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Beyond Stenosis Severity: Top 5 Important Duplex Characteristics to Identify in a Patient with Carotid Disease

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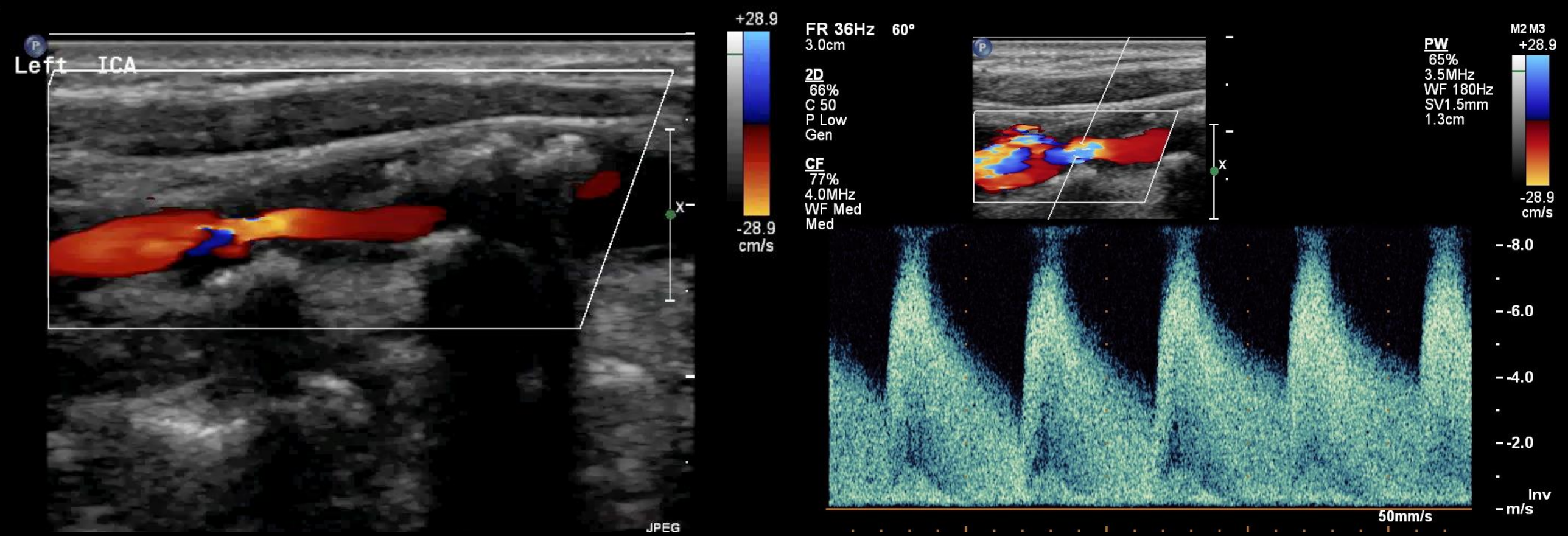
Technical Director
New York Cardiovascular Associates

Disclosures

None

Introduction

Defining the severity of stenosis by duplex is only half of the carotid story. There's more than just the PSV and EDV.



Plaque Characterization

Zebras

Carotid Disease

String Sign

Vessel Tortuosity

Post CEA Evaluation

Plaque Characterization

Plaque morphology includes:

- "Surface" (smooth vs. irregular)
- "Structure" (heterogeneous, echolucent, ulcerated, hemorrhagic, homogeneous, or calcified)
- Combination of "surface" and "structure" defines plaque stability
- One or more of these qualities increases the patient's risk for ischemic stroke

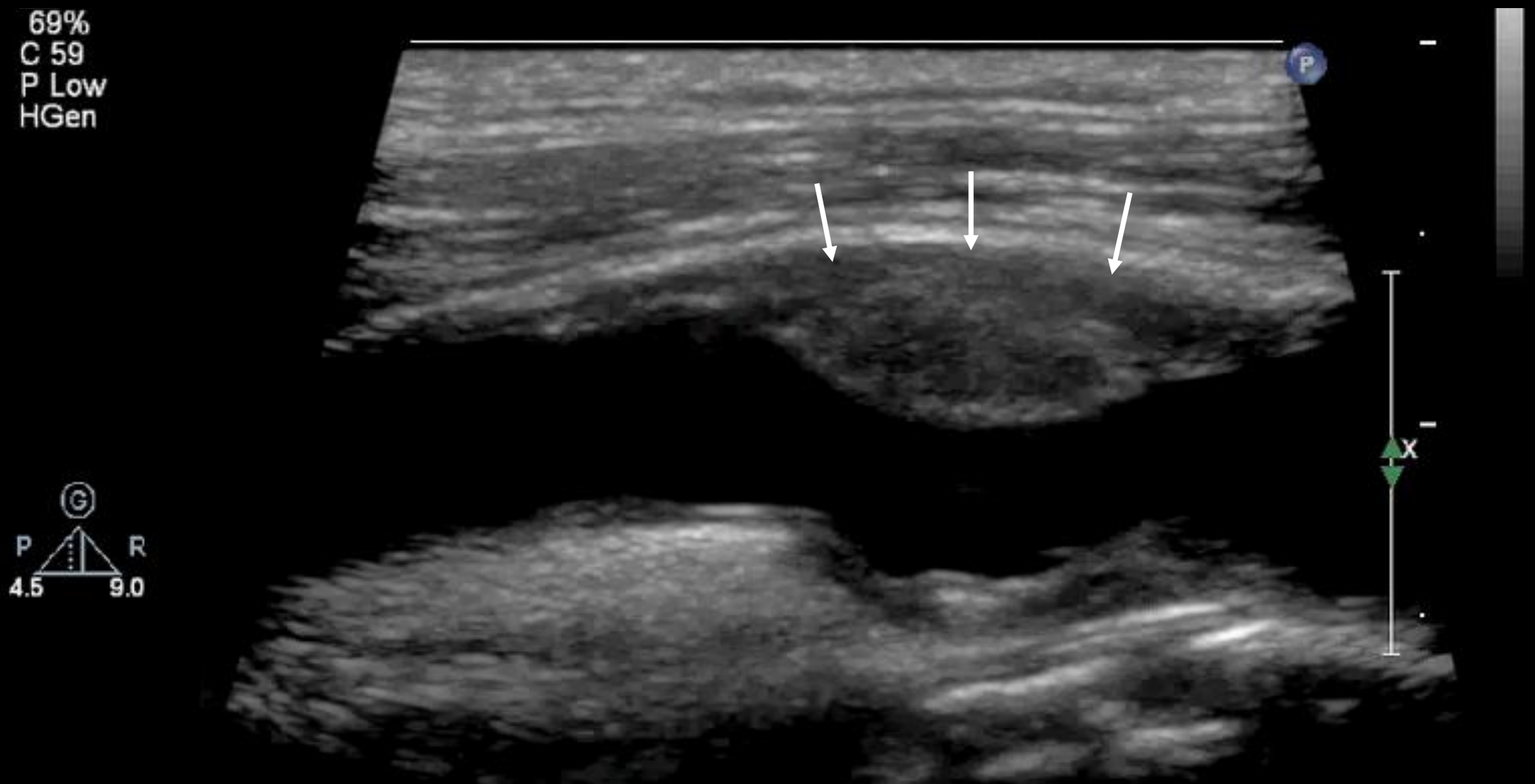
Heterogenous Plaque

Ulcerated Plaque

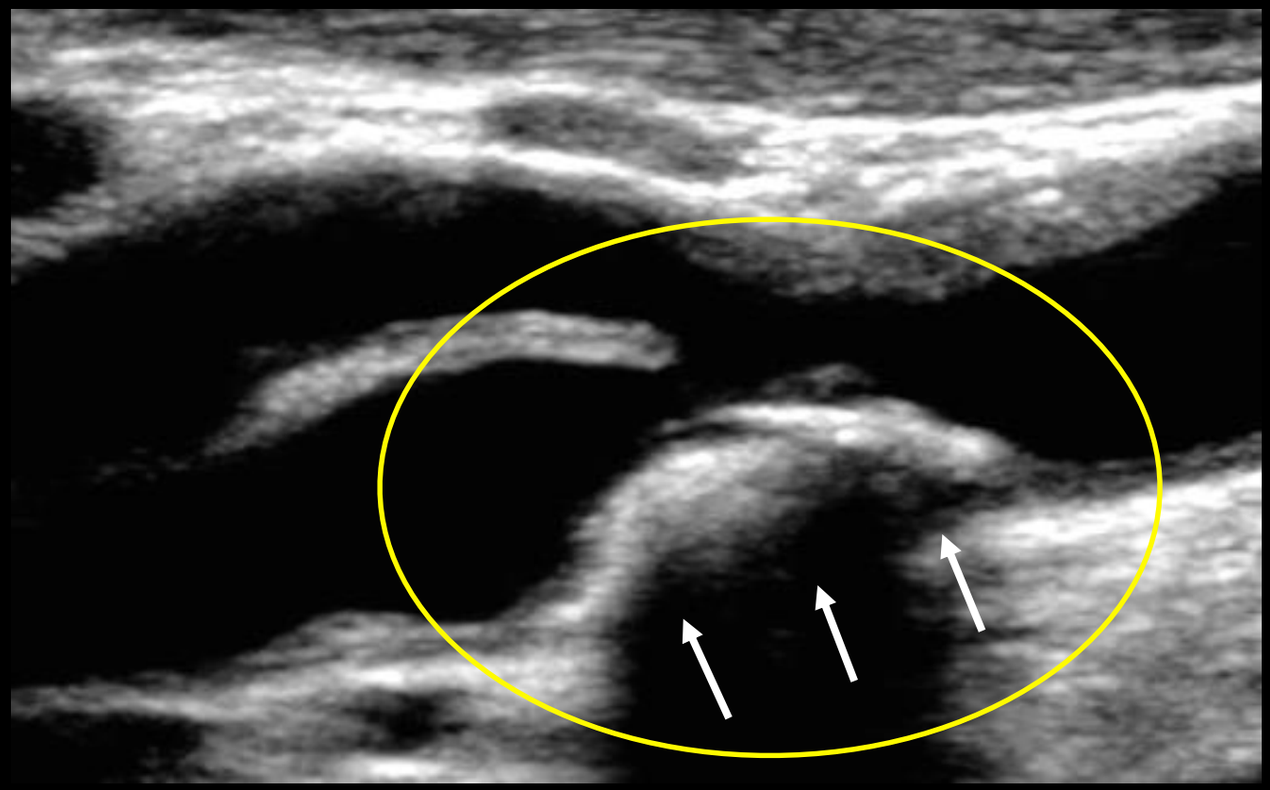
The Current Role of Carotid Duplex Ultrasonography in the Management of Carotid Atherosclerosis: Foundations and Advances, International journal of Vascular Medicine 2012, By Kelly. Byrnes and Charles B. Ross

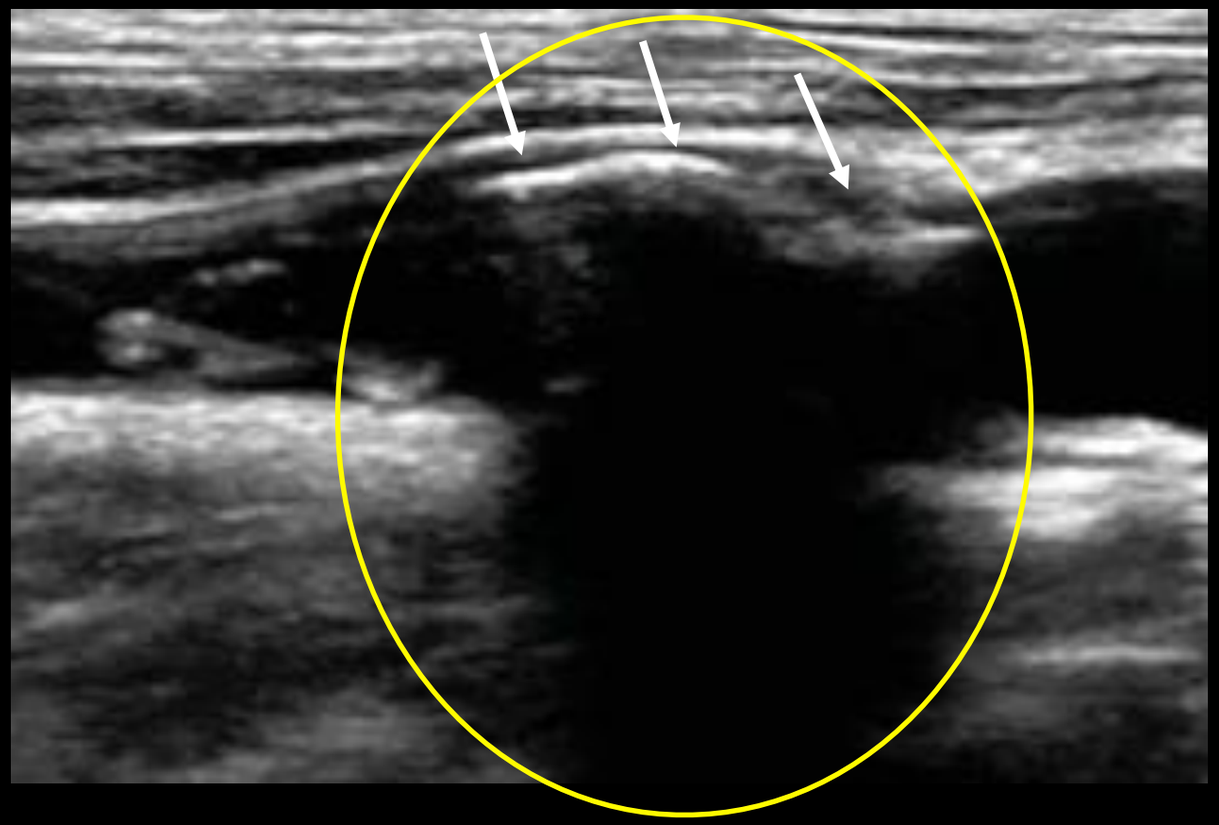
Homogeneous Plaque

Uniform echotexture and smooth surface



Calcified Plaque with Acoustic Shadowing





Heterogeneous Plaque

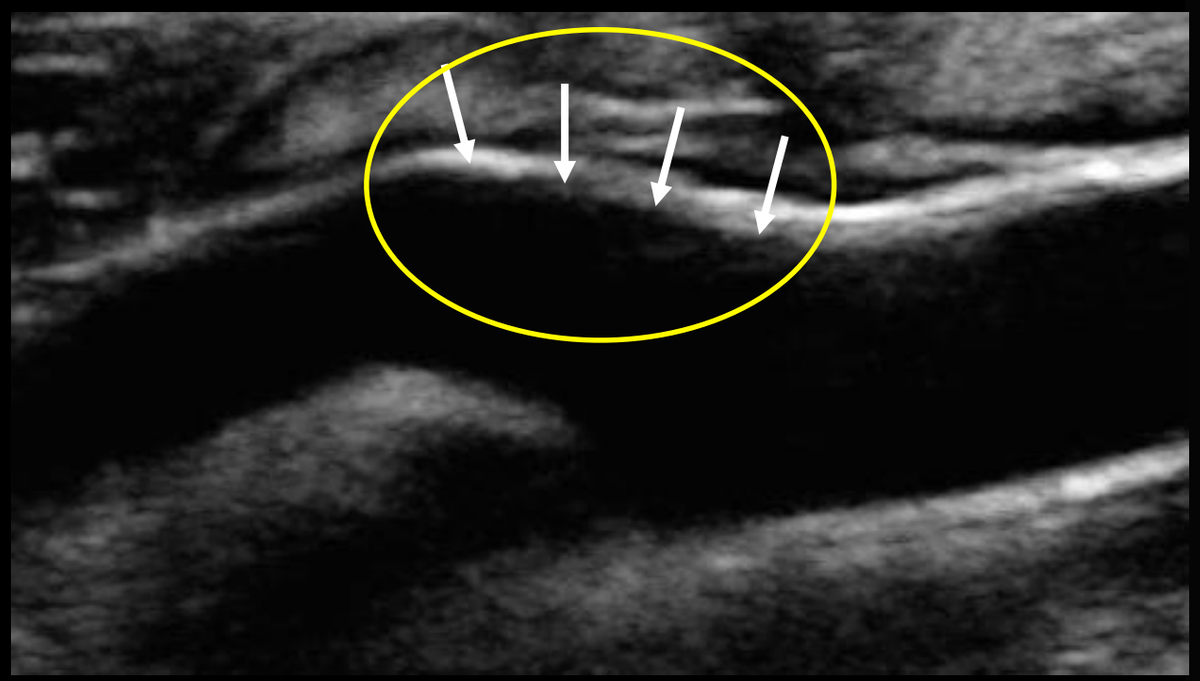
Mixed echo pattern with high and low levels of echogenicity

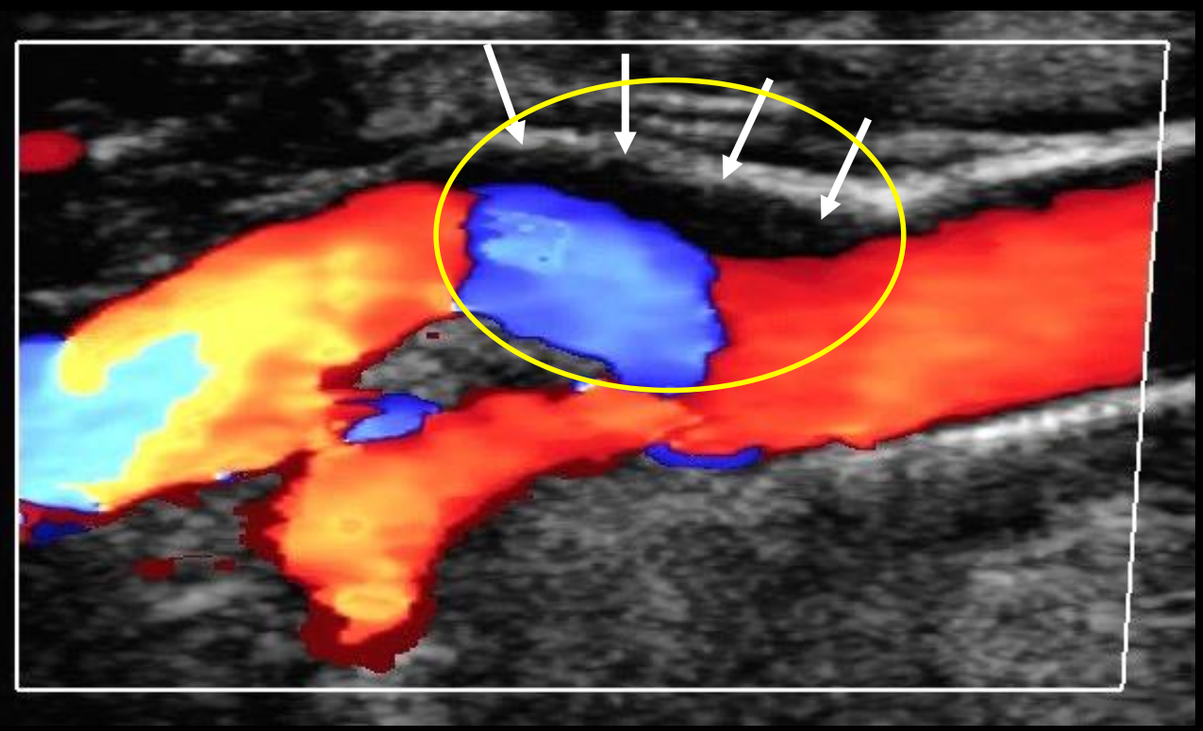
Heterogeneous Plaque

Focal anechoic area, which is the hallmark of intra-plaque hemorrhage

Echolucent Plaque

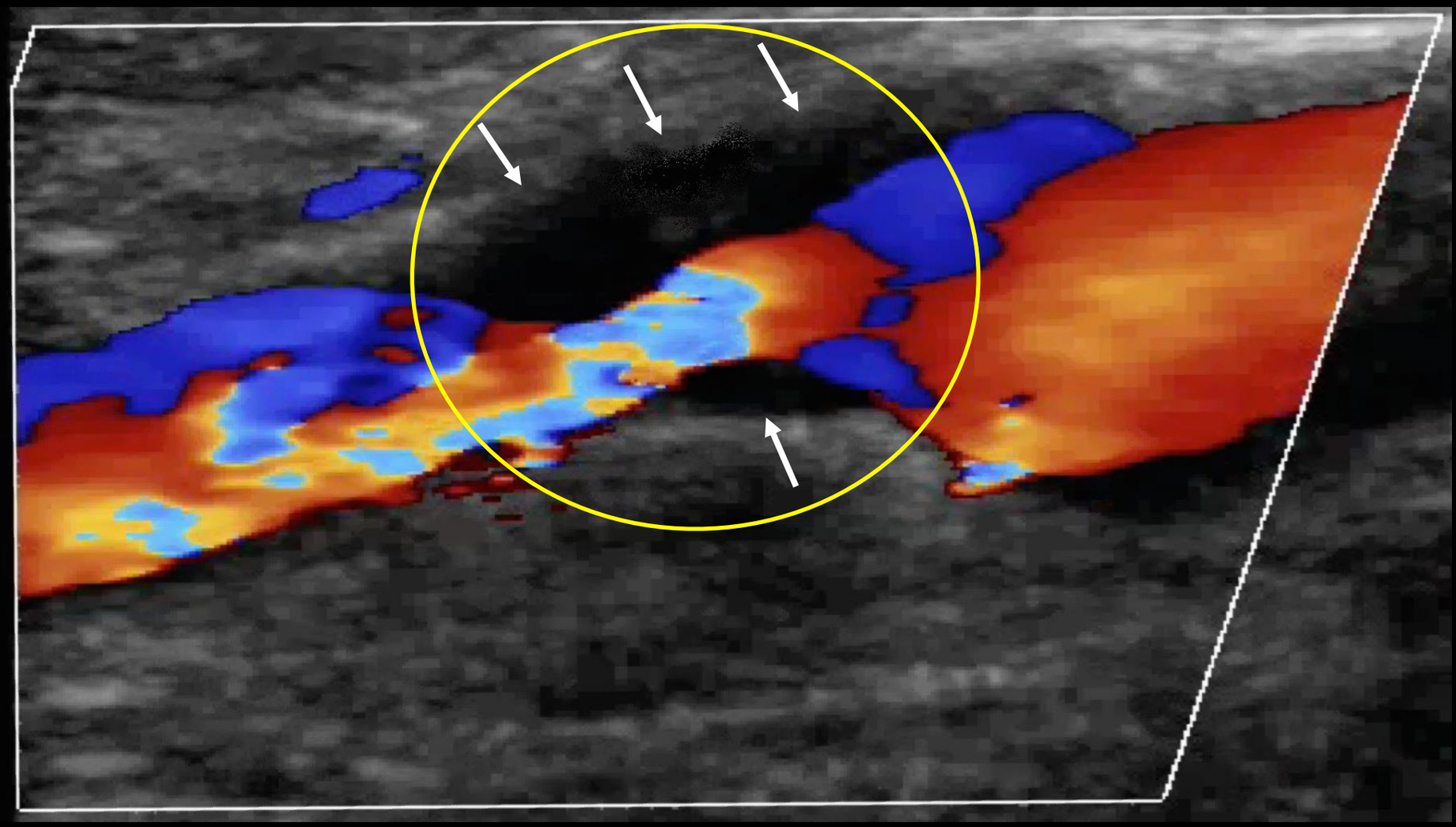
Independent risk factor for ischemic event; whether or not stenosis is hemodynamically significant



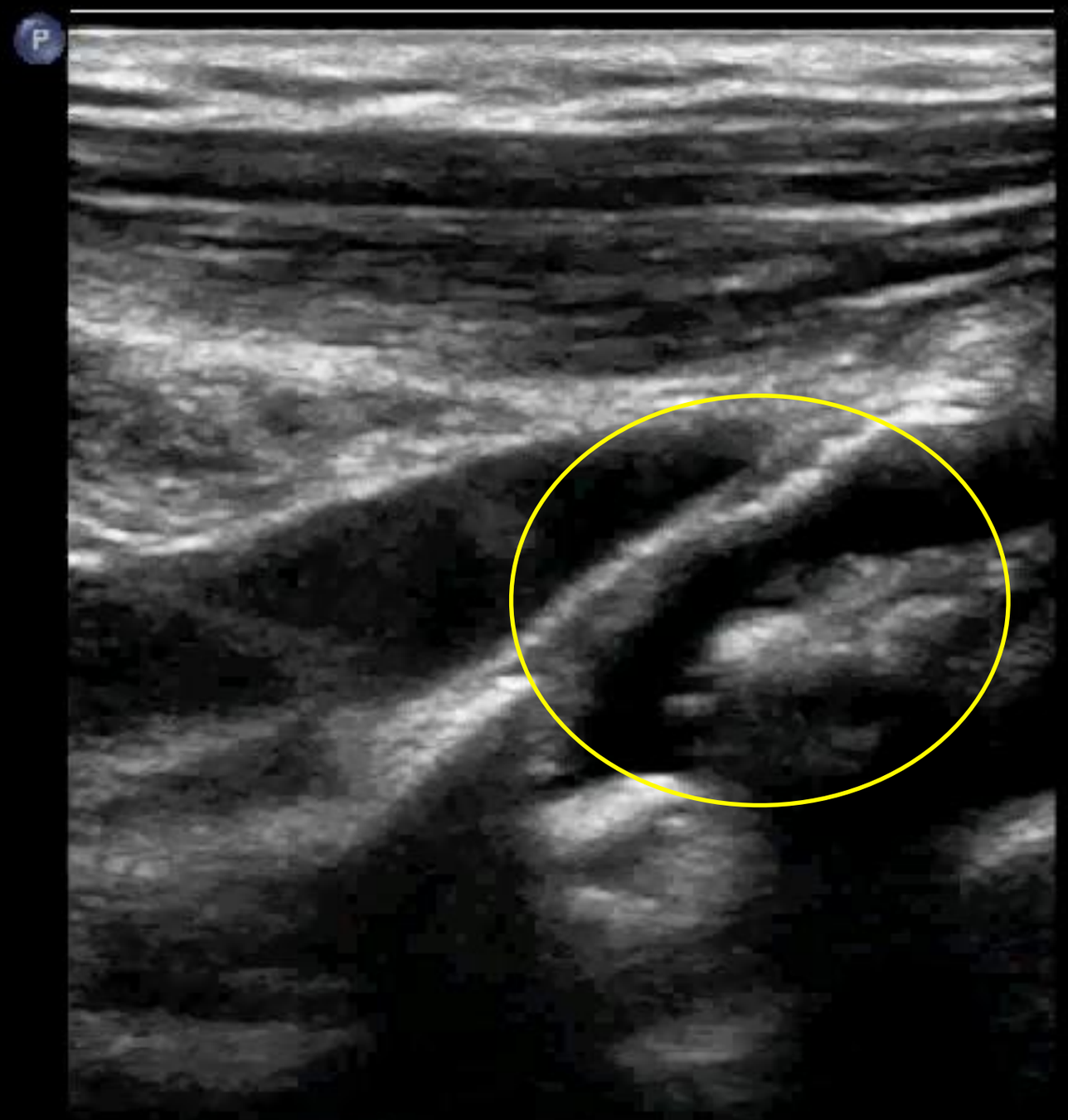


Echolucent Plaque

Echolucent lesions appear to be more likely to result in emboli post CAS vs. post CEA



Calcified Plaque with Mobile Atheroma



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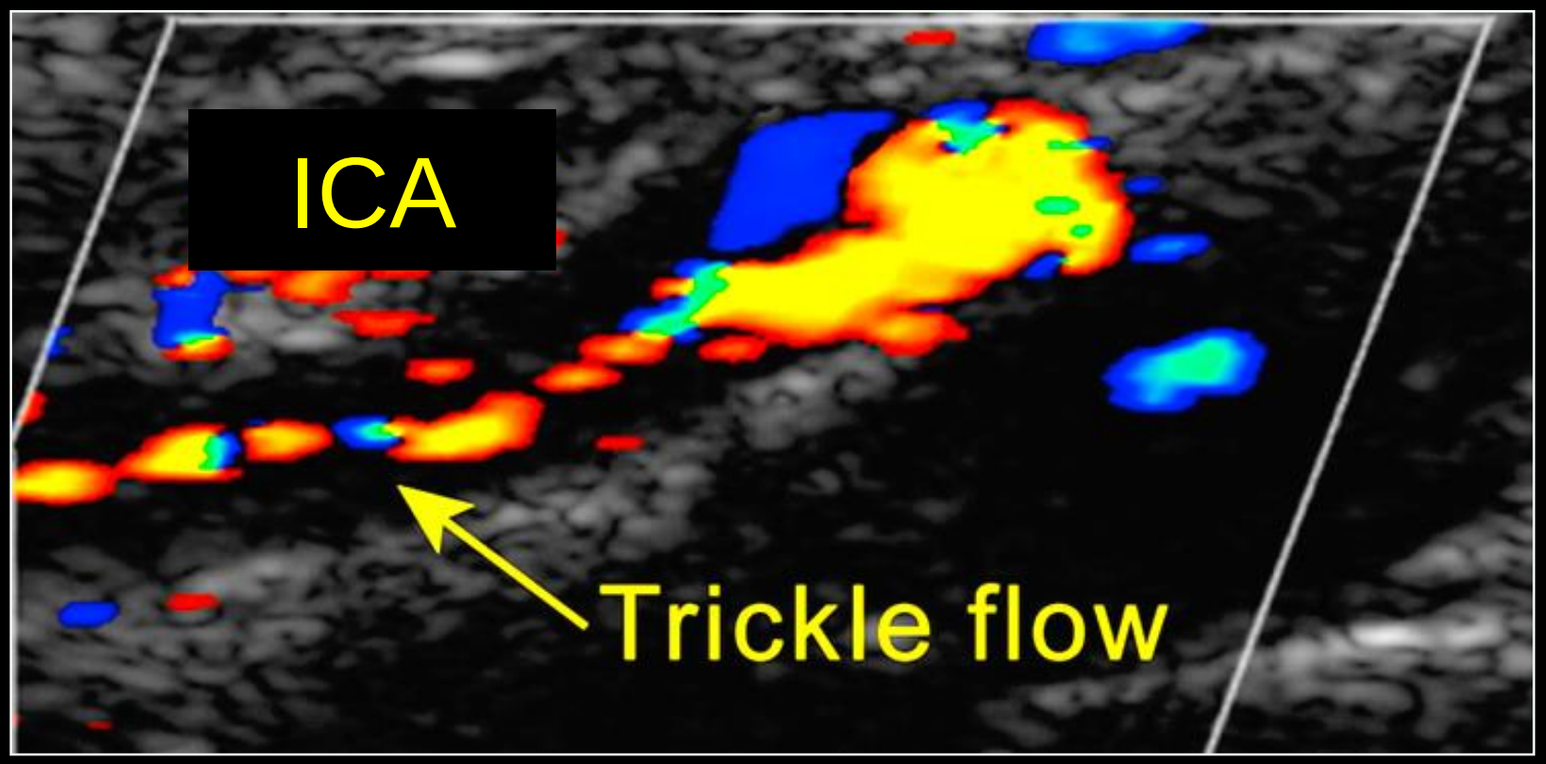
String Sign

- The ICA is typically long and tapers distally
- Post stenotic segment with markedly reduced vessel caliber size and low amplitude antegrade flow distally



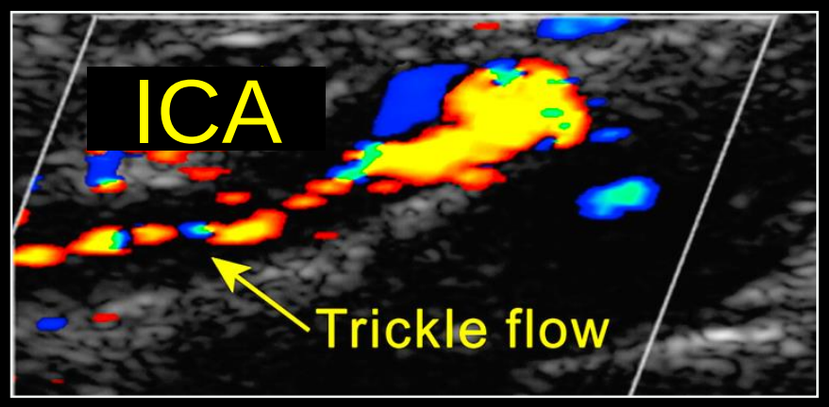
Radiographic's 2005 Sonographic Examination of the Carotid Arteries
Hamid R. Tahmasebpour, BSc, RDMS, Anne R. Buckley, MD, Peter L. Cooperberg, MD, and Cathy H. Fix, RDMS

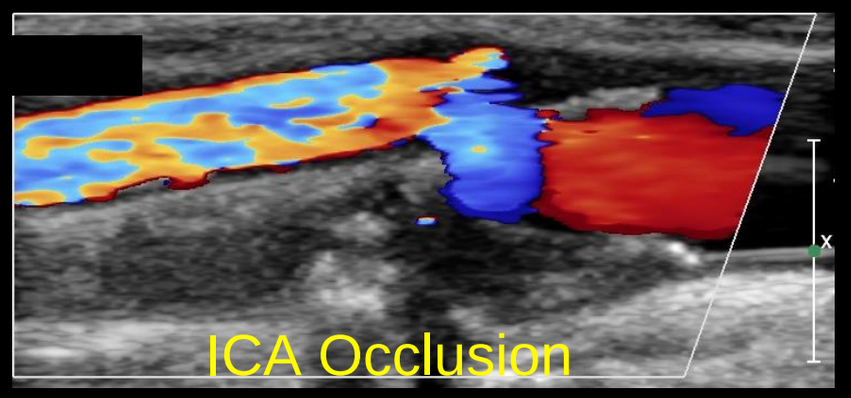
JACC Cardiovasc Interv. 2010
Carotid artery stenting with proximal cerebral protection for patients with angiographic appearance of string sign.
Nikas DN1, Ghany MA, Stabile E, Sorropago G, Saccá S, Favero L, Zakaryan N, Reimers B, Rubino P.

Optimizing Image Settings for Low Flow Detection

- Color Flow
- Decrease scale
- Increase gain
- Increase persistence
- Low wall filter
- Steer & adjust box size

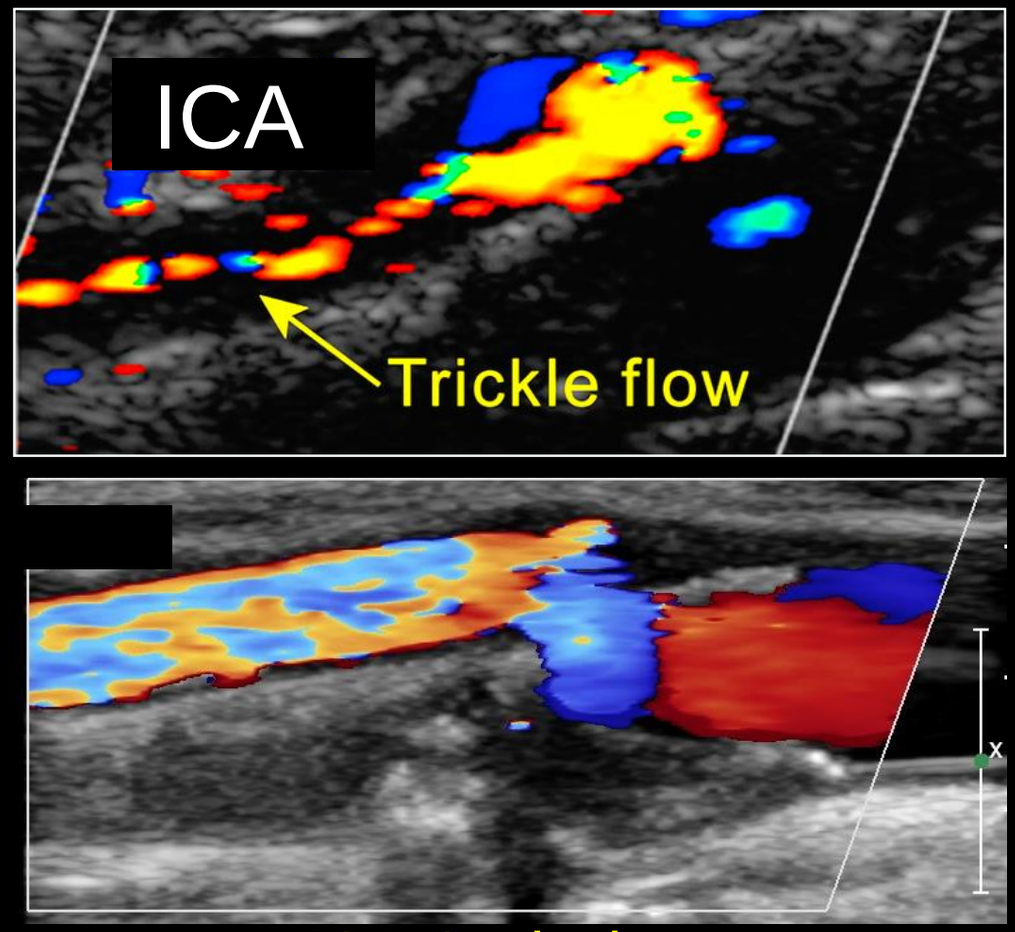
- Spectral Doppler
- Decrease scale
- Increase gain
- Low wall filter
- Utilize 60°



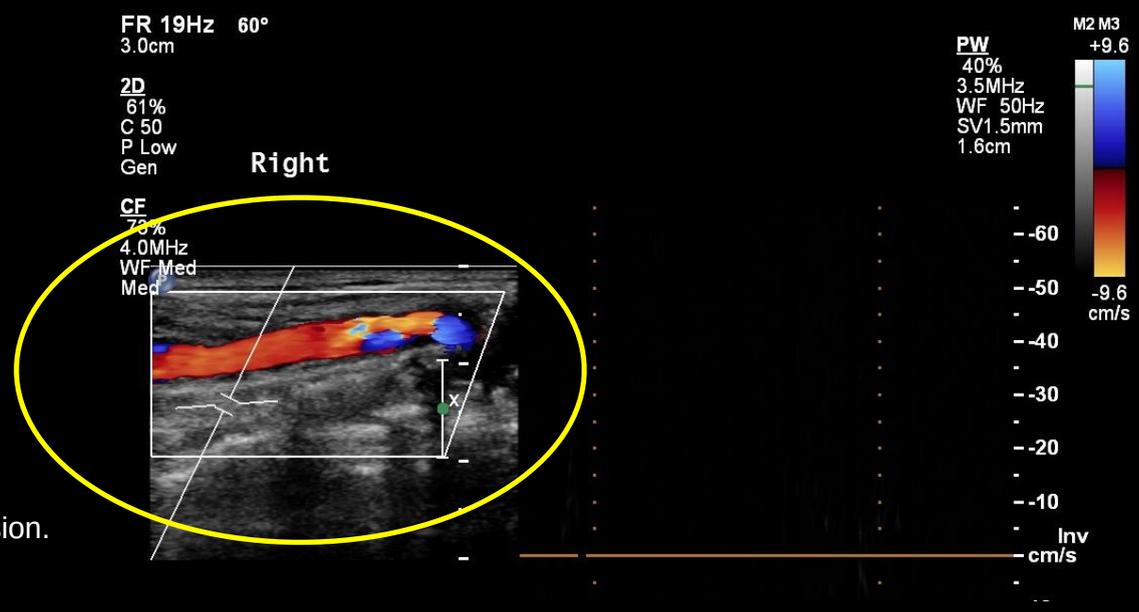


String Sign

- It’s important to distinguish between ICA near occlusion vs. total occlusion
- Diagnosing an ICA as occluded when patent, but significantly stenotic could result in stroke or total occlusion



ICA Occlusion



AbuRahma AF et al.The Reliability of Color Duplex Ultrasound in Diagnosing Total Carotid Artery Occlusion. Am J Surg. 1997;174:185-187.

Plaque Characterization

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Vessel Tortuosity

Post CEA Evaluation

Post CEA Evaluation

- Annual incidence of restenosis or occlusion ~1%-4.5%
- Early recurrent stenosis usually develops within 2 years of CEA and represents scar/neointimal hyperplasia
- After 3 years, new post CEA lesions must be evaluated for the possibility of neo-atherosclerosis
- Both diseases have a distinctly different natural history, with interventional outcomes
- Neo-atherosclerosis has a less benign course

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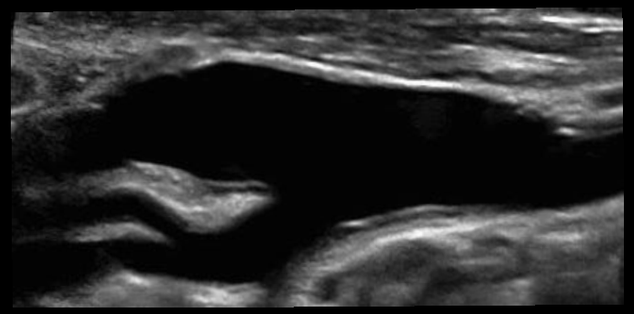
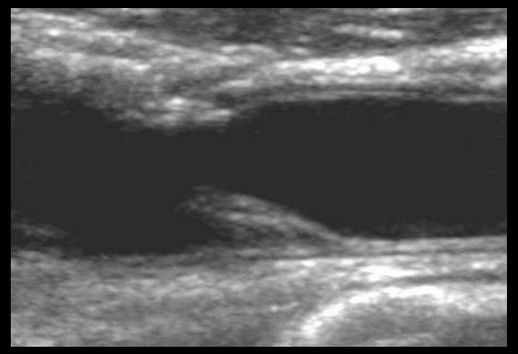
Post CEA Evaluation

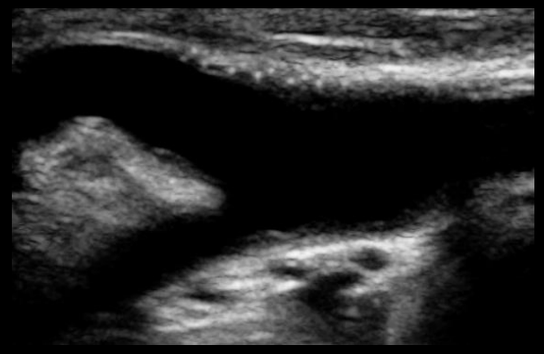
Intra-op injury, i.e., arterial clamping, intraluminal shunt insertion or suture placement may cause intimal hyperplasia



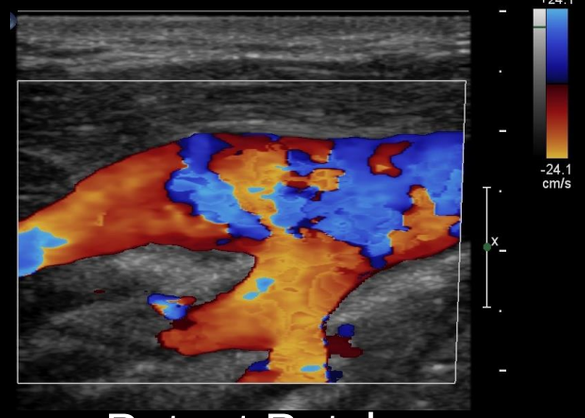
Proximal And Distal Endpoint



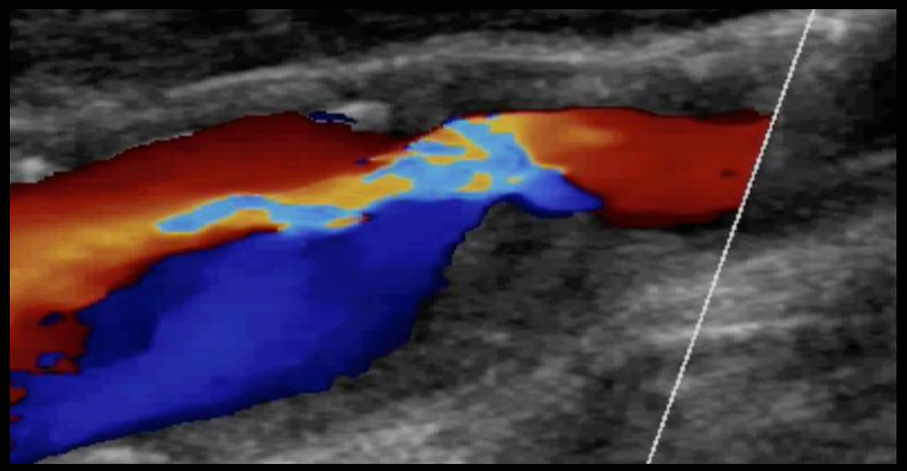
Flap Or Shelf



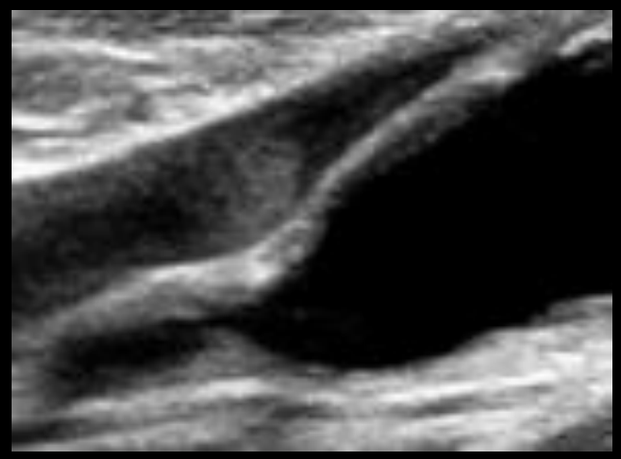
Post CEA at 1 Month



Patent Patch



Intimal Hyperplastic Lesion at 1 year



Distal End Point

S/P CEA 10 Years

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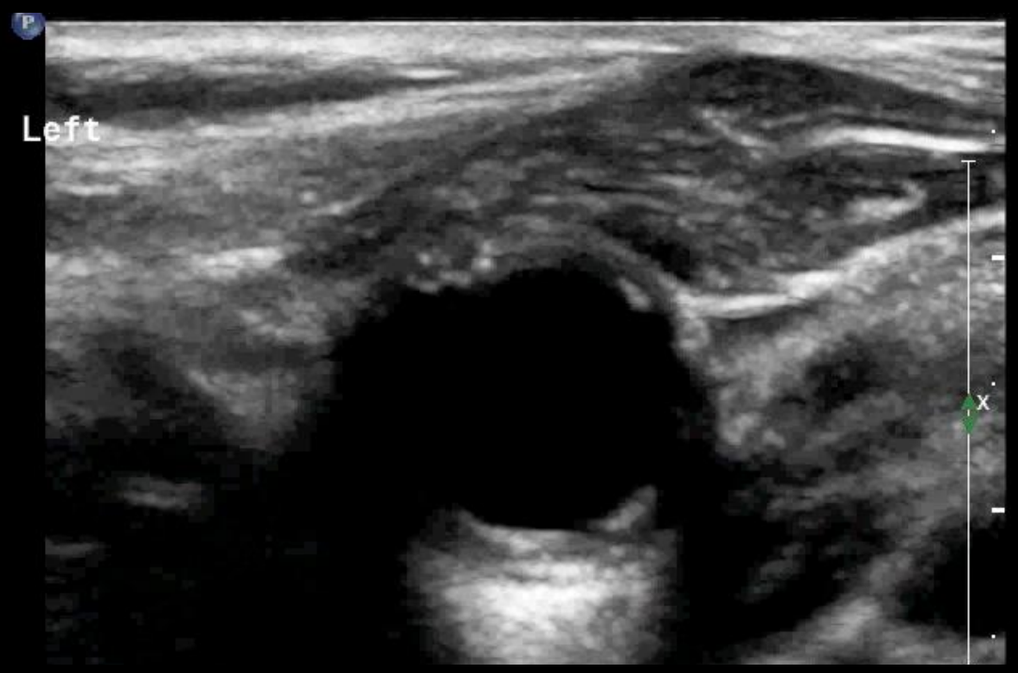
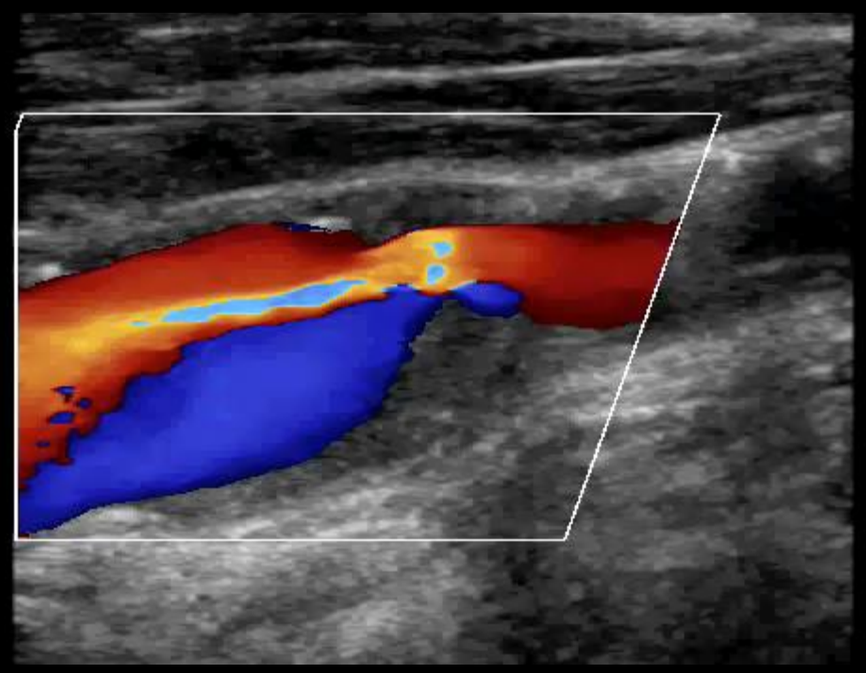
Post CEA Evaluation

CDU of CEA Restenosis

- Common 1-35%; < 8% symptomatic
- Type of closure: primary vs. patch angioplasty (decreased rates)
- Debatable whether clinically significant to continue CDU surveillance due to low recurrent rate of restenosis



The value and economic analysis of routine postoperative carotid duplex ultrasound surveillance after carotid endarterectomy. AbuRahma AF JVS 2015



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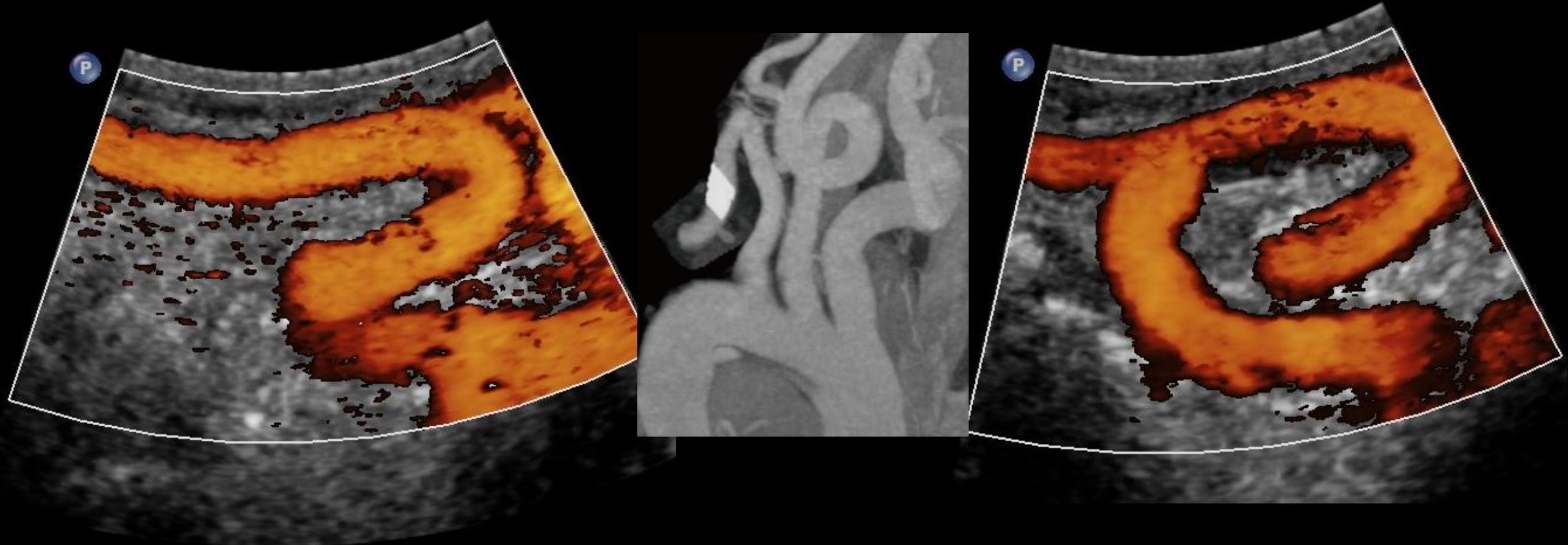
Proximal CCA Tortuosity

Tortuosity of the CCA increases the difficulty of axis in CAS, increases the risk of complication with vessel injury, and loss of guide support, etc.



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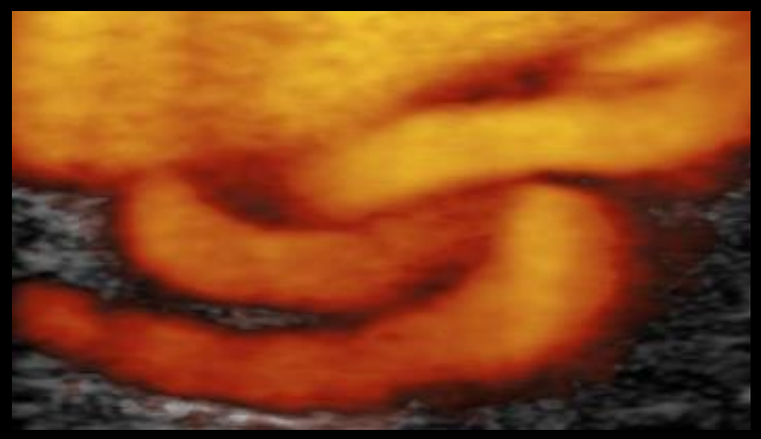
ICA Tortuosity

Distal ICA tortuosity may present challenges that complicate placement of a distal embolic protection device and stent



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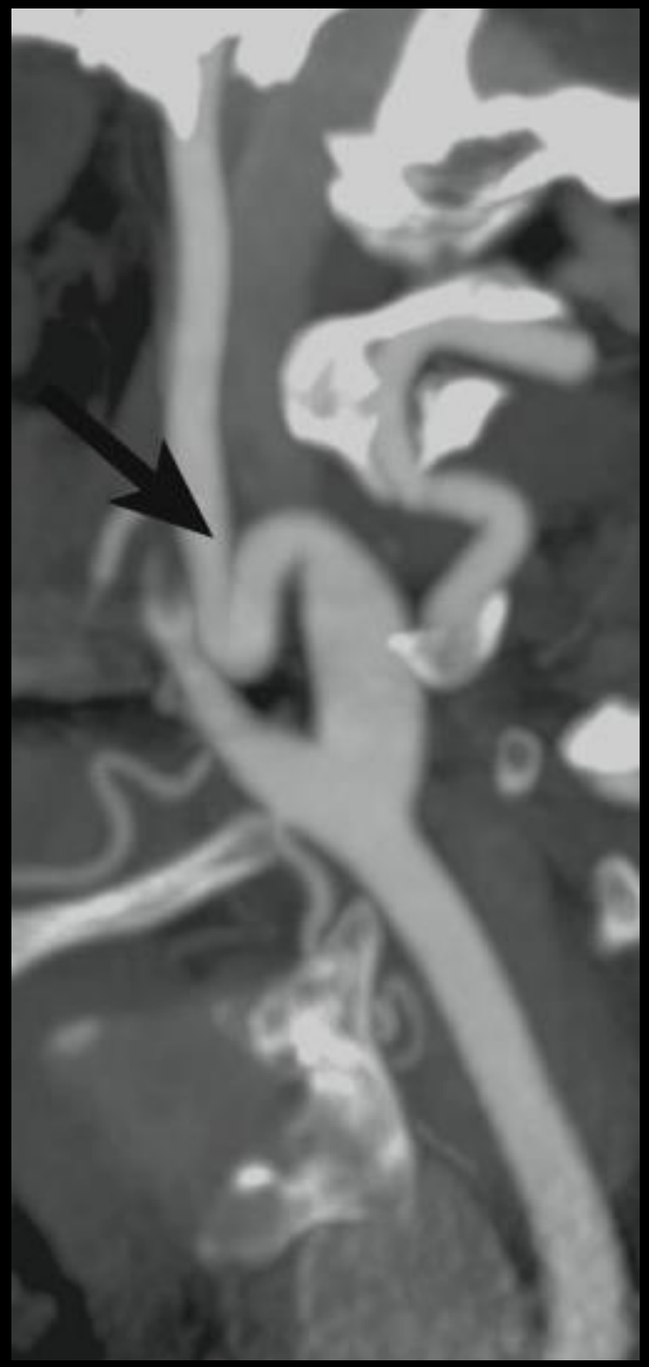
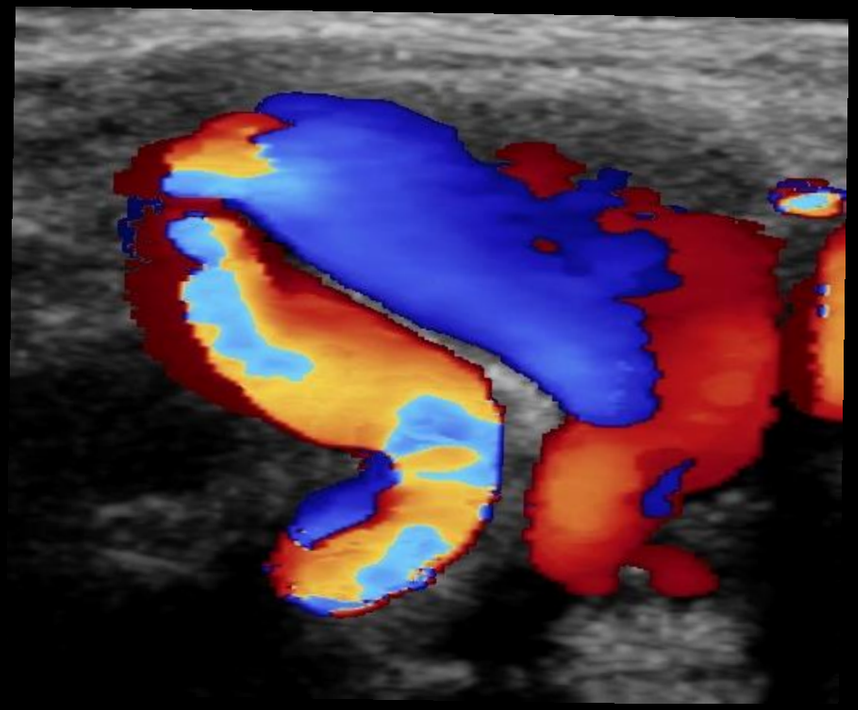
Stent supported Carotid Artery Angioplasty as Prevention of Stroke Sriram Iyer, Gary Roubin Lenox Hill Heart and Vascular Institute of NY 2007

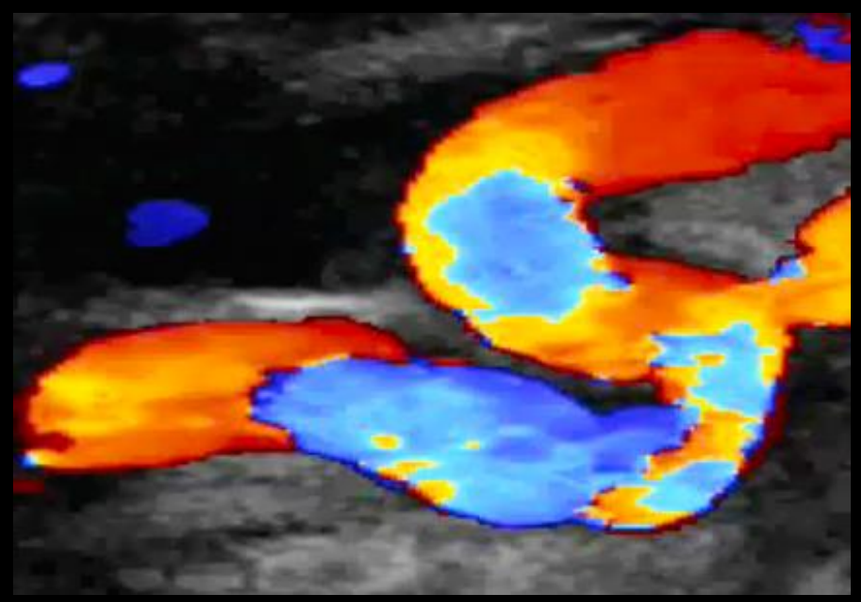
ICA Tortuosity

Kinking 5%

~27% of which is bilateral







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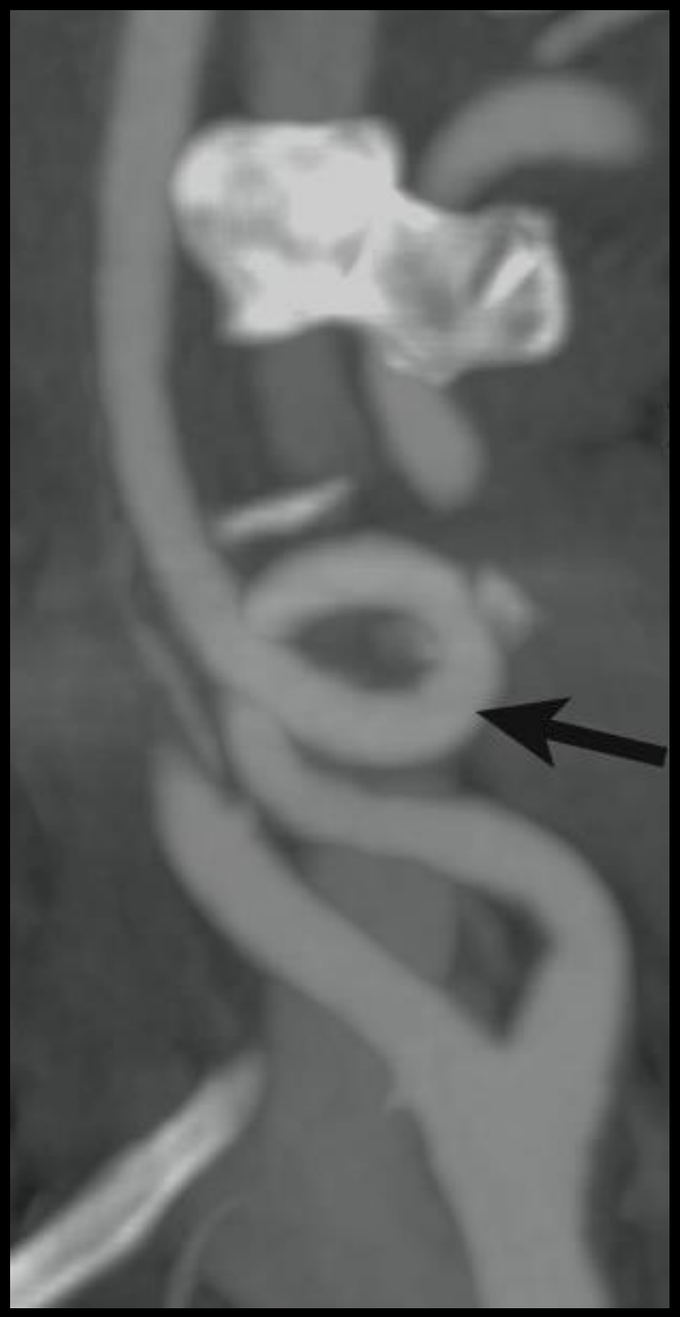
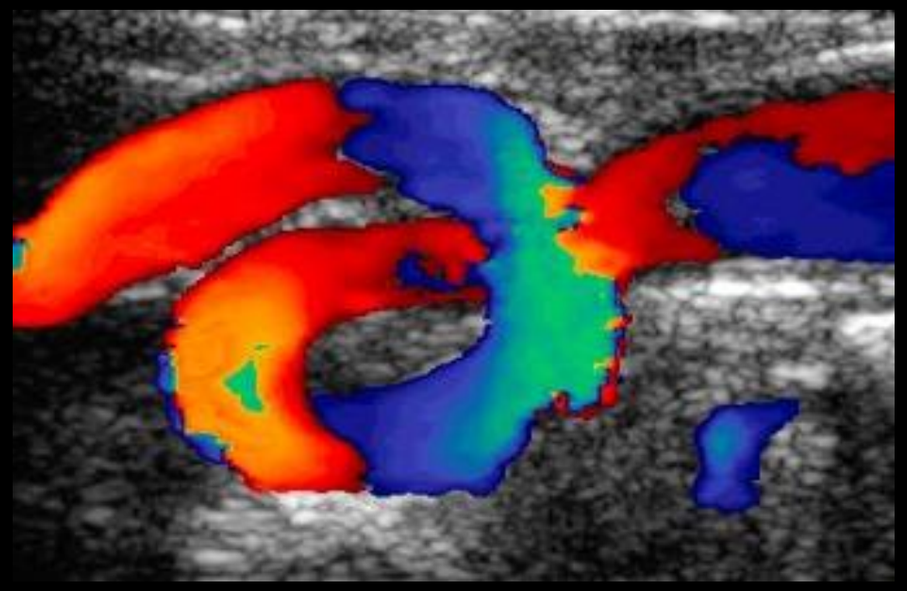
ICA Tortuosity

Coiling 6%

~53% of which is bilateral





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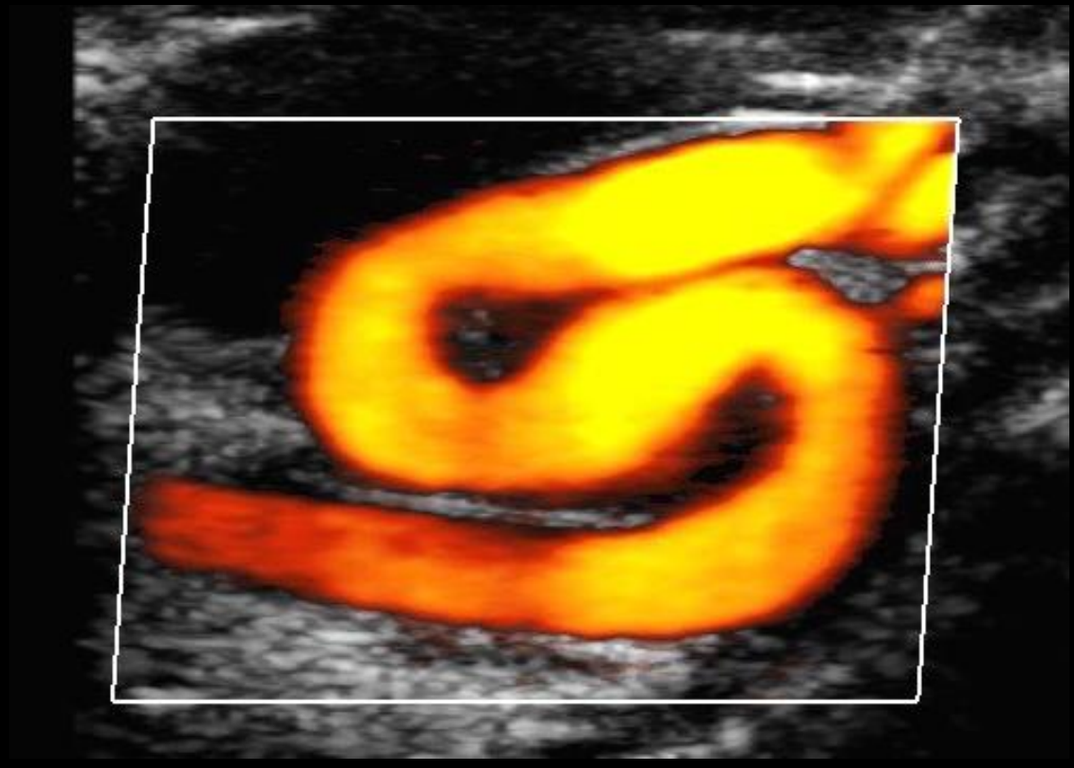
ICA Tortuosity

S-Shaped Curve

Not specific to FMD, though when noted on CDU < 70 YO -> high suspicion for the presence of FMD



Fibromuscular Dysplasia: State of the Science and Critical Unanswered Questions
A Scientific Statement From the American Heart Association
Jeffrey W. Olin, DO, FAHA, Co-Chair; Heather L. Gornik, MD, MHS, FAHA, Co-Chair;

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Post CEA Evaluation

Takayasu’s Arteritis

Diffuse concentric heterogeneous thickening of the intima and media of the CCA

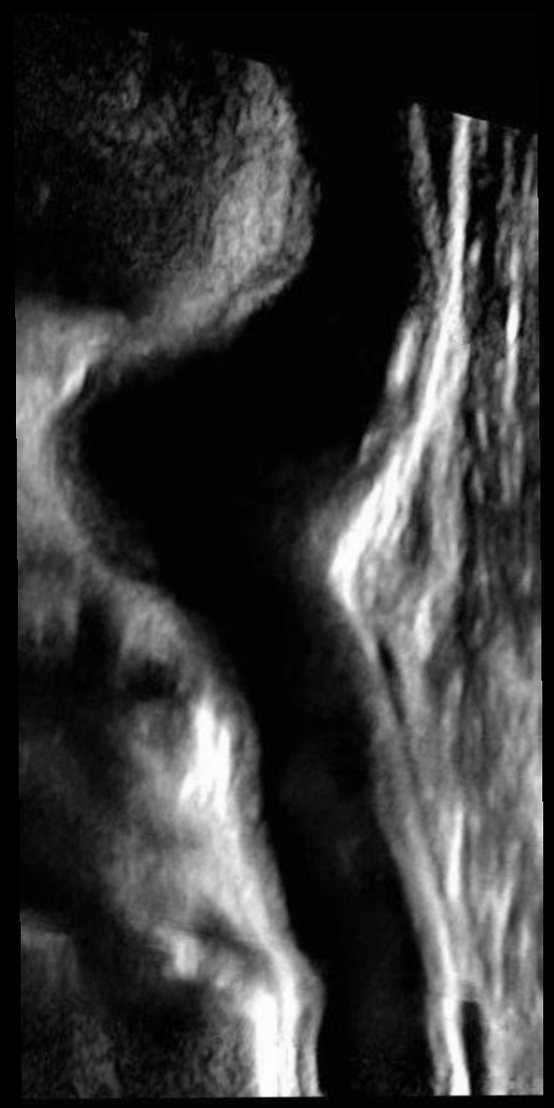
Appearance of a stuffed macaroni: “Macaroni Sign”

Aortitis - Circulation by HL Gornik- 2008

Maeda H, Handa N et al. Carotid lesions detected by B-mode ultrasonography in Takayasu's arteritis: “Macaroni sign” as an indicator of the disease.Ultrasound in Medicine & Biology, Volume 17, Issue 7, 1991

Carotid Artery Aneurysm

- Defined as:
  Bulb dilatation > 200% of the diameter of the ICA or 150% of the diameter of the CCA
- Epidemiology:
  Rare < 1% of all carotid pathologies
- Male:female=2:1, Age>60



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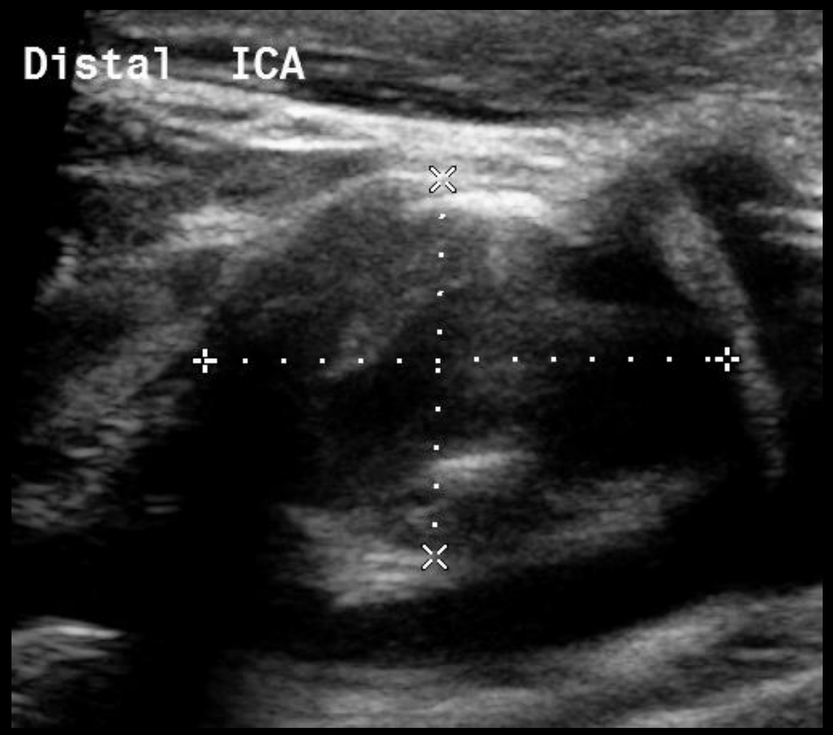
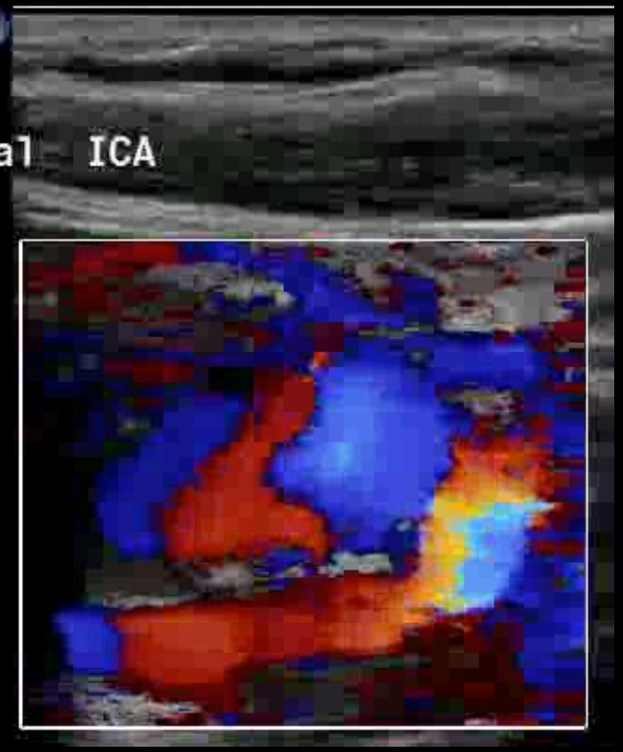
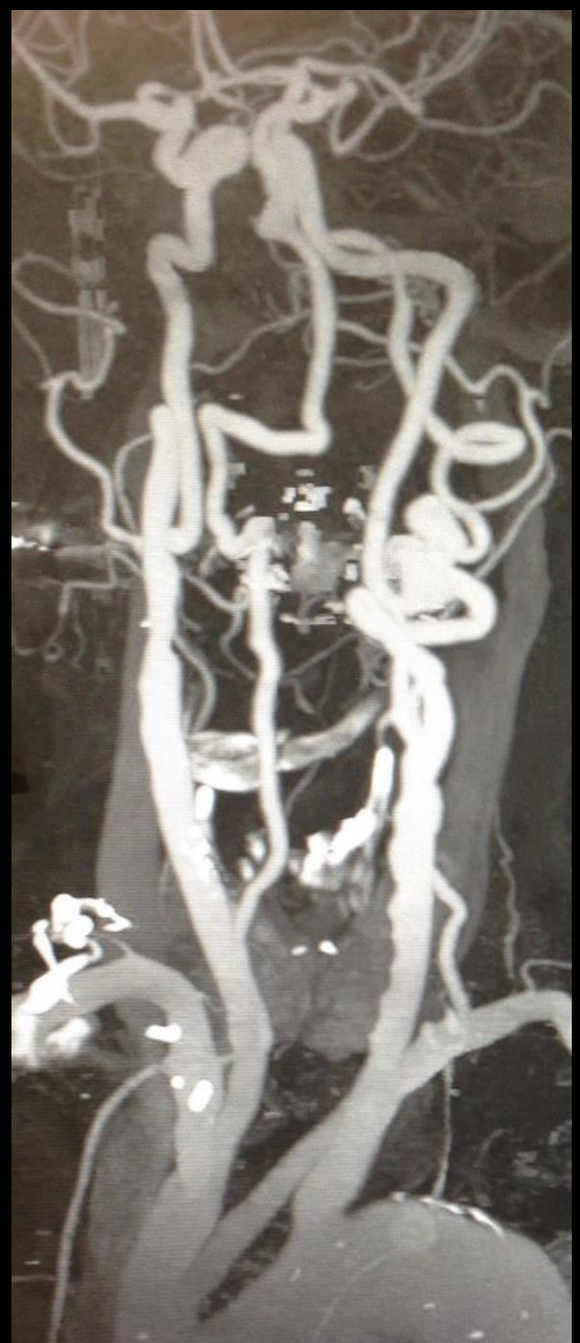
Carotid Artery Aneurysm

- Clinical Presentation: Horners syndrome, pulsatile mass, neurologic symptoms, cranial nerve dysfunction, dysphagia, hemorrhage, and rupture

- Duplex characteristics: saccular dilation with mural thrombus measuring 2 x 2.5 cm







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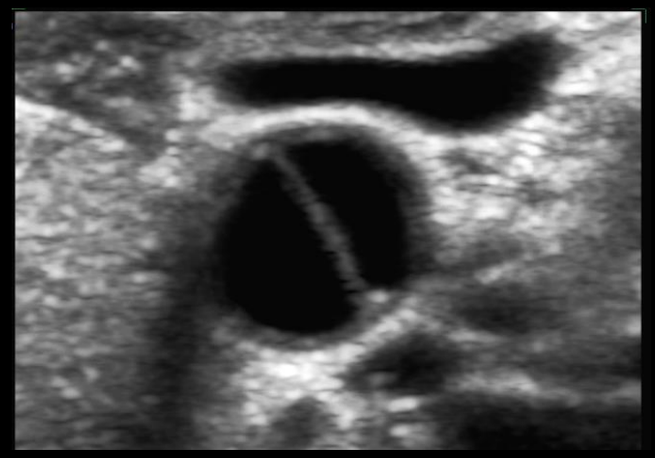
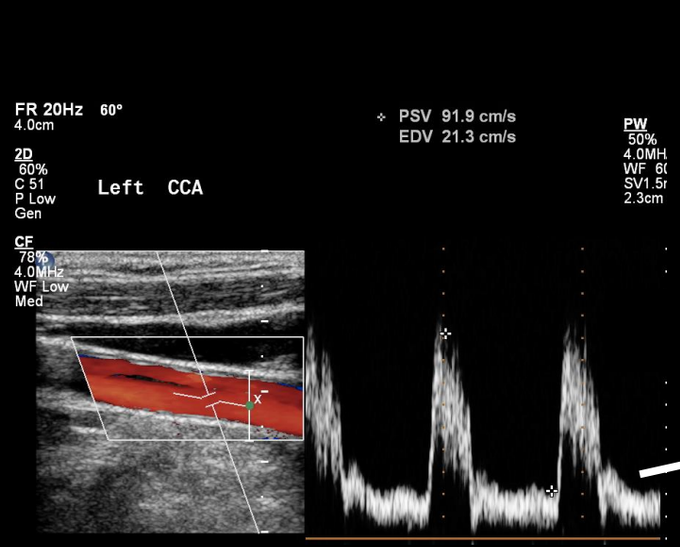
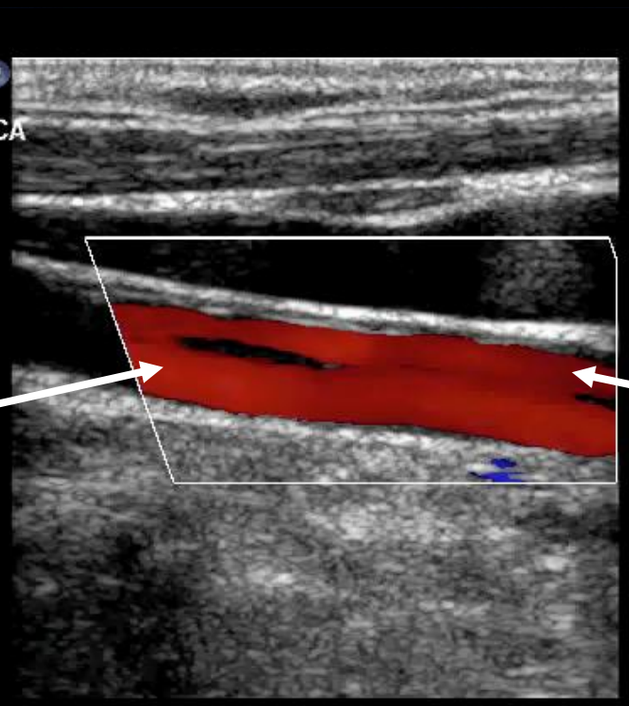
Carotid Artery Dissection

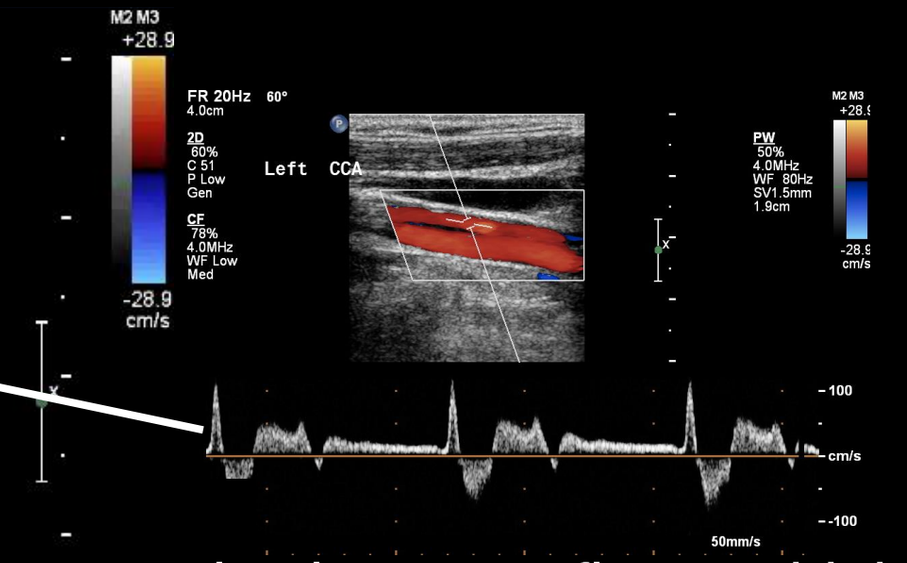


Duplex characteristics: dissection flap, true and false lumens and differential flow patterns



True lumen: forward flow with normal peak and end diastolic velocities





False lumen: reflects a high resistance bidirectional flow pattern with minimal diastolic flow

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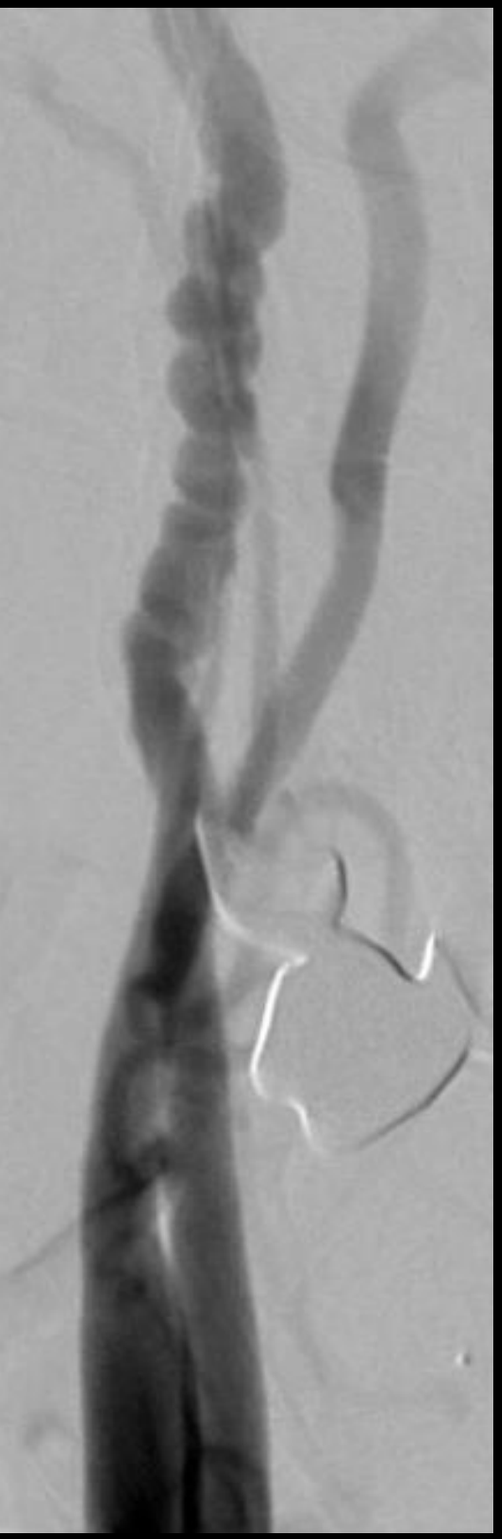
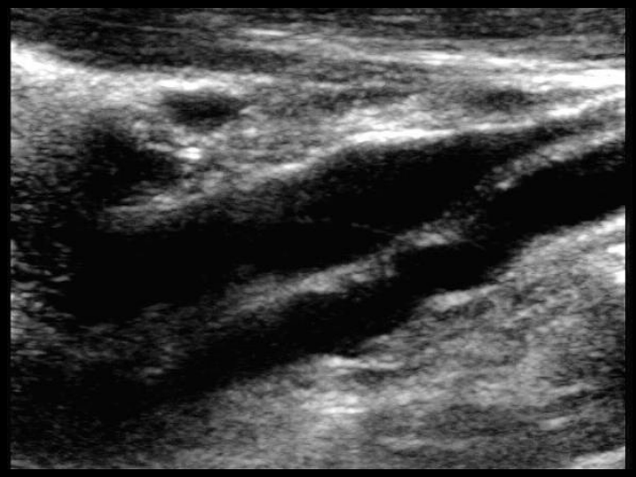
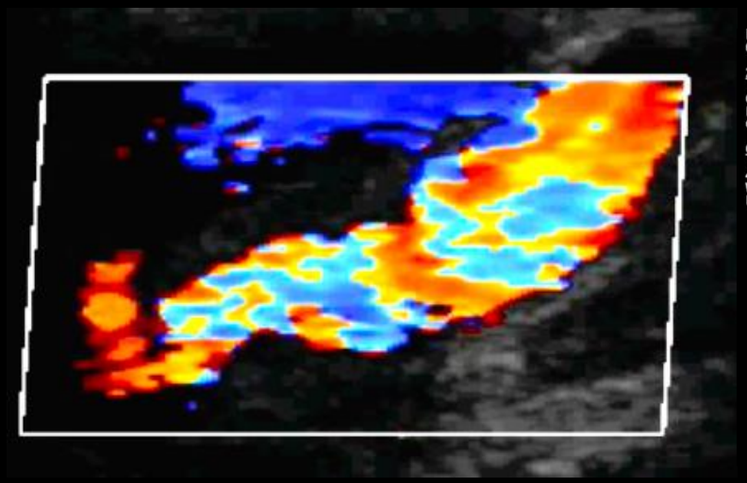
Carotid FMD



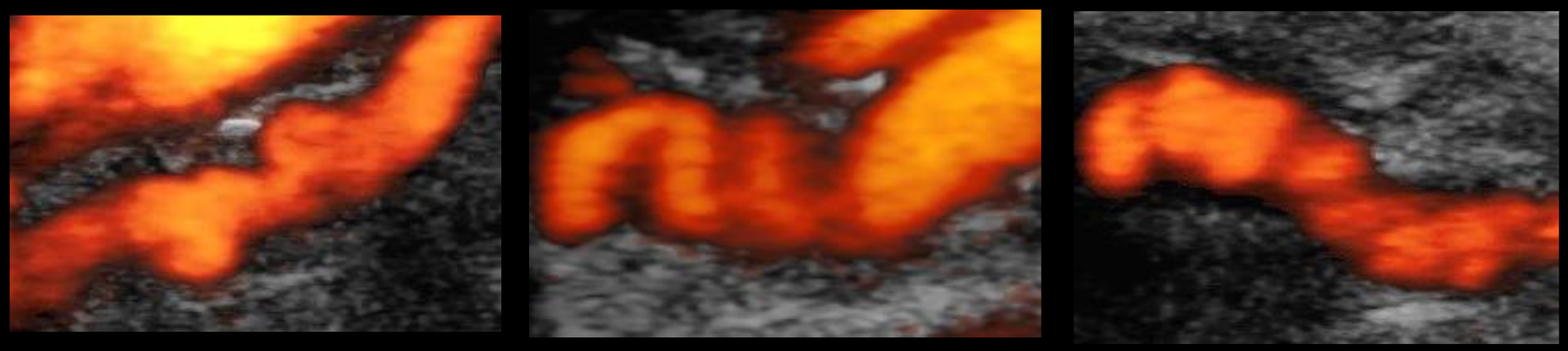


Gray Scale



Color Flow

Spectral Doppler



Mid and Distal ICA FMD Power Doppler

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Thank You