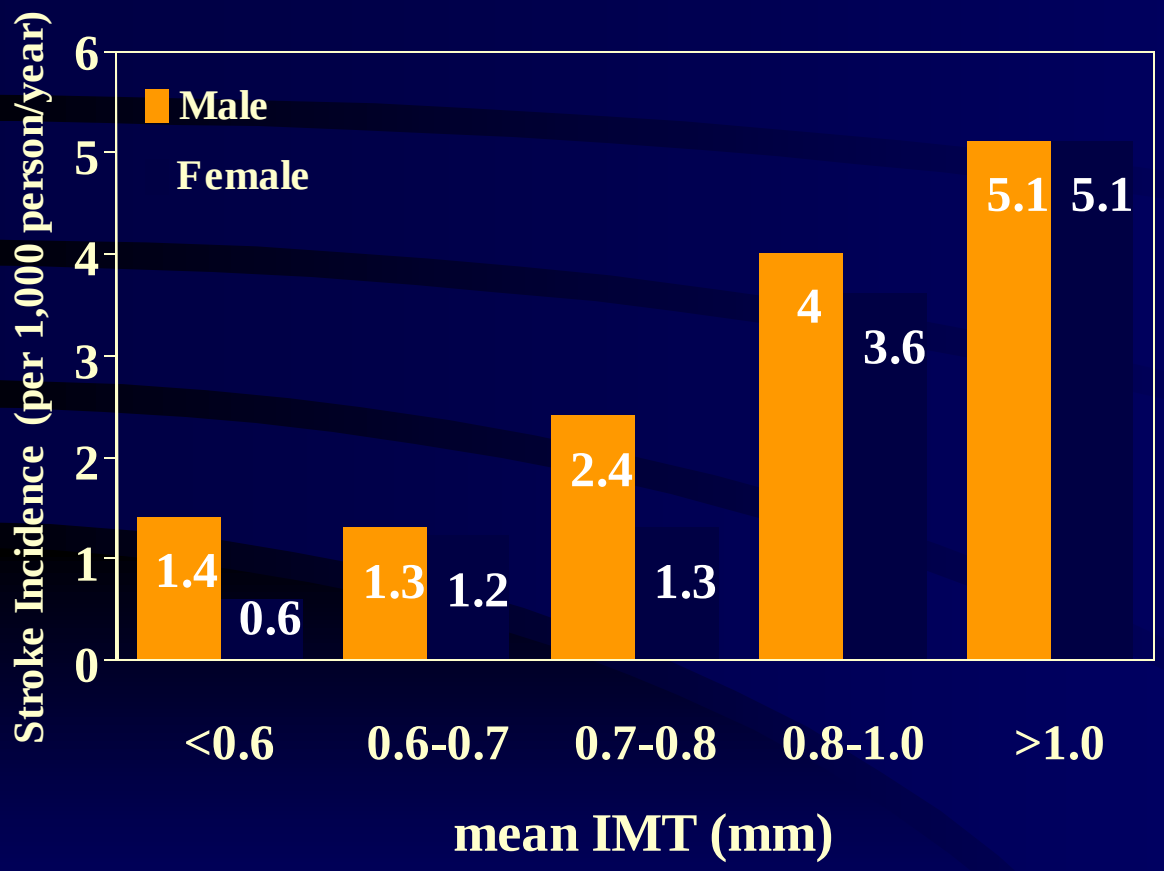


- **N=12,841**
- **Age: 45~64 years**
- **'Healthy', No CVD symptom**
- **Follow-up: 4~7 years**
- **Adjusted for age, center and race**

Adapted from Chambless LE et al. Am J Epidemiol 1997;146

Absolute IMT and Risk of Stroke

Atherosclerosis Risk in Communities (ARIC)

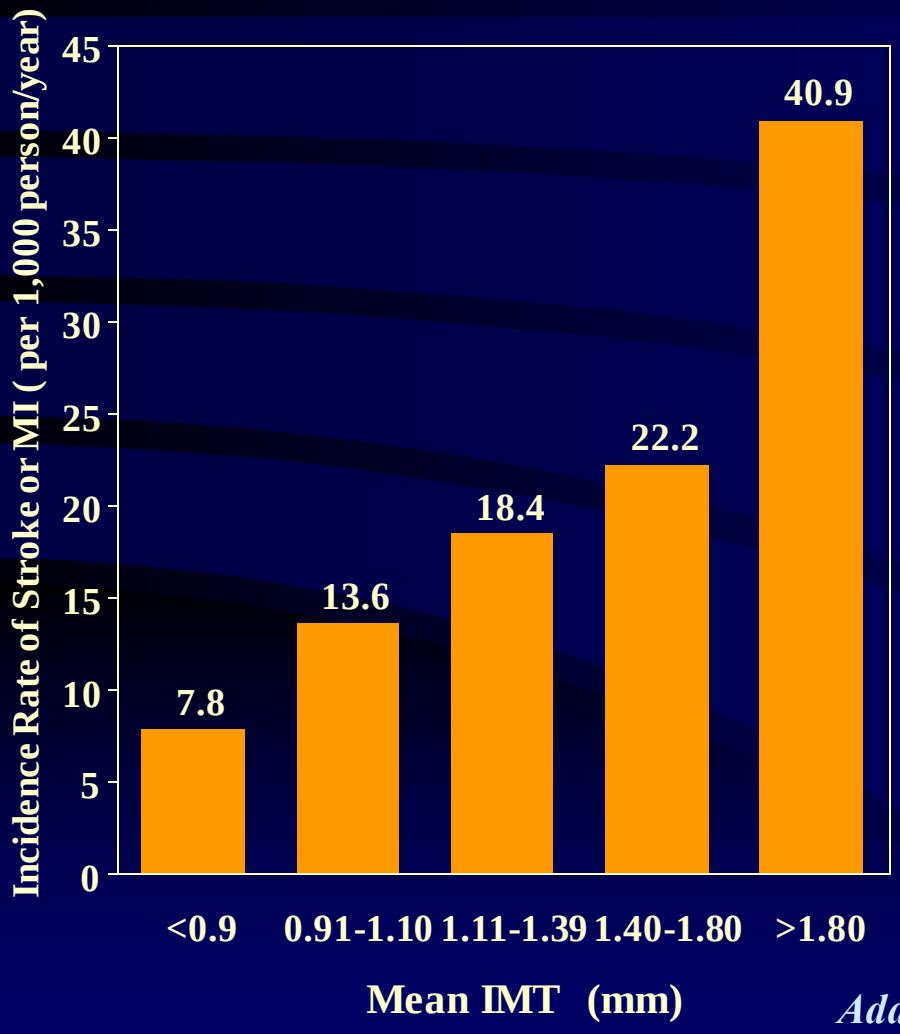


- N=14,214
- Age: 45~64 years
- 'Healthy' without CVD symptom
- Followed-up: 6~9 years
- Adjusted for age, center and race

Adapted from Chambless LE et al. Am J Epidemiol 1997;146

Absolute IMT and Risk of Stroke or MI

Cardiovascular Health Study (CHS)

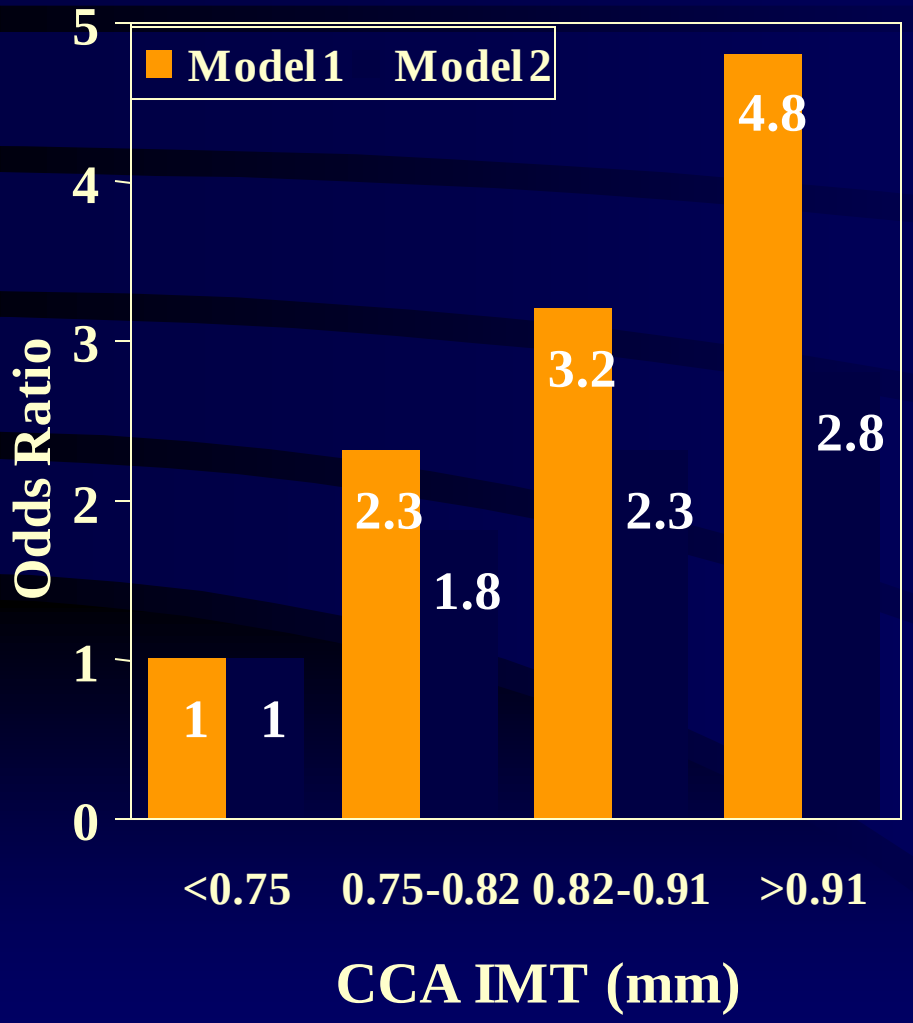


- **N=4,476**
- **Age: ≥65 years**
- **'Healthy', No CVD symptom**
- **Follow-Up: 7 years**
- **After controlling for age/sex, the odds ratio of MI or stroke was 4.5 for the highest IMT quintile as compared to the lowest quintile**
- **The possibility of stroke or MI incidence was 4% for the lowest IMT quintile, 26% for the highest quintile**
- **Compared to other risk factors, IMT was the strongest predictor of stroke or MI**

Adapted from O'Leary DH, et al. N Engl J Med 1999;340

Absolute IMT and Risk for Stroke (Cont')

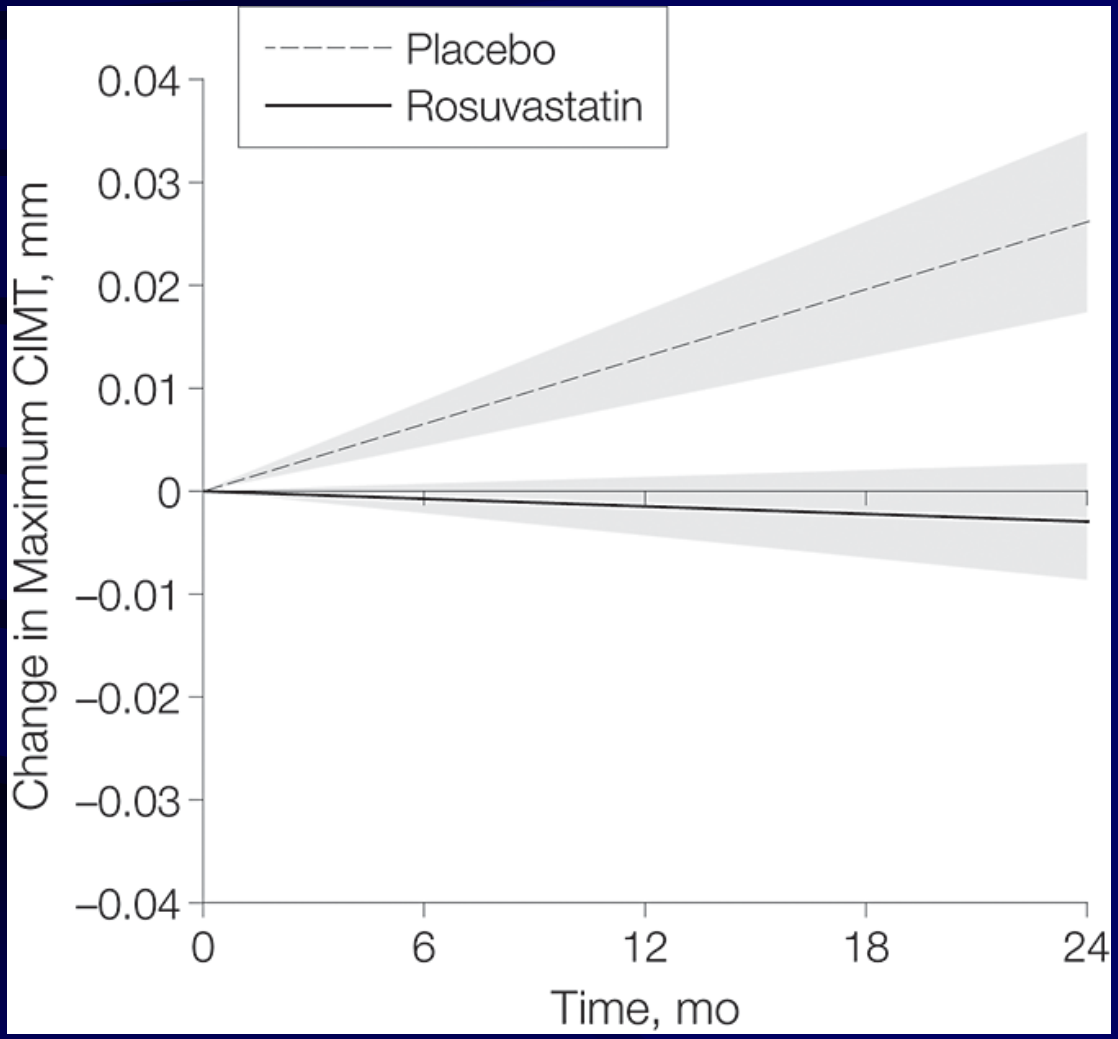
The Rotterdam Study



- **N=1,683**
- **Age ≥ 55 years**
- **Model 1- adjusted for age/sex**
- **Model 2- adjusted for age/sex, stroke history, BMI, smoke, SBP, TPC, HDL-C, DM**
- **With every 0.15 mm increase in Baseline IMT, the 10 year absolute risk for stroke increased by 4.1%**

Adapted from Bots et al. Circulation 1997; 96

Change in Maximum Carotid Intima-Media Thickness (CIMT) for the Primary End Point



Crouse, J. R. et al. JAMA 2007;297:1344-1353.

JAMA

Carotid IMT

- Precise, computer assisted measurements of carotid wall thickness associated with risk factors
- IMT predicts risk
- Used as surrogate for atherosclerosis and clinical endpoints
- Translate to clinical realm
- Assess IMT given age, race, gender to predict CV risk

Ward A. Riley Ultrasound Center
CIMT Screening Exam Report

Max CIMT: 4.401
Report Generated at 12:03 on 11JAN12

Table 1. Far Wall IMT Measurements

	Far Wall IMT		Far Wall Percentile[1]	
Arterial Site	Observed	80% Prediction Interval[2]	Observed	80% Prediction Interval[2]
Left Bifurcation	0.98 mm	(0.76,1.2)	92 %	(75,99)
Left Common	1.06 mm	(0.84,1.27)	99 %	(96,99)
Left Internal	0.69 mm	(0.52,0.86)	79 %	(41,92)
Right Bifurcation	2.04 mm	(1.36,2.71)	99 %	(98,99)
Right Common	0.84 mm	(0.73,0.95)	99 %	(89,99)
Right Internal	0.87 mm	(0.64,1.1)	87 %	(67,93)
Average	1.08 mm		93 %	

[1] Percentiles:

Percentiles are based on individuals of similar age, gender and ethnicity from the Atherosclerosis Risk in Communities (ARIC) Study (ref: Stroke 1993:24:1297-1304). Percentiles greater than 50 are associated with thicker IMT and greater risk. Percentiles less than 50 imply thinner IMT and lower risk.

[2] Prediction Intervals:

Prediction Intervals describe uncertainty in IMT measurements. If a large number of repeat examinations were performed, we would expect 4 of every 5 new measurements to fall within the interval shown for each arterial site.

Risk Assessment:

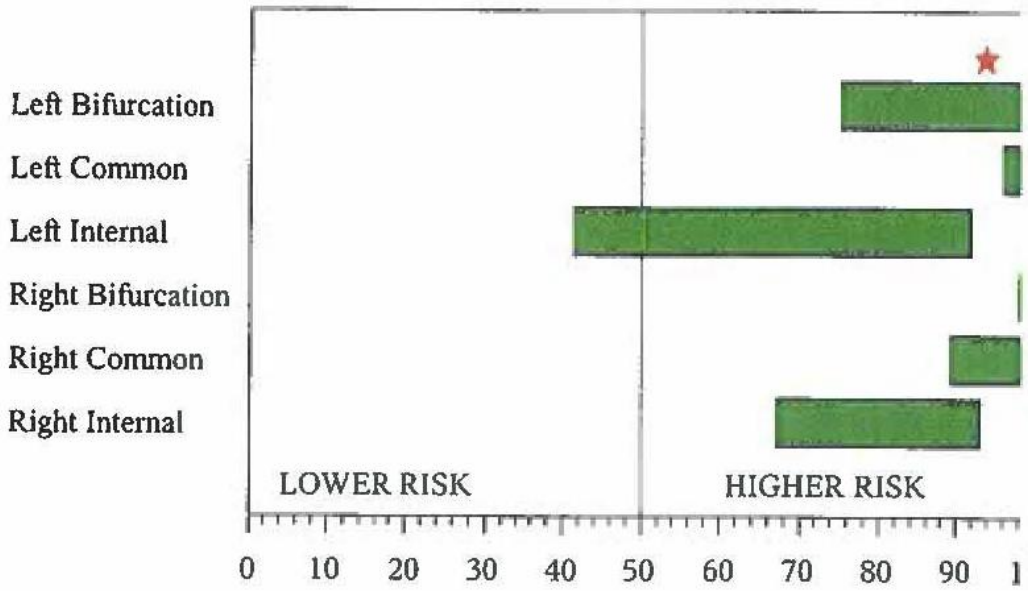
Your relative risk for CHD is 2.17, based on your average far wall percentile score and data from 4-7 years of follow-up in the ARIC Study (Am J Epi 1997:146:483-494). A relative risk of 2.17 means that you are 117% more likely to develop heart disease than other people of similar age, gender and ethnicity

Presence of plaque ≥ 2 mm suggests increased cardiovascular risk independent of IMT results

Plaque ≥ 2 mm identified?

☐ No ☒ Yes (see comment below)

Figure 1. Percentile Intervals (Star = Average Percentile)



Physician Notes:

Large plaque was seen in the right BIF/ICA region (4.4 mm, far wall). No hemodynamically important stenosis was seen.

I have personally reviewed the CIMT results and agree with the interpretation.

Reviewing Physician: C Tegeler MD **Date:** 1/11/12

Charles H. Tegeler, M.D.

Ward A. Riley Ultrasound Center
CIMT Screening Exam Report

Max CIMT: 1.323
Report Generated at 11:28 on 03FEB12

Table 1. Far Wall IMT Measurements

	Far Wall IMT		Far Wall Percentile[1]	
Arterial Site	Observed	80% Prediction Interval[2]	Observed	80% Prediction Interval[2]
Left Bifurcation	0.71 mm	(0.56,0.87)	51 %	(21,76)
Left Common	0.53 mm	(0.45,0.6)	26 %	(8,49)
Left Internal	0.6 mm	(0.45,0.74)	57 %	(24,77)
Right Bifurcation	0.72 mm	(0.55,0.88)	49 %	(17,75)
Right Common	0.53 mm	(0.45,0.6)	25 %	(8,49)
Right Internal	0.5 mm	(0.37,0.63)	28 %	(6,53)
Average	0.6 mm		39 %	

[1] Percentiles:

Percentiles are based on individuals of similar age, gender and ethnicity from the Atherosclerosis Risk in Communities (ARIC) Study (ref: Stroke 1993:24:1297-1304) Percentiles greater than 50 are associated with thicker IMT and greater risk. Percentiles less than 50 imply thinner IMT and lower risk.

[2] Prediction Intervals:

Prediction Intervals describe uncertainty in IMT measurements. If a large number of repeat examinations were performed, we would expect 4 of every 5 new measurements to fall within the interval shown for each arterial site.

Risk Assessment:

Your relative risk for CHD is 0.86, based on your average far wall percentile score and data from 4-7 years of follow-up in the ARIC Study (Am J Epi 1997:146:483-494). A relative risk of 0.86 means that you are 14% less likely to develop heart disease than other people of similar age, gender and ethnicity

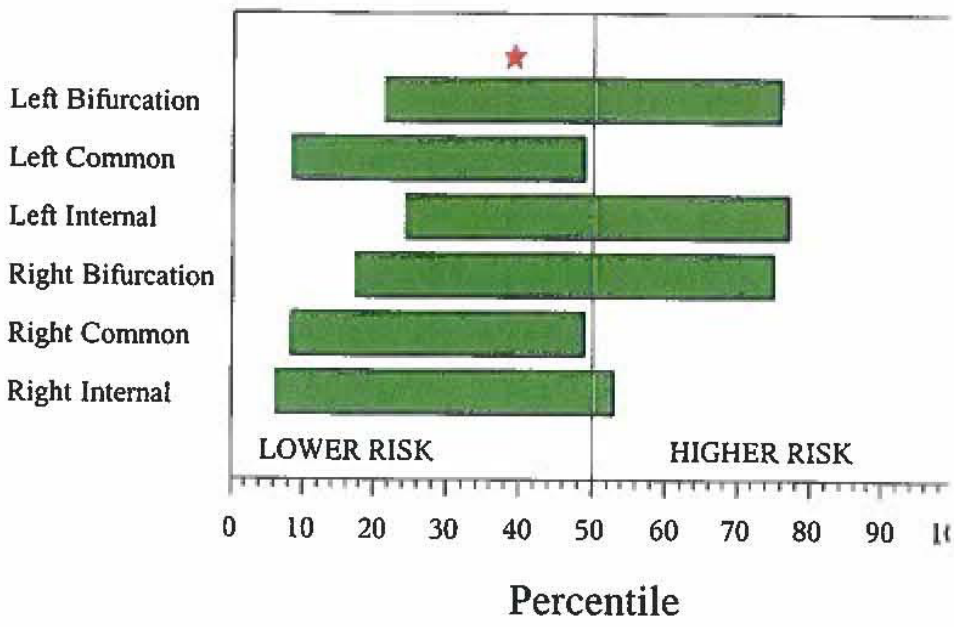
Presence of plaque ≥ 2 mm suggests increased cardiovascular risk independent of IMT results

Plaque ≥ 2 mm identified?

☒ No ☐ Yes (see comment below)

Physician Notes:

Figure 1. Percentile Intervals (Star = Average Percentile)



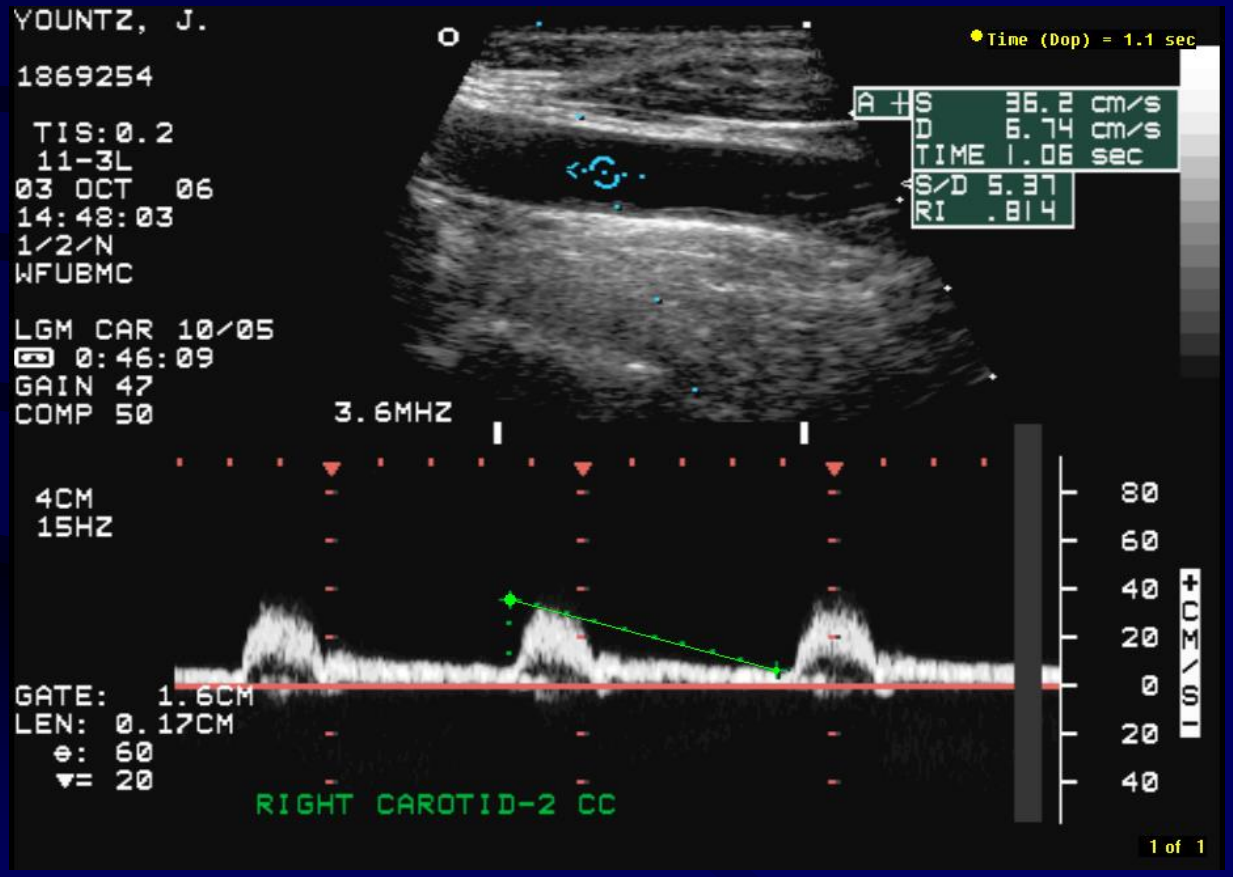
I have personally reviewed the CIMT results and agree with the interpretation.

Reviewing Physician: C Tegeler **Date:** 2/8/12

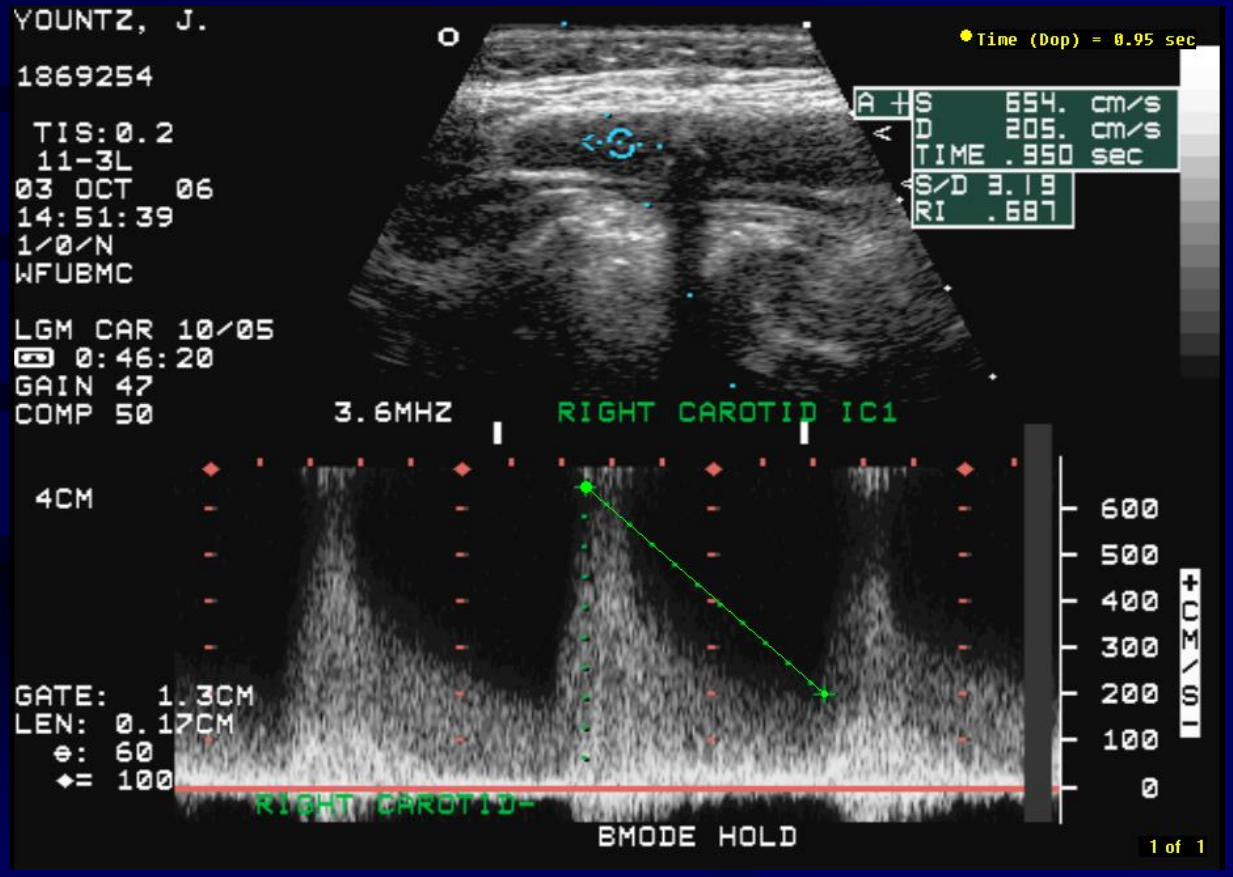
Charles H. Tegeler, M.D.

Principles in Practice

Indirect Changes
Right ICA String Sign

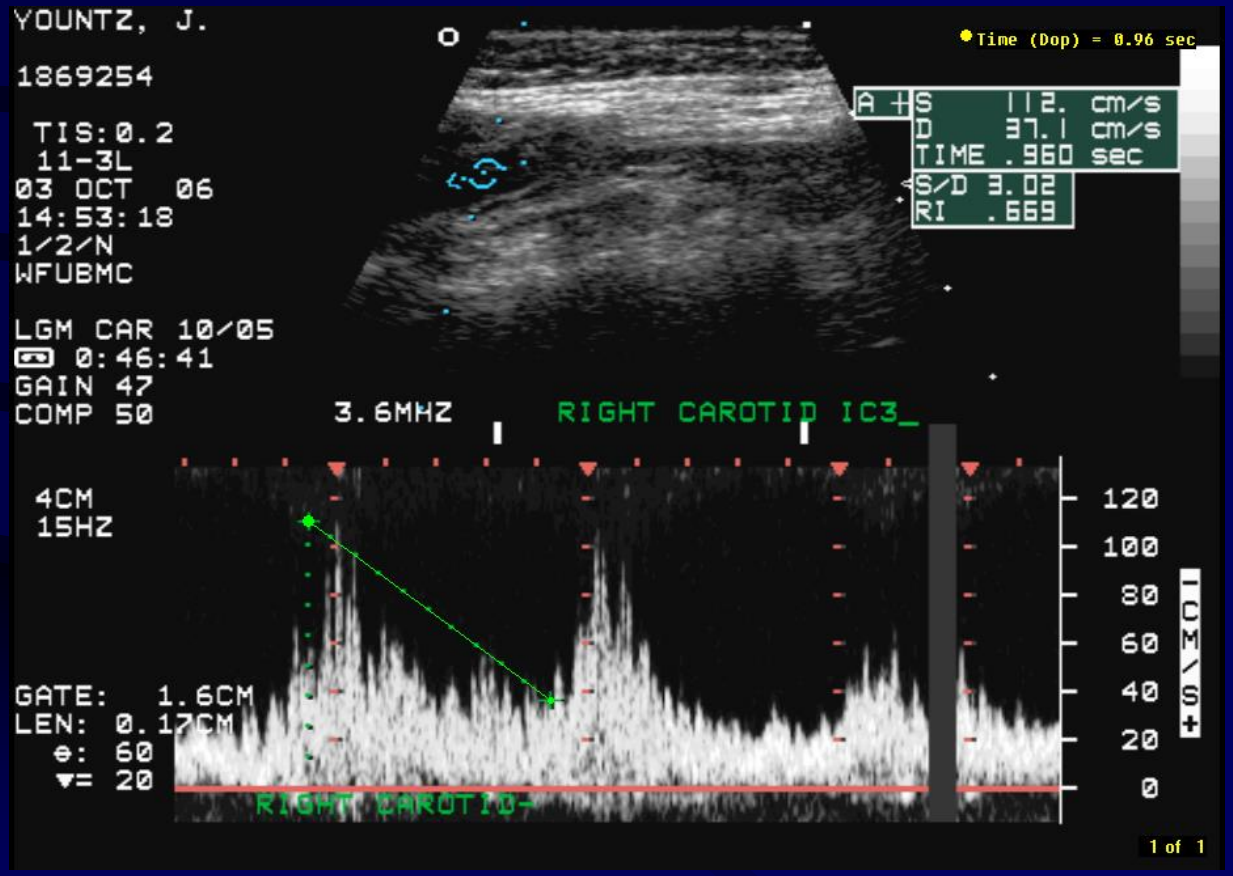


Right ICA String Sign



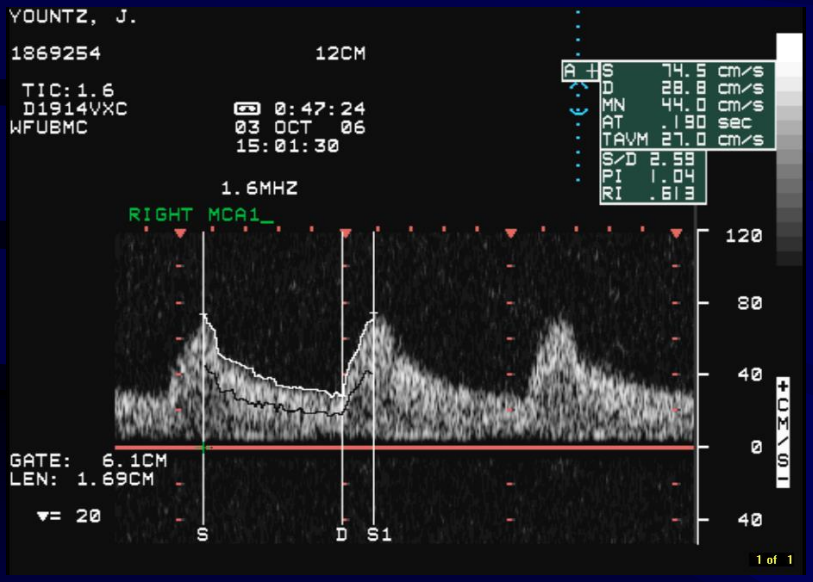
ICA String Sign

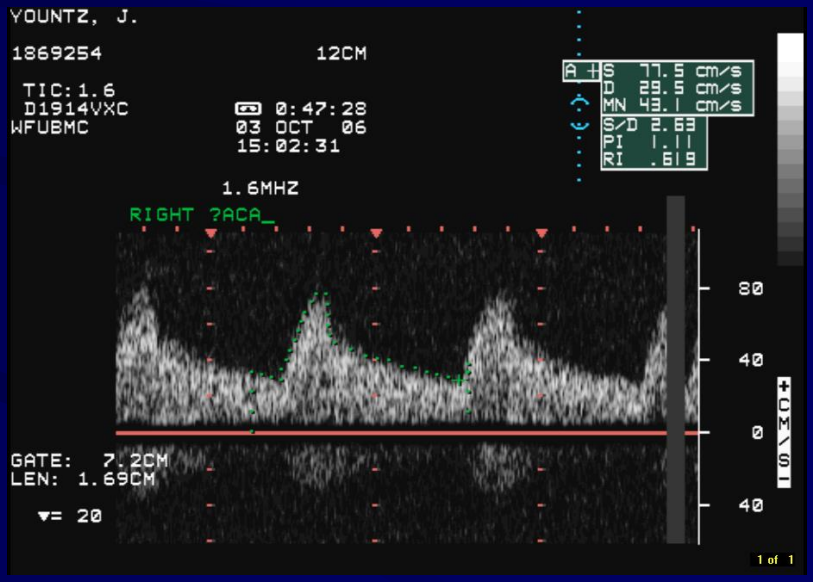
Distal/Post-Stenotic Turbulence



Right ICA String Sign

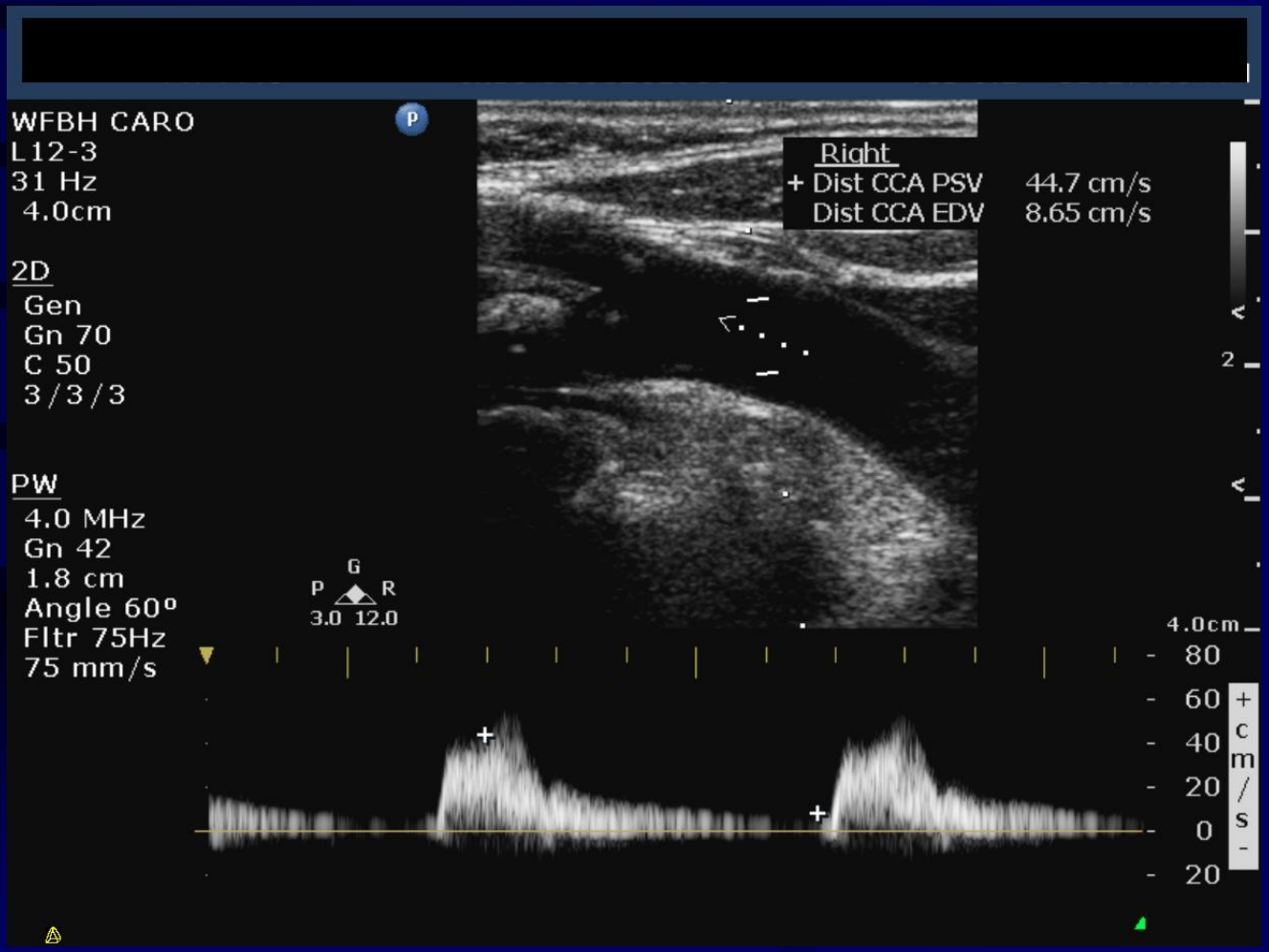
Intracranial Effects





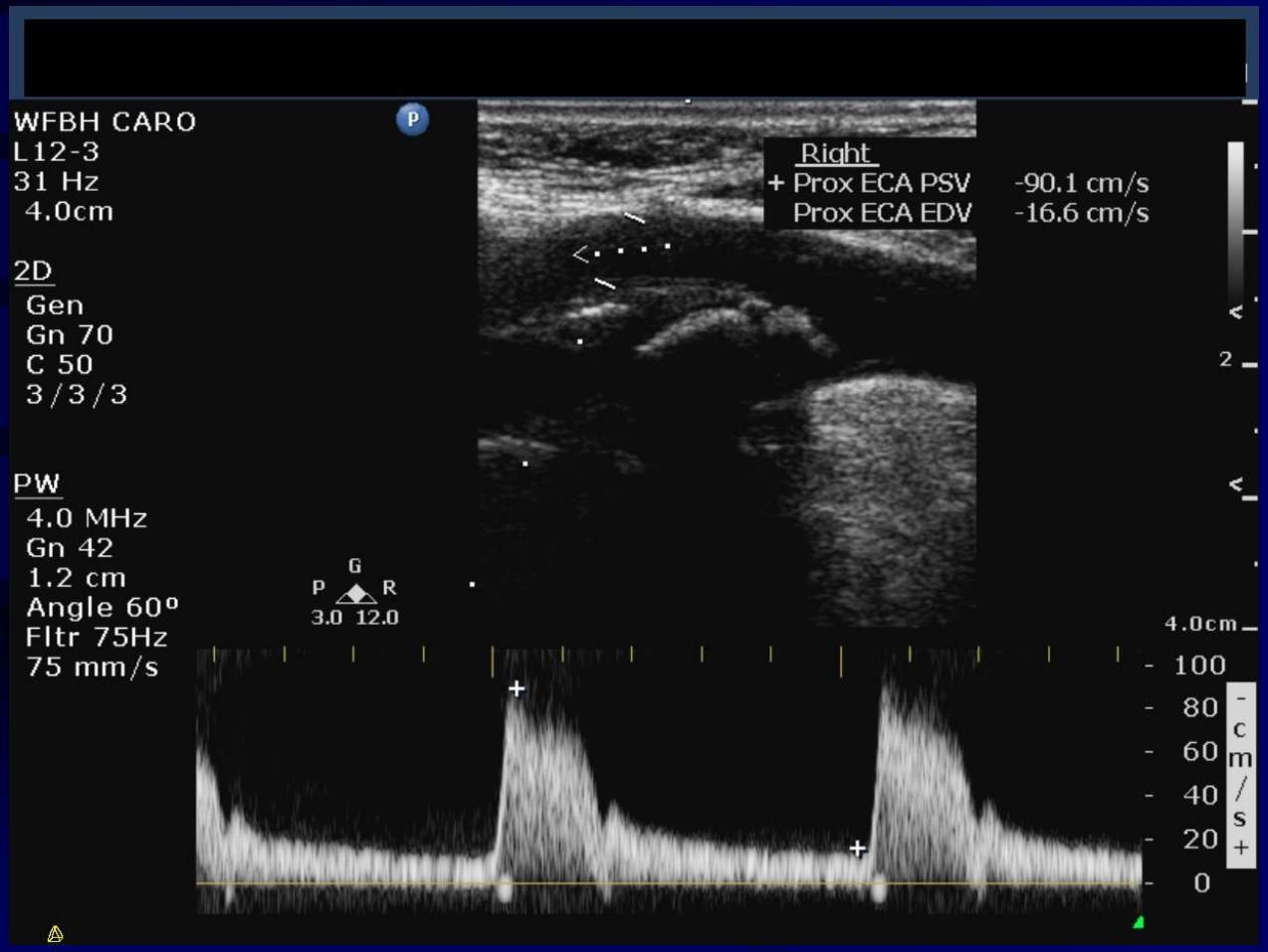
Right ICA Severe Stenosis Case

Resistive Signal in CCA



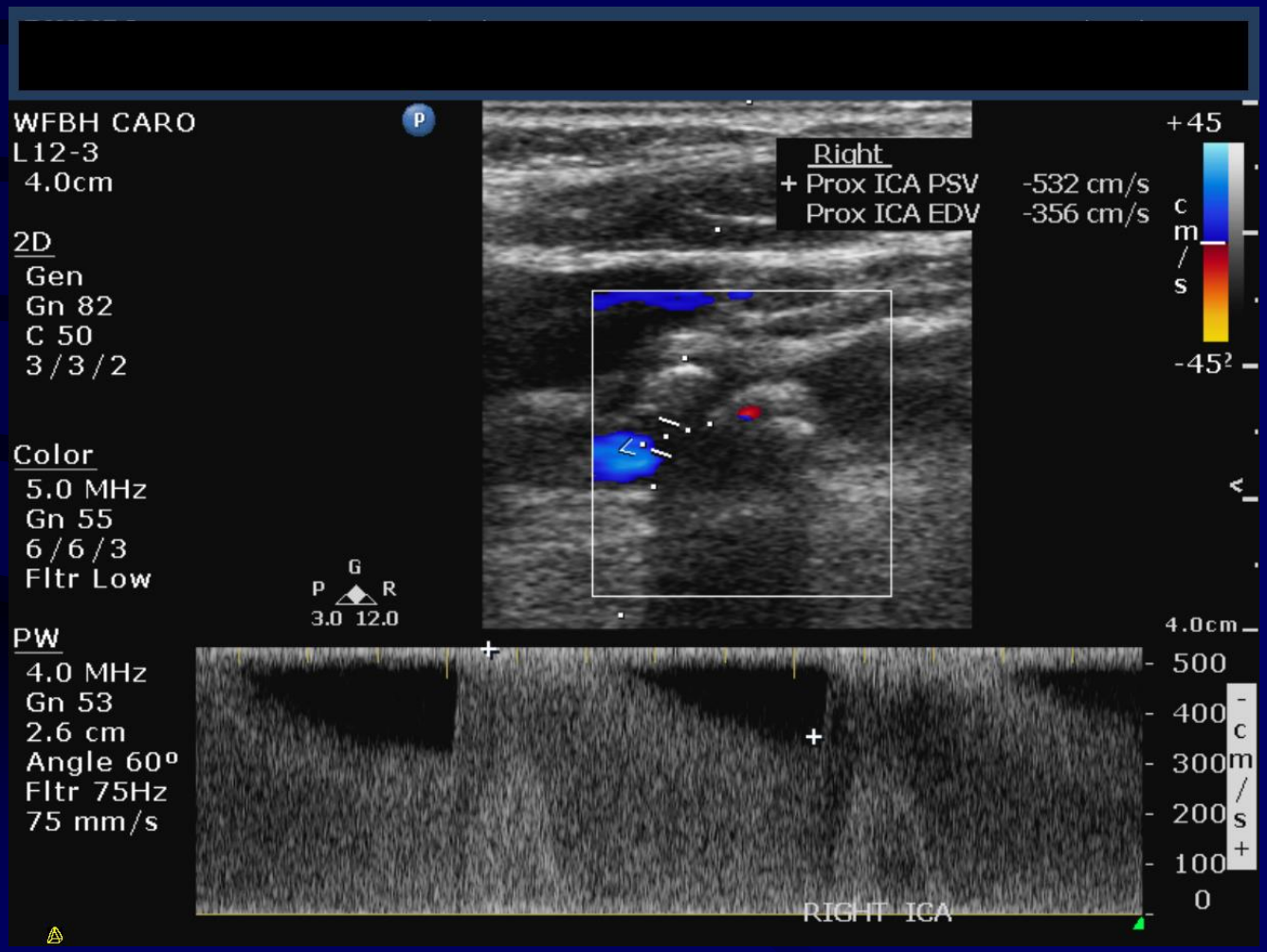
Right ICA Severe Stenosis

Increased Diastolic Velocity ECA



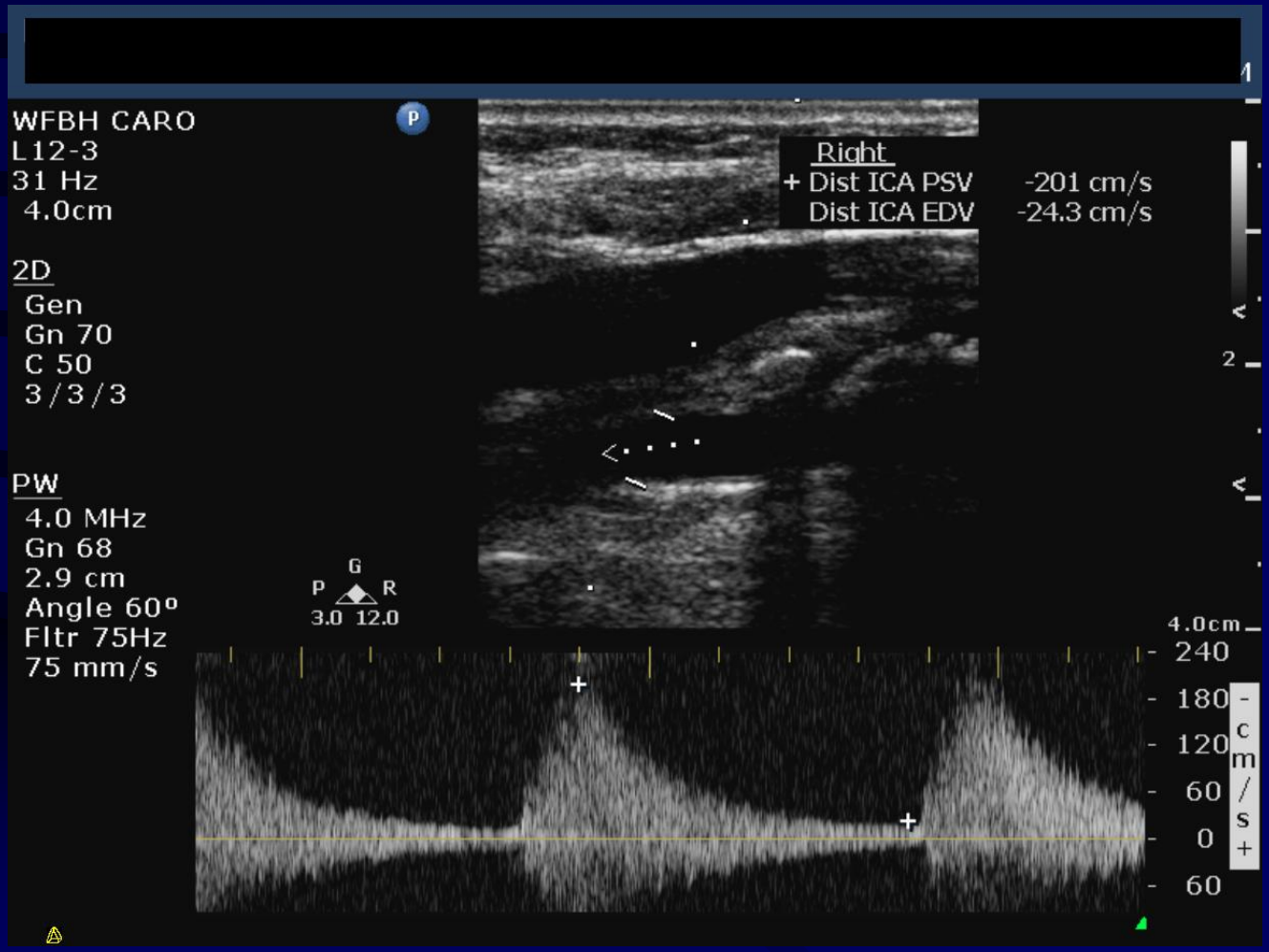
Right ICA Severe Stenosis

Aliasing with actual systolic velocity >800 cm/s



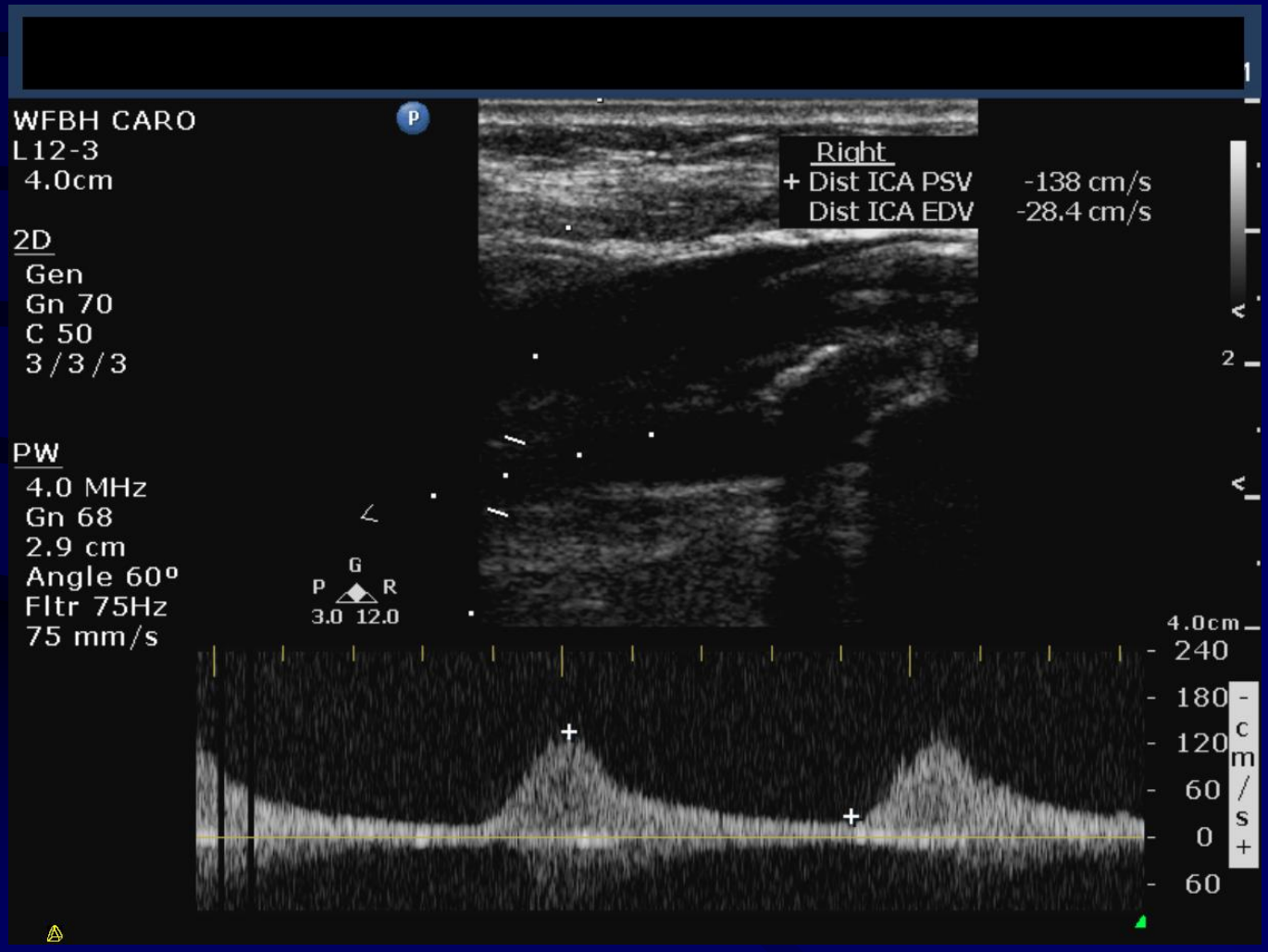
Right ICA Severe Stenosis

Post-Stenotic Turbulence



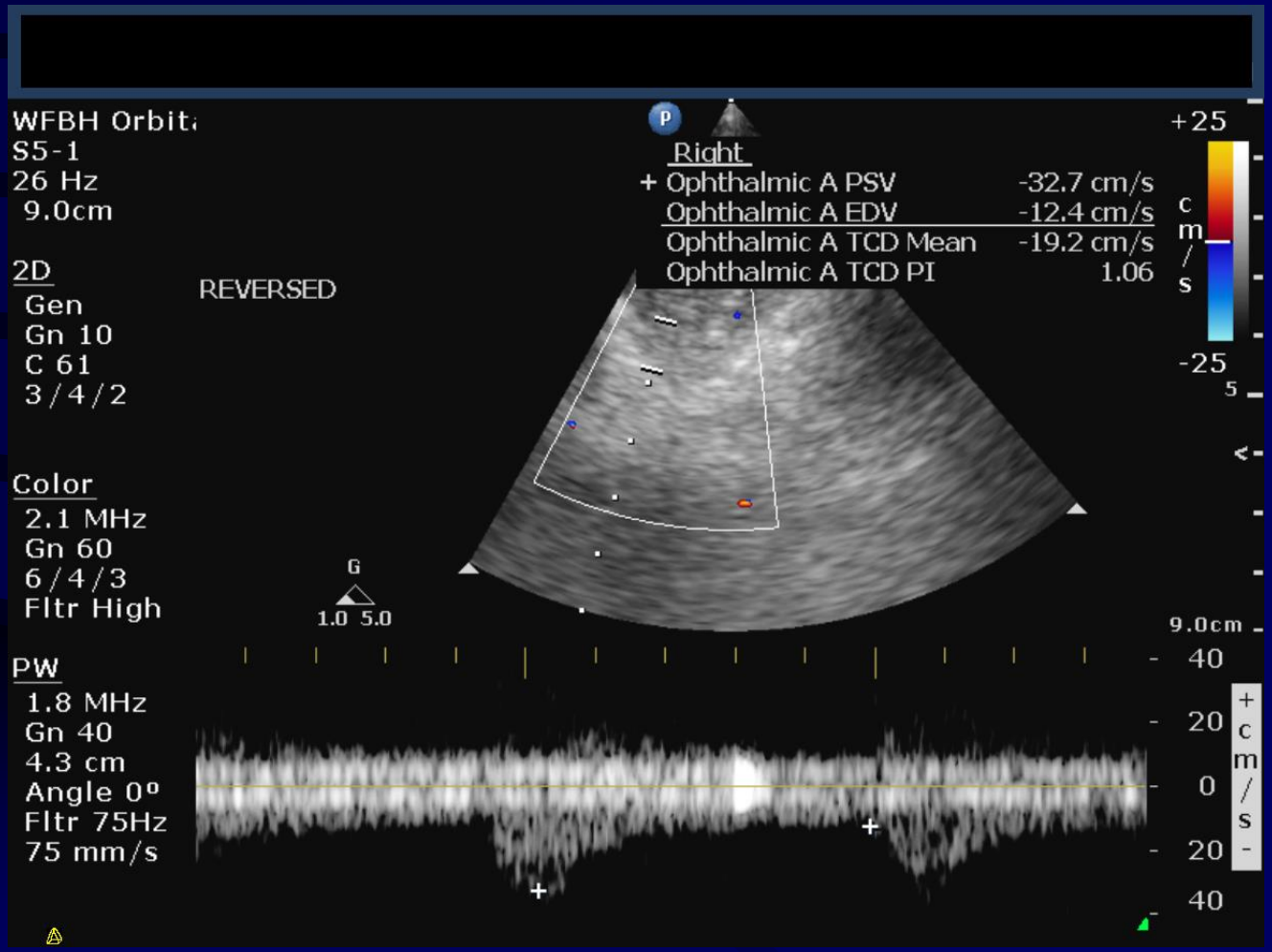
Right ICA Severe Stenosis

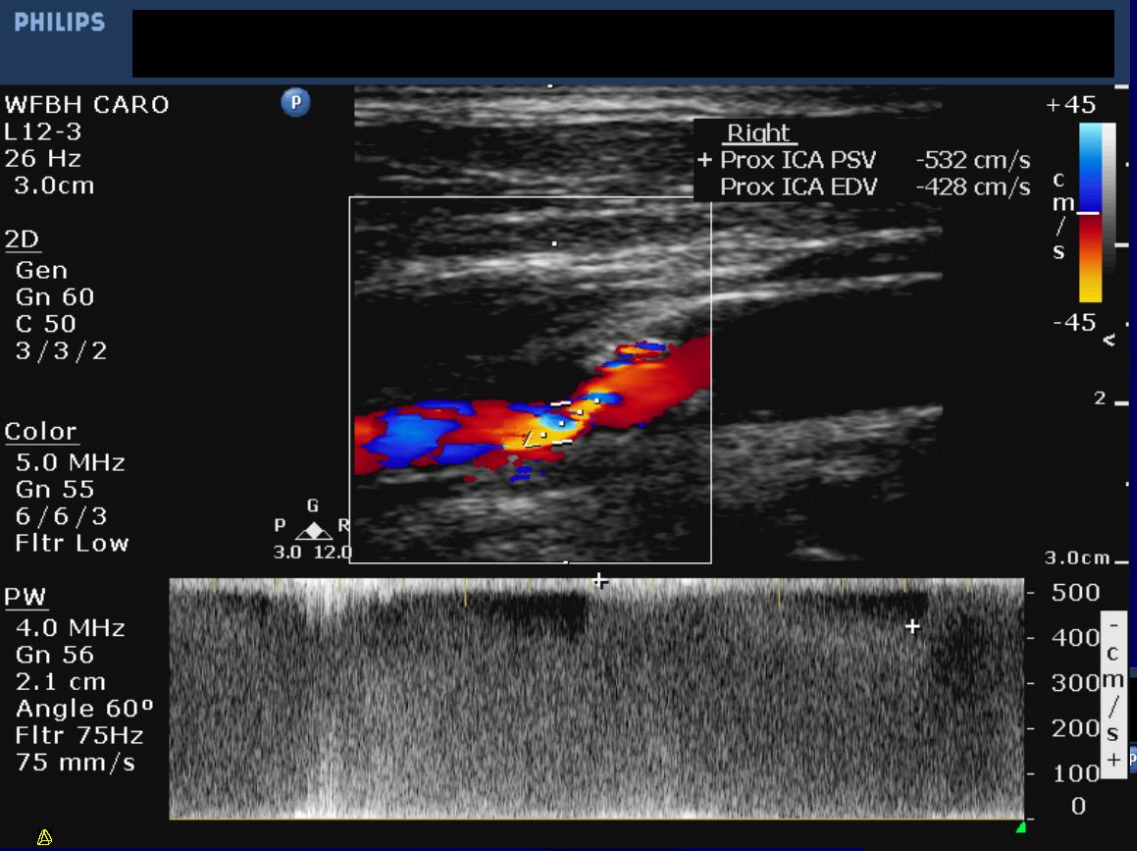
Decreased Acceleration Slope Distally



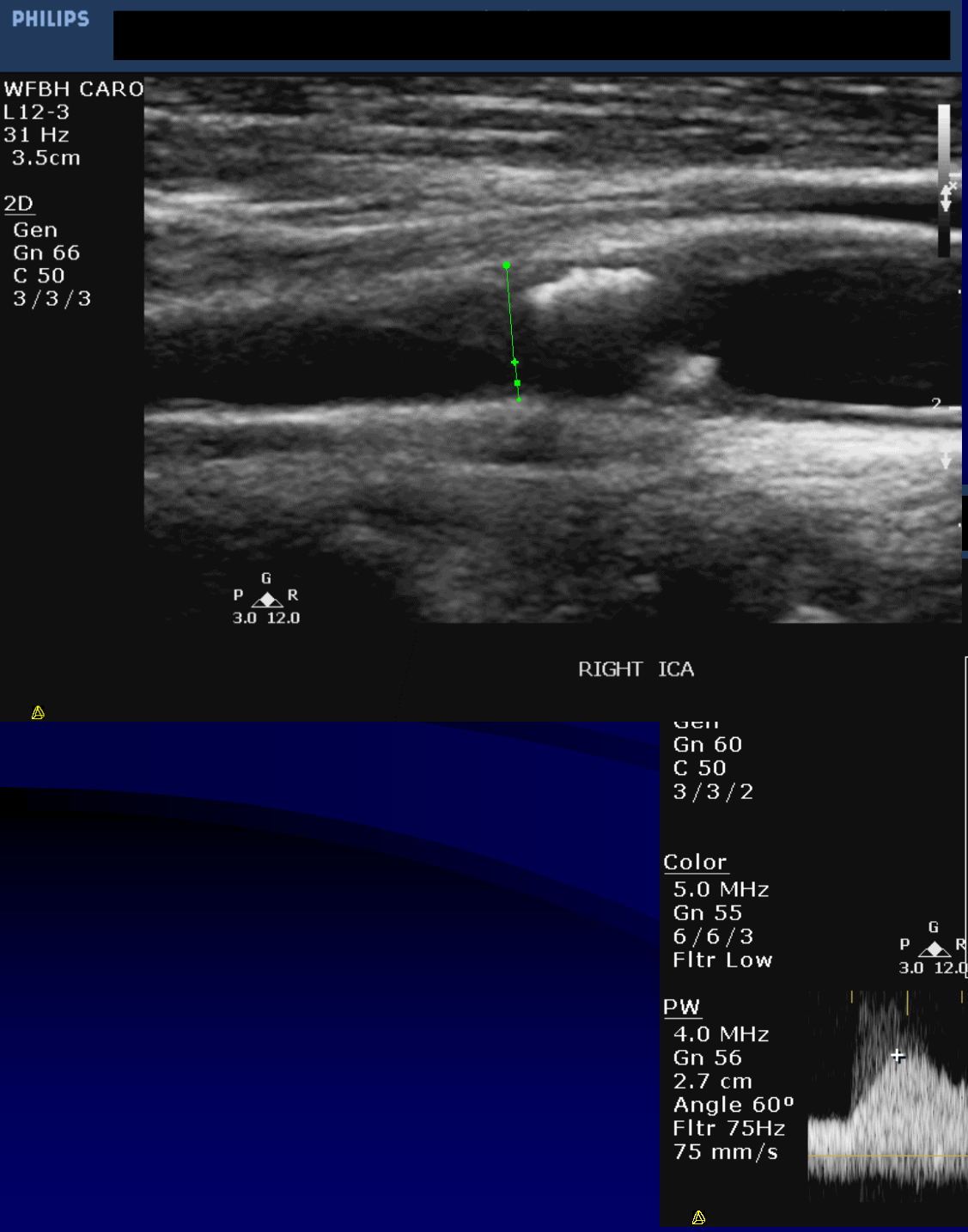
Right ICA Severe Stenosis

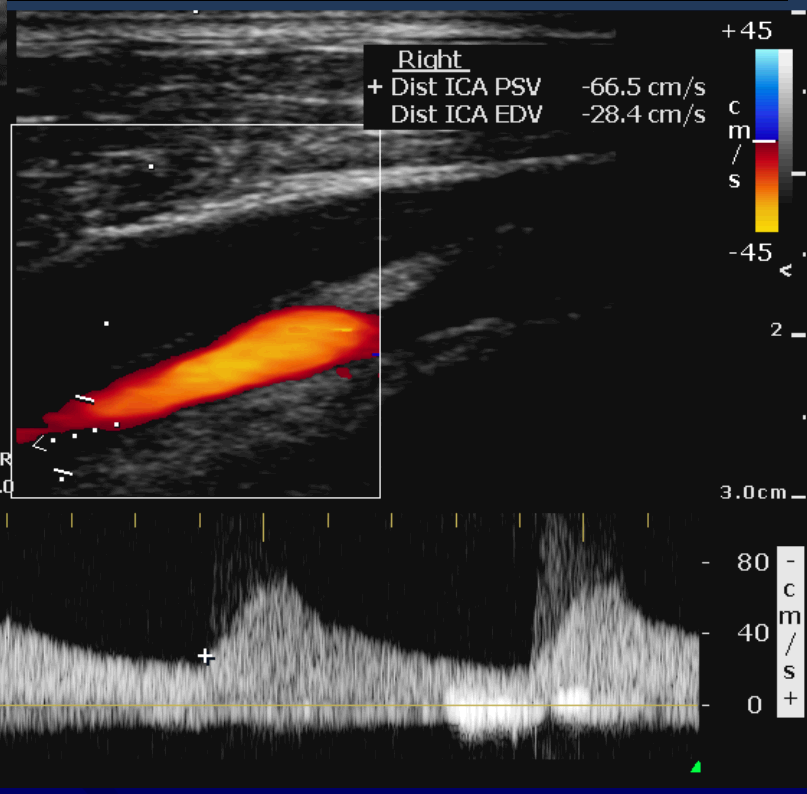
Reversed OA as Collateral Pathway

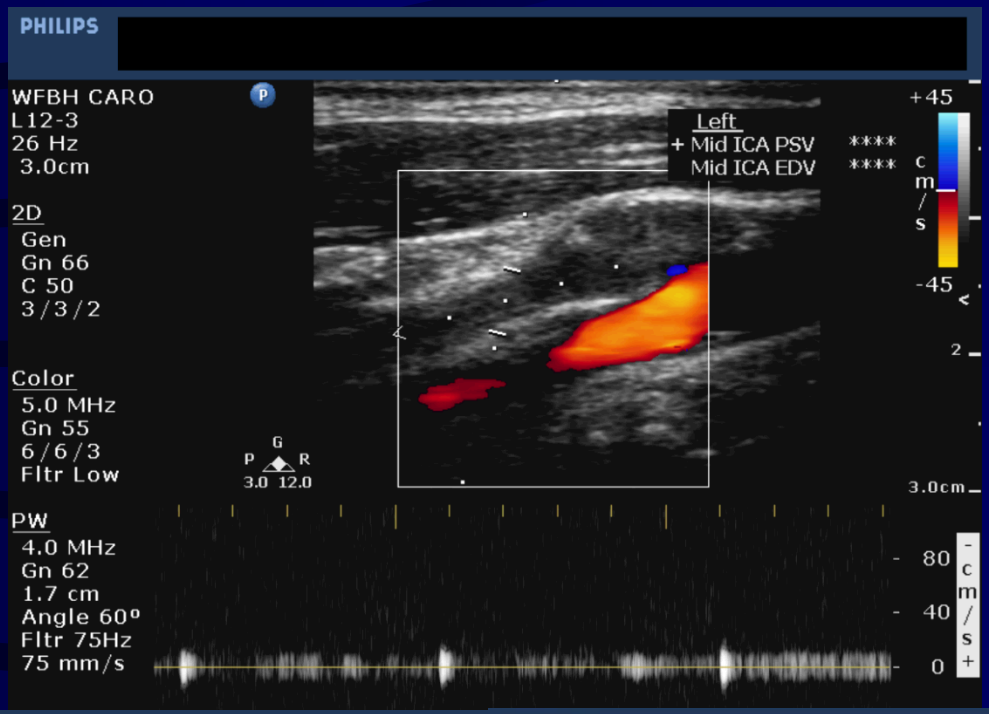


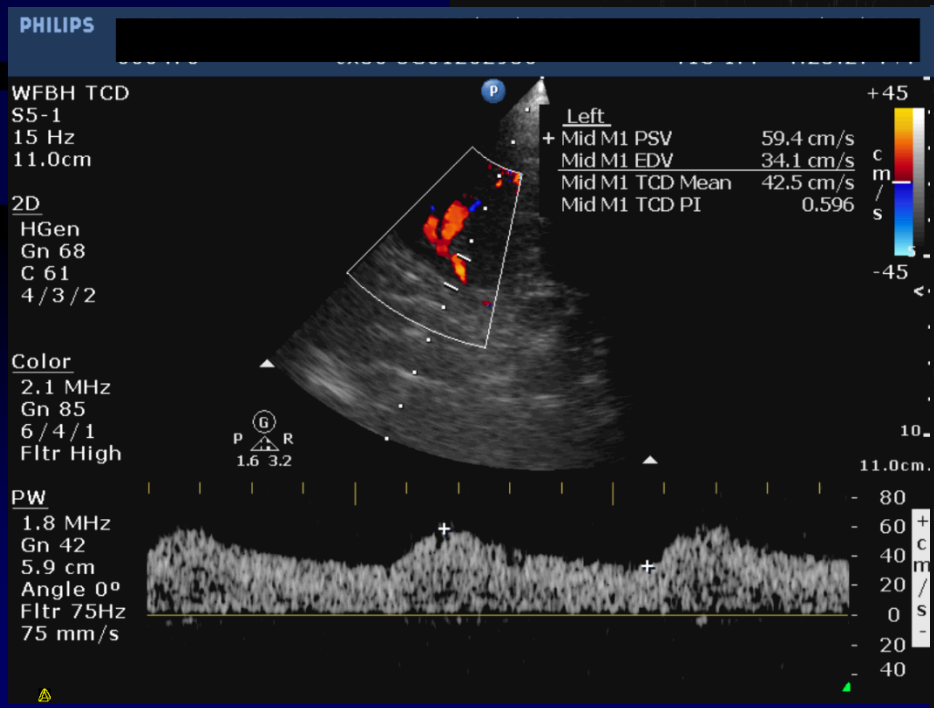

PHILIPS
WFBH CARO
L12-3
26 Hz
3.0cm
2D
Gen
Gn 60
C 50
3/3/2
Color
5.0 MHz
Gn 55
6/6/3
Fltr Low
PW
4.0 MHz
Gn 56
2.1 cm
Angle 60°
Fltr 75Hz
75 mm/s
Right
+ Prox ICA PSV -532 cm/s
Prox ICA EDV -428 cm/s
+45
cm/s
-45
2
3.0cm
500
400
300
200
100
0

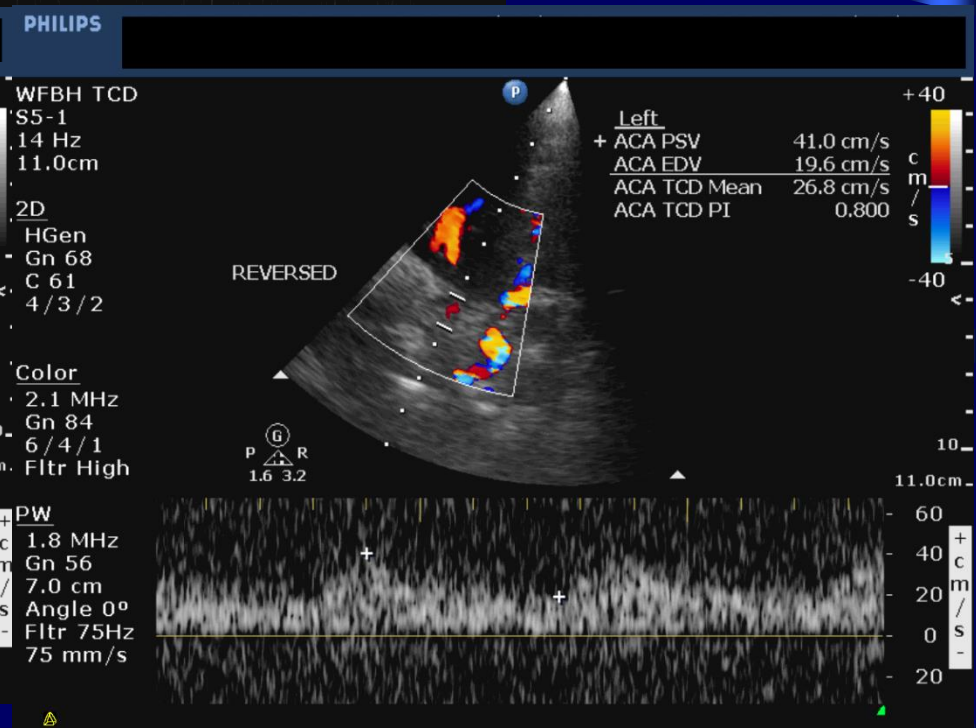
Right
+ Mid ICA PSV -125 cm/s
Mid ICA EDV -33.1 cm/s
+45
cm/s
-45
2
3.0cm
2D
Gen
Gn 60
C 50
3/3/2
Color
5.0 MHz
Gn 55
6/6/3
Fltr Low
PW
4.0 MHz
Gn 56
2.2 cm
Angle 60°
Fltr 75Hz
75 mm/s
120
60
0
60

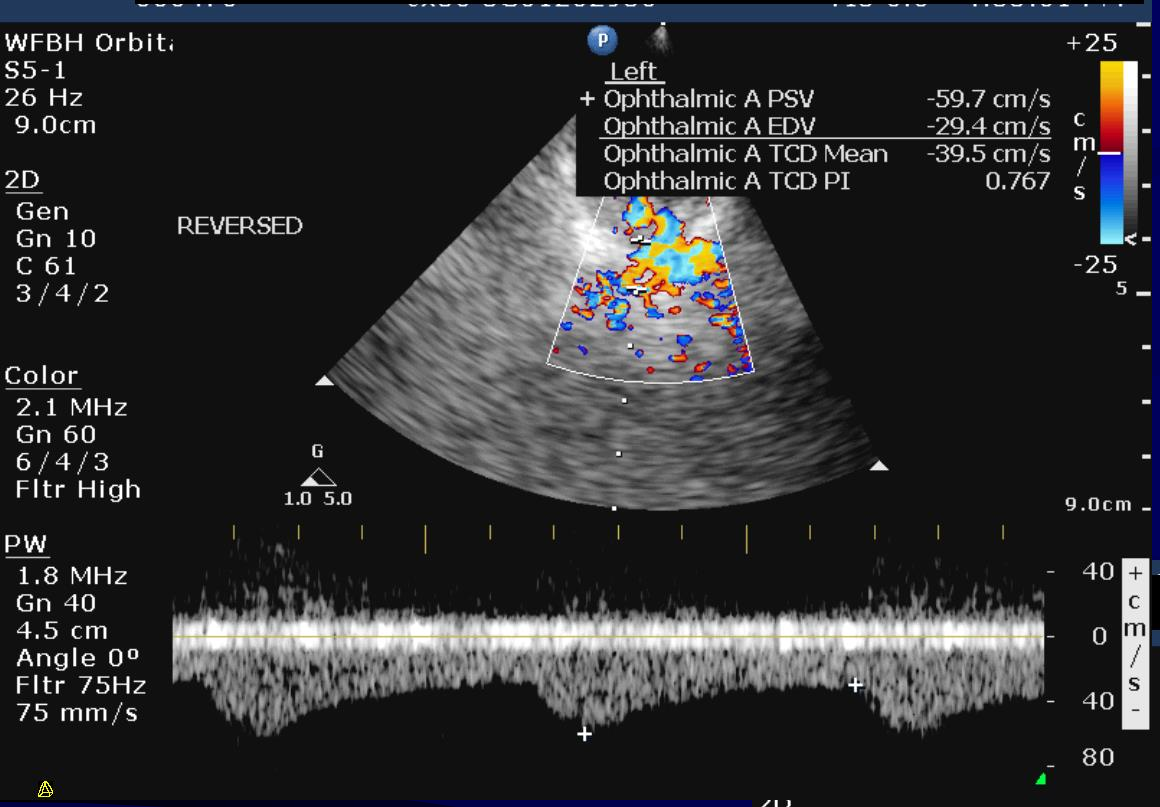

PHILIPS
WFBH CARO
L12-3
31 Hz
3.5cm
2D
Gen
Gn 66
C 50
3/3/3
G
P
R
3.0 12.0
RIGHT ICA
Gen
Gn 60
C 50
3/3/2
Color
5.0 MHz
Gn 55
6/6/3
Fltr Low
PW
4.0 MHz
Gn 56
2.7 cm
Angle 60°
Fltr 75Hz
75 mm/s

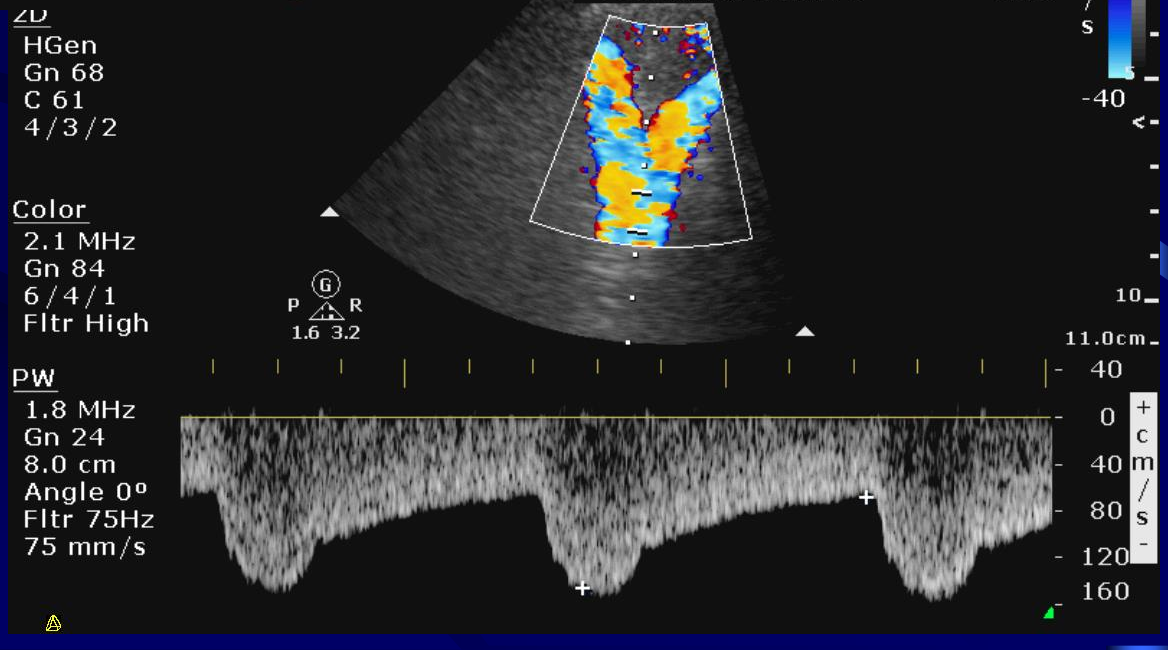

Right
+ Dist ICA PSV -66.5 cm/s
Dist ICA EDV -28.4 cm/s
+45
cm/s
-45
2
G
P
R
3.0 12.0
3.0cm
80
40
0
cm/s


PHILIPS
WFBH CARO
L12-3
26 Hz
3.0cm
2D
Gen
Gn 66
C 50
3/3/2
Color
5.0 MHz
Gn 55
6/6/3
Fltr Low
PW
4.0 MHz
Gn 62
1.7 cm
Angle 60°
Fltr 75Hz
75 mm/s
Left
+ Mid ICA PSV ****
Mid ICA EDV ****
+45
cm/s
-45
2
3.0cm
80
40
0

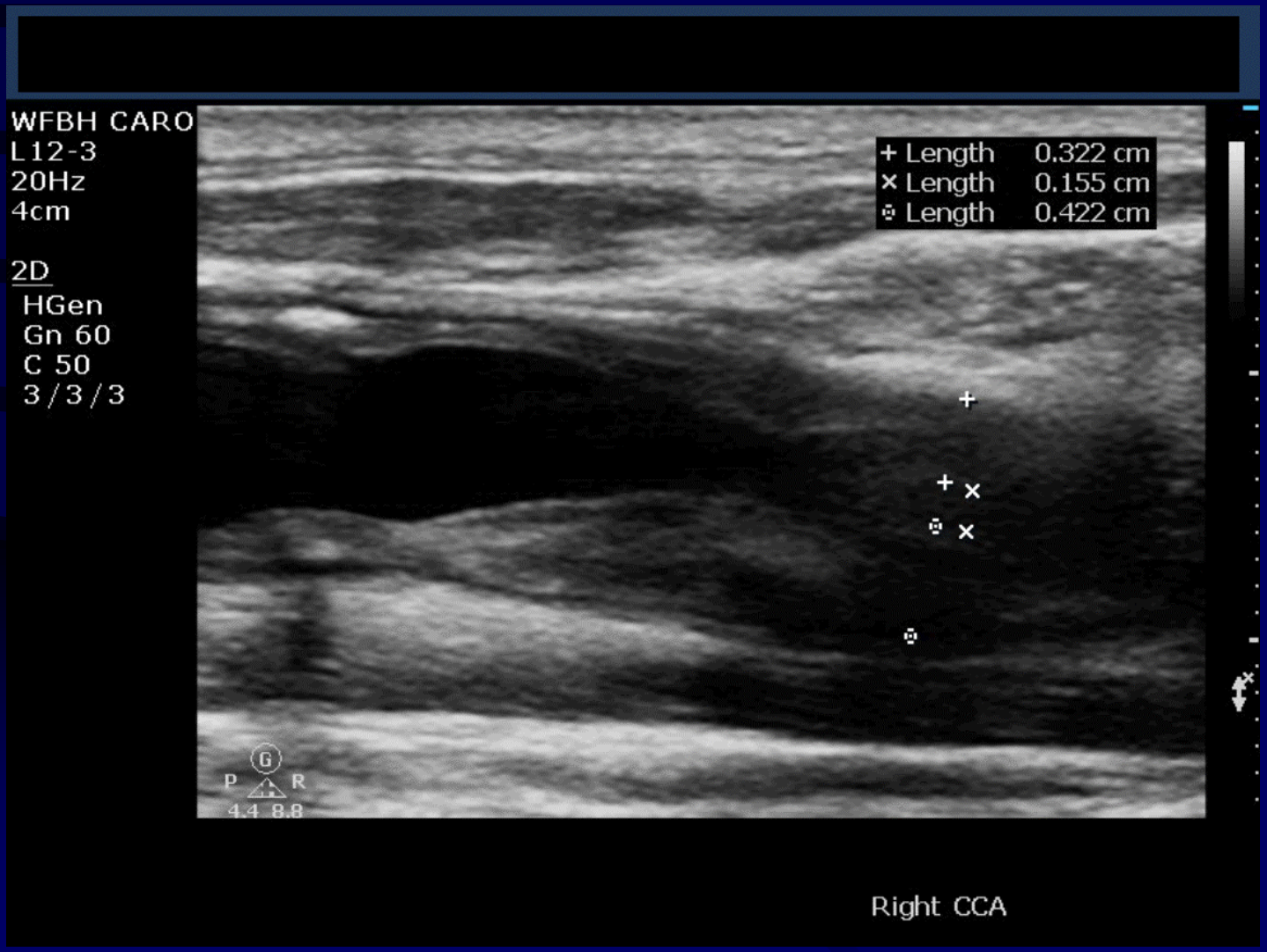

PHILIPS
WFBH TCD
S5-1
15 Hz
11.0cm
2D
HGen
Gn 68
C 61
4/3/2
Color
2.1 MHz
Gn 85
6/4/1
Fltr High
PW
1.8 MHz
Gn 42
5.9 cm
Angle 0°
Fltr 75Hz
75 mm/s
Left
+ Mid M1 PSV 59.4 cm/s
Mid M1 EDV 34.1 cm/s
Mid M1 TCD Mean 42.5 cm/s
Mid M1 TCD PI 0.596
+45
-45
11.0cm
80
60
40
20
0
20
40


PHILIPS
WFBH TCD
S5-1
14 Hz
11.0cm
2D
HGen
Gn 68
C 61
4/3/2
Color
2.1 MHz
Gn 84
6/4/1
Fltr High
PW
1.8 MHz
Gn 56
7.0 cm
Angle 0°
Fltr 75Hz
75 mm/s
REVERSED
Left
+ ACA PSV 41.0 cm/s
ACA EDV 19.6 cm/s
ACA TCD Mean 26.8 cm/s
ACA TCD PI 0.800
+40
-40
11.0cm
60
40
20
0
20

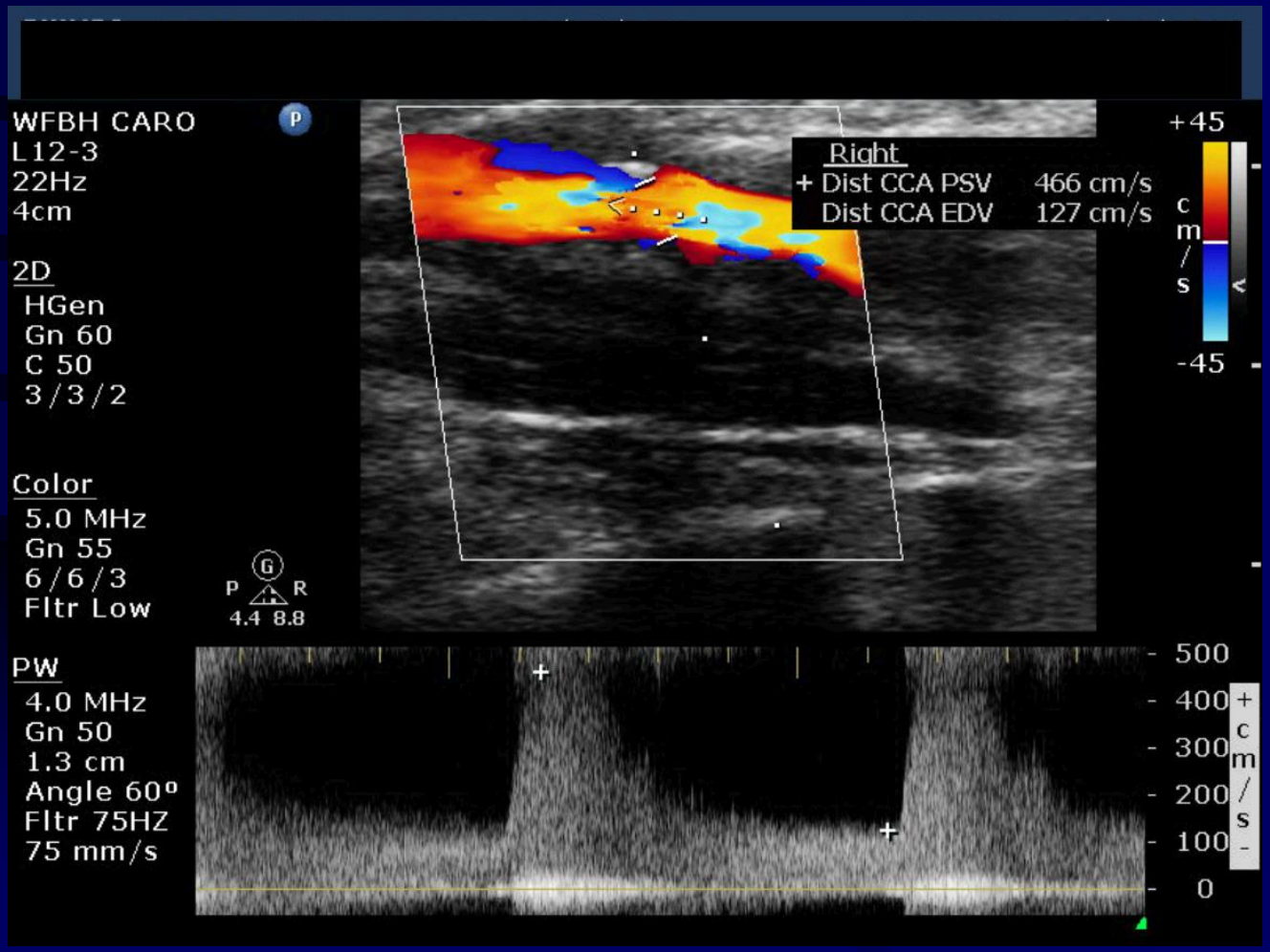

WFBH Orbit
S5-1
26 Hz
9.0cm
2D
Gen
Gn 10
C 61
3/4/2
Color
2.1 MHz
Gn 60
6/4/3
Fltr High
PW
1.8 MHz
Gn 40
4.5 cm
Angle 0°
Fltr 75Hz
75 mm/s
REVERSED
Left
Ophthalmic A PSV -59.7 cm/s
Ophthalmic A EDV -29.4 cm/s
Ophthalmic A TCD Mean -39.5 cm/s
Ophthalmic A TCD PI 0.767
+25
-25
cm/s
9.0cm
40
0
40
80


2D
HGen
Gn 68
C 61
4/3/2
Color
2.1 MHz
Gn 84
6/4/1
Fltr High
PW
1.8 MHz
Gn 24
8.0 cm
Angle 0°
Fltr 75Hz
75 mm/s
Prox Basilar A PSV -146 cm/s
Prox Basilar A EDV -68.1 cm/s
Prox Basilar A TCD Mean -94.1 cm/s
Prox Basilar A TCD PI 0.829
+40
-40
cm/s
11.0cm
40
0
40
80
120
160

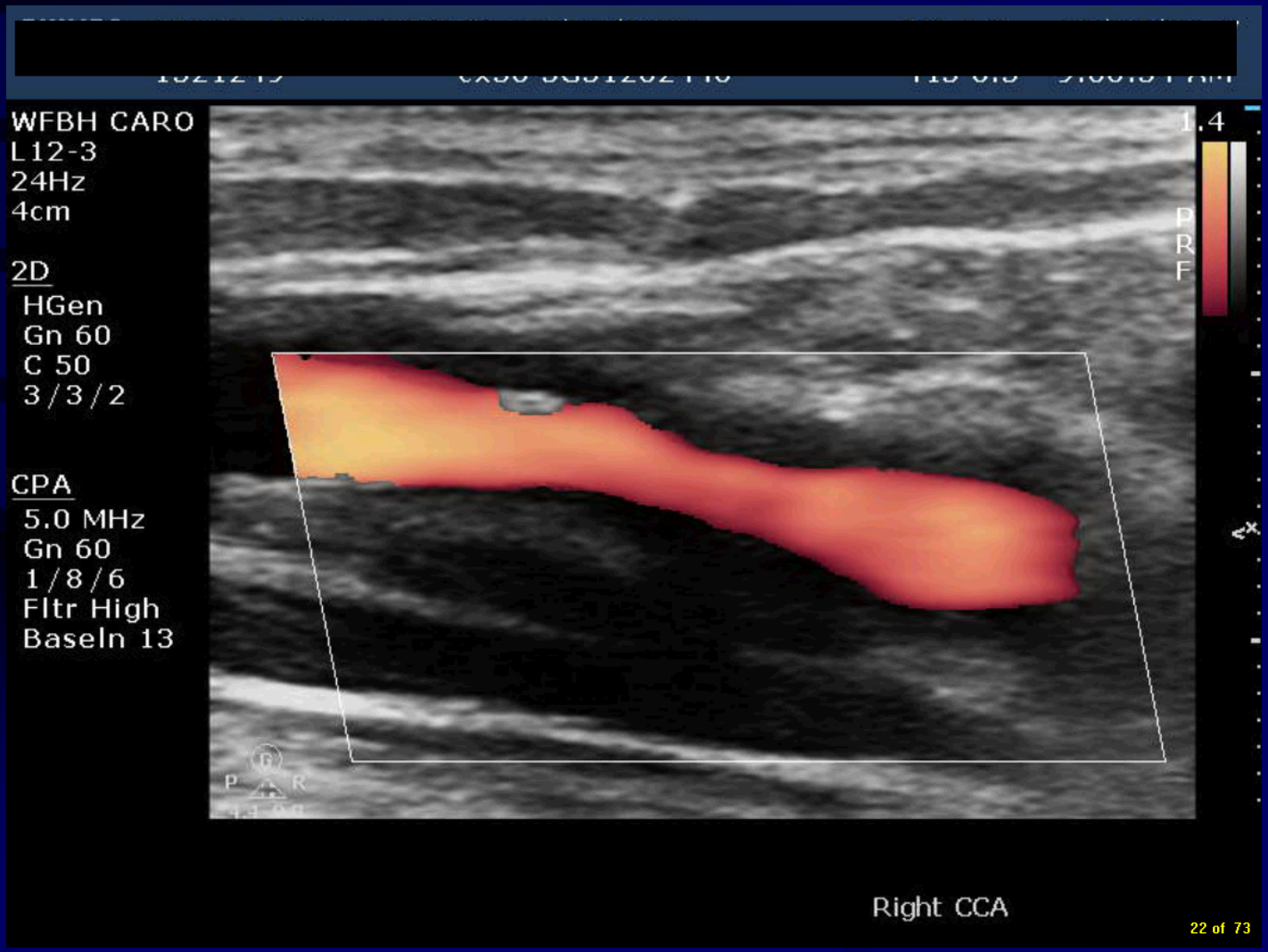
Put It All Together



Put It All Together

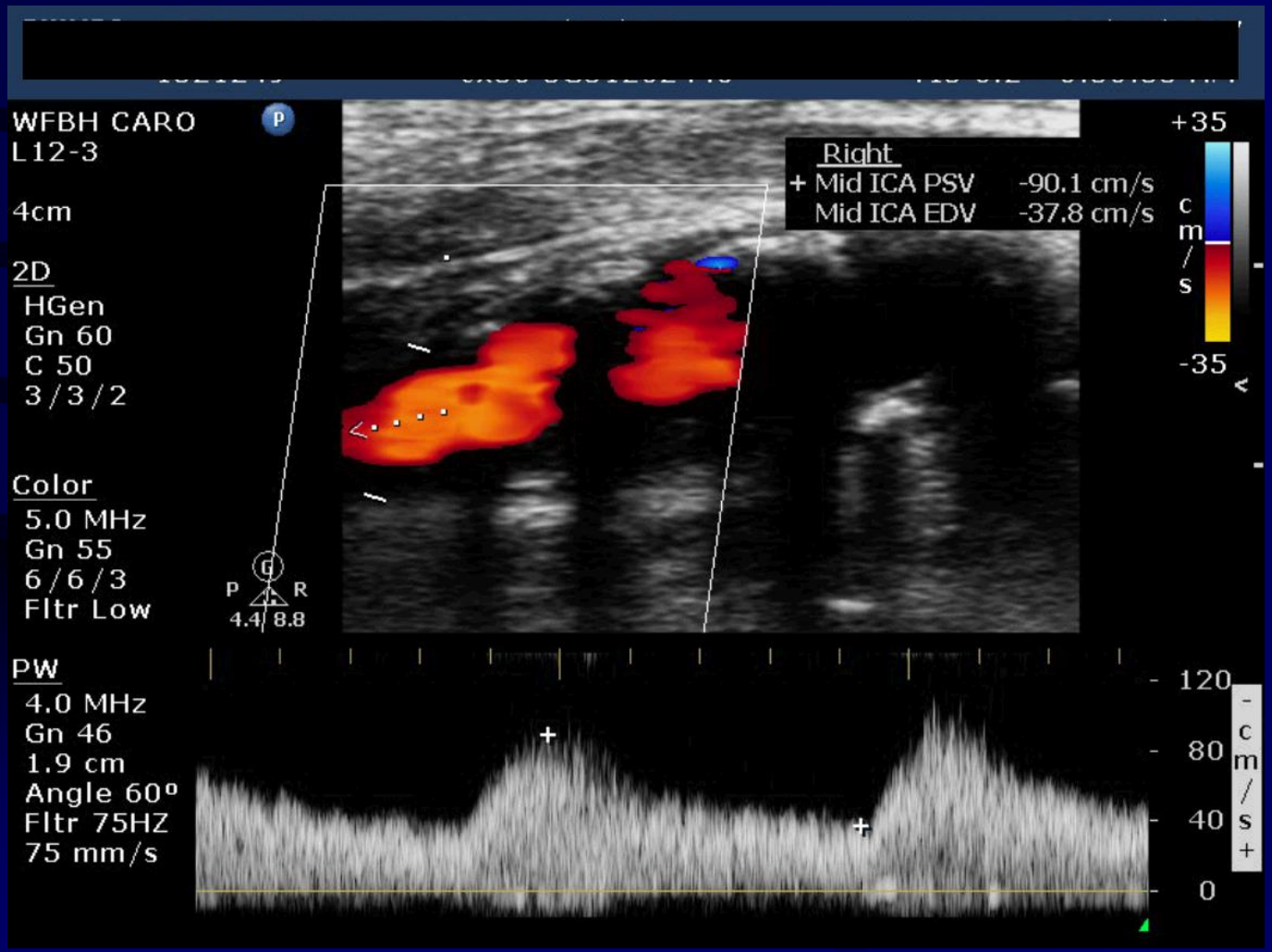


Put It All Together

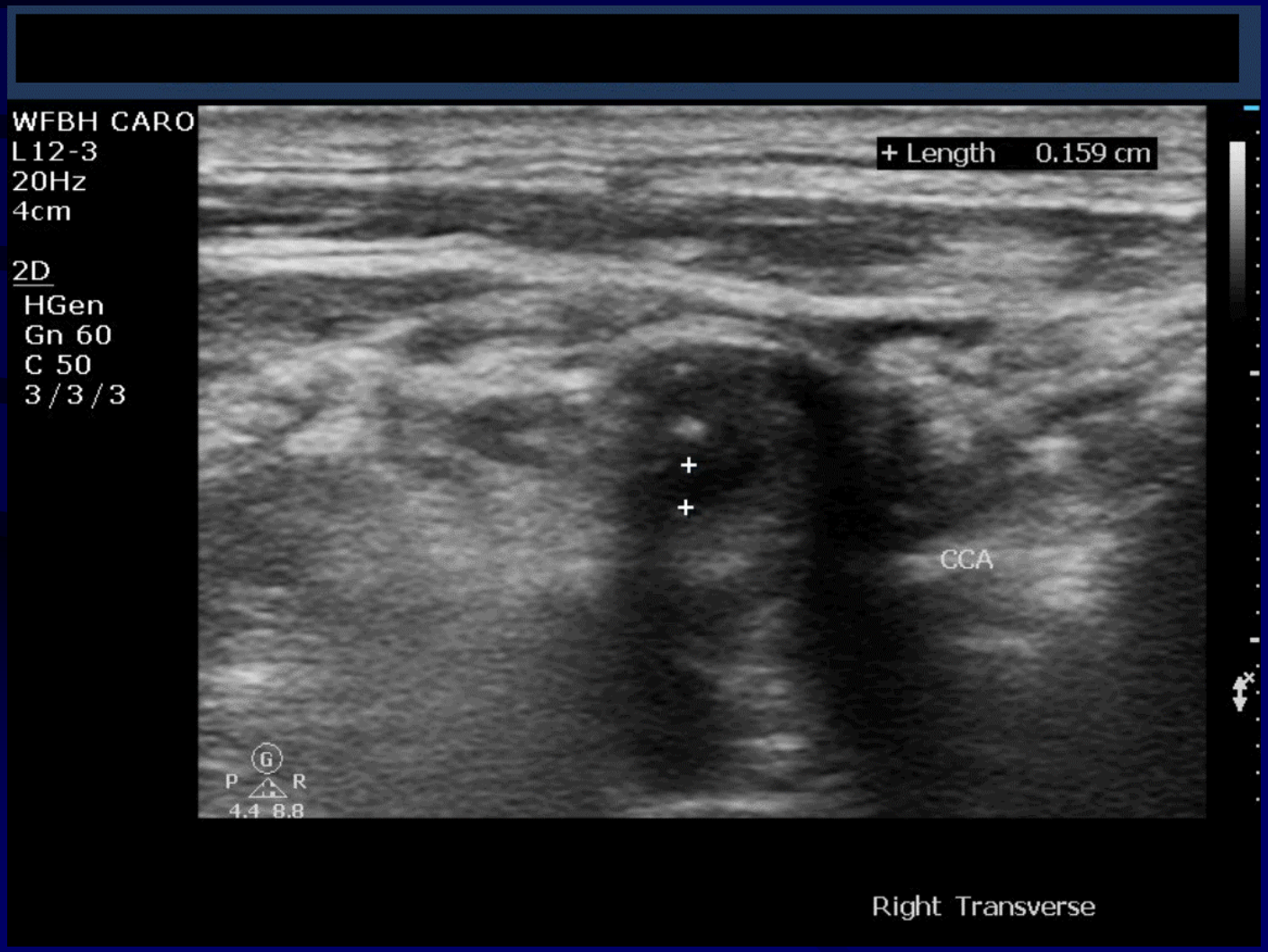


Put It All Together

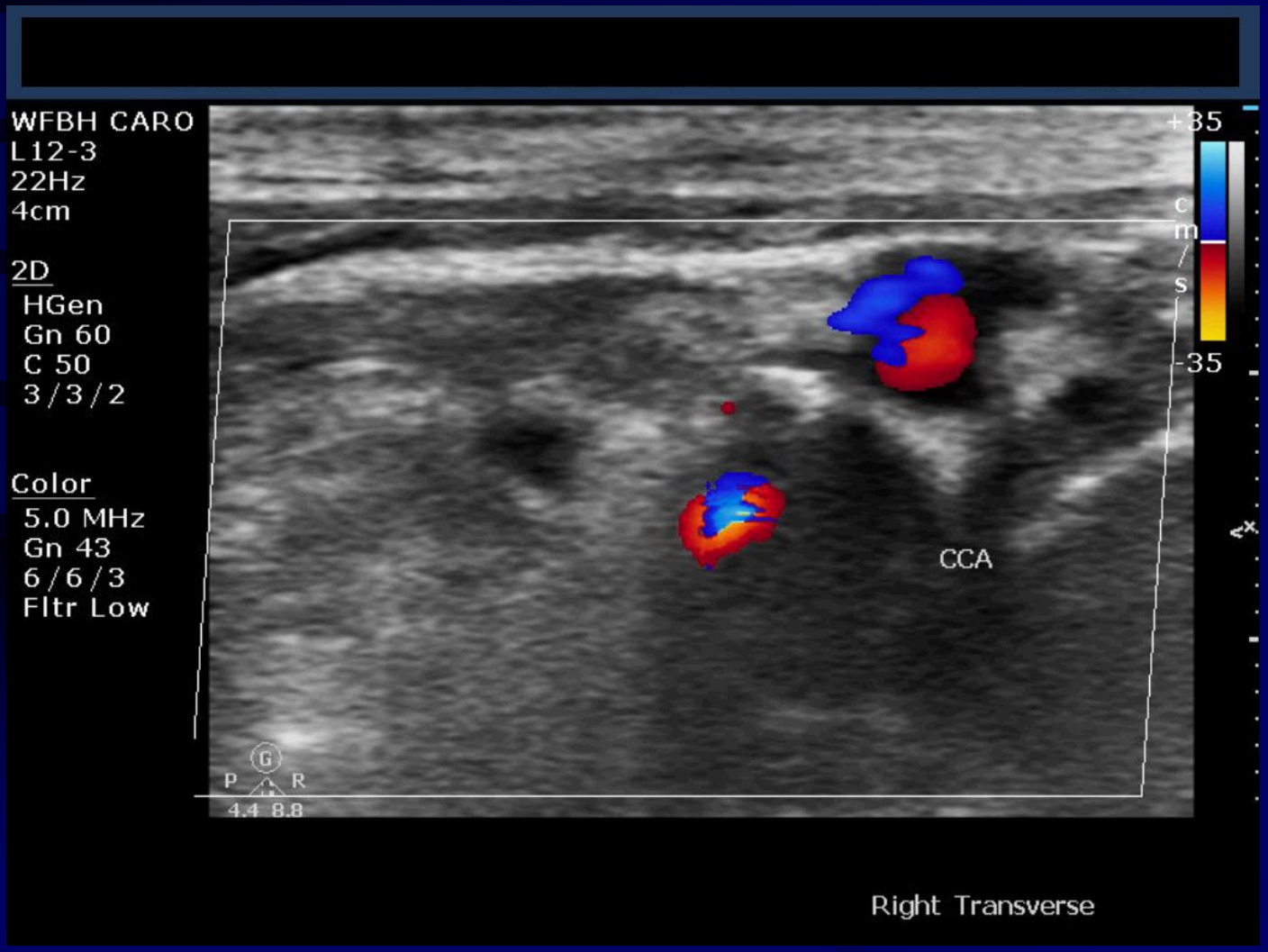
Put It All Together

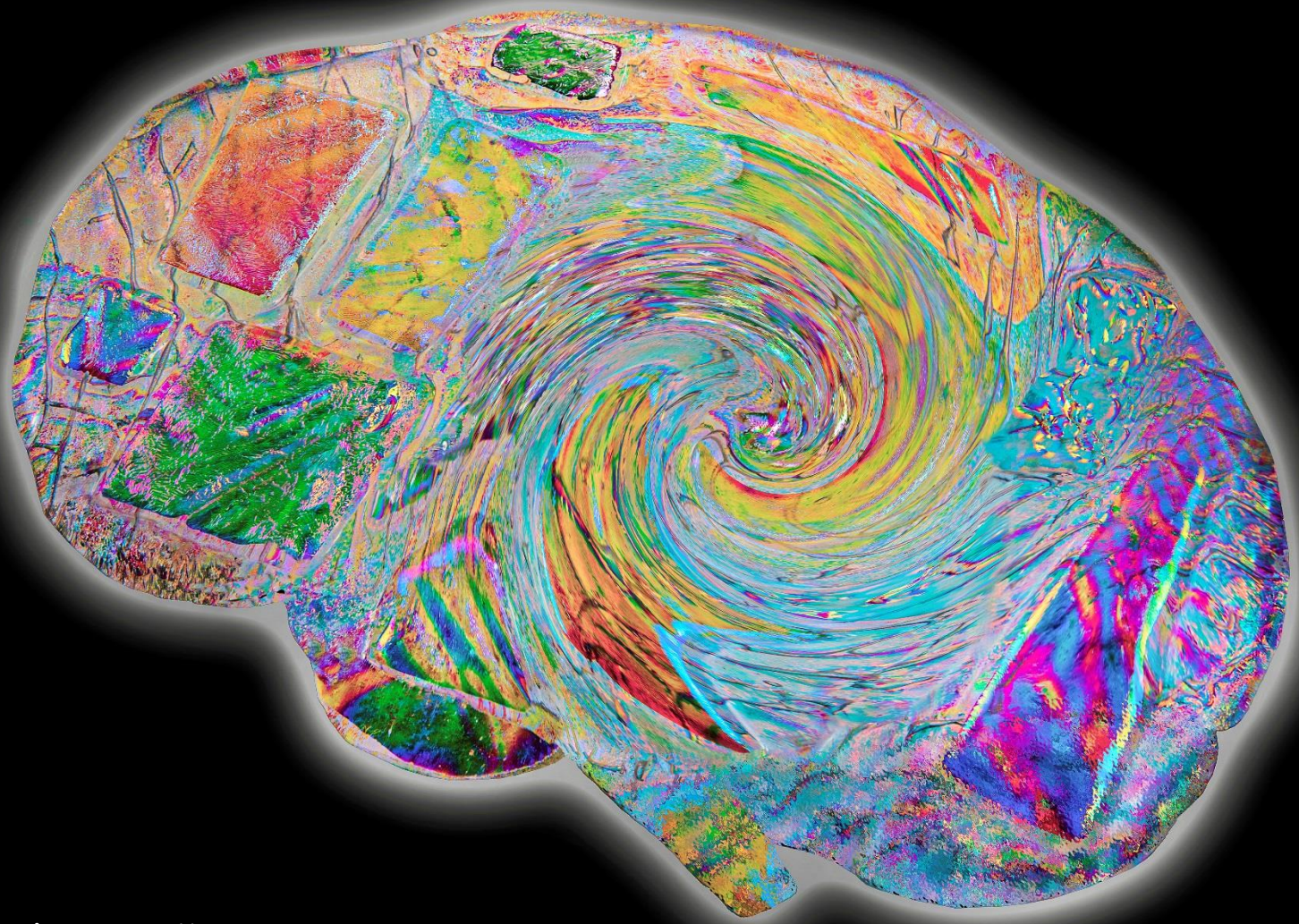


Put It All Together



Put It All Together





“Brainstorm”
Courtesy of Dr. Renee Healing Art