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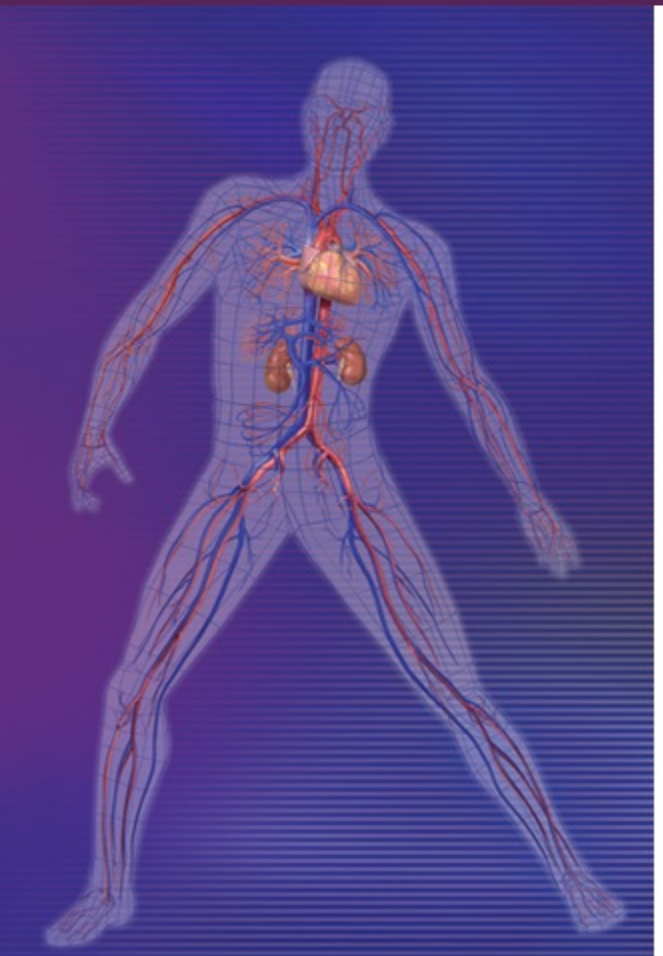

Appropriate Screening for Vascular Disease

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What is Peripheral Artery Disease?

"Atherosclerosis is a progressive process affecting multiple vascular beds: its clinical consequences, which include coronary artery disease, cerebrovascular disease, and peripheral artery disease, are potentially life threatening."

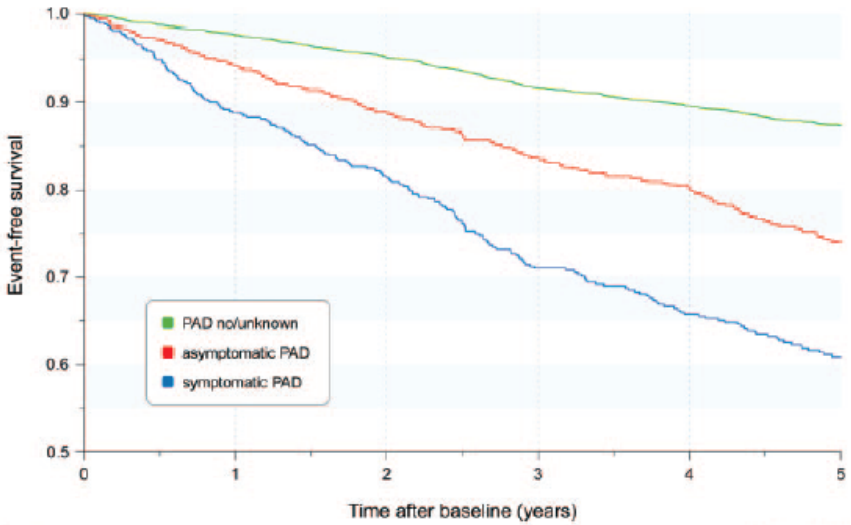
Marso SP, Hiatt WR. J Am Coll Cardiol 2006;47:921-9

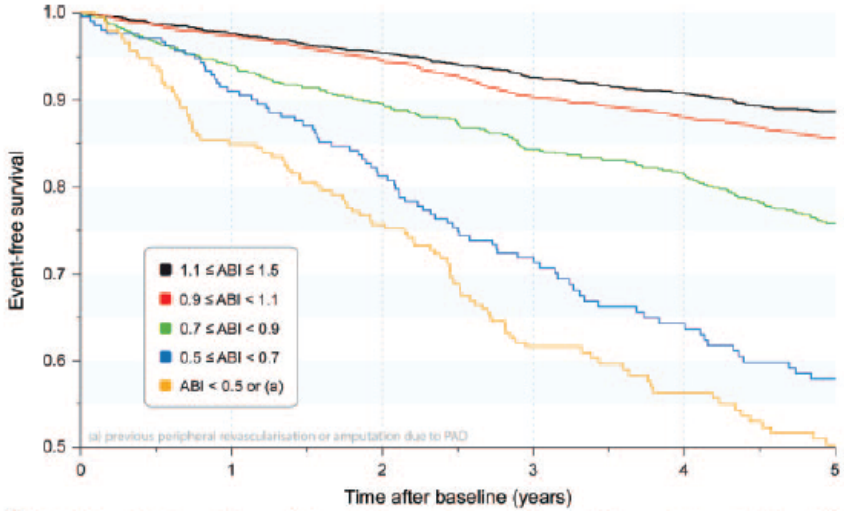
What is Peripheral Artery Disease?

PAD is arterial obstruction of the lower extremity arteries resulting in exertional limb discomfort or, in advanced cases, critical limb ischemia/CLI (rest pain, ulceration, gangrene)

Mortality and Vascular Morbidity in Older Adults With Asymptomatic Versus Symptomatic Peripheral Artery Disease

- 6880 patients ≥65 years of age followed for 5 years
  - 5392 patients without PAD
  - 836 asymptomatic with ABI <0.9
  - 593 with symptomatic PAD





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Circulation 2009;120:2053

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Historical Clues to the Diagnosis of Intermittent Claudication

Variable symptom complex described as:
Pain
Ache
Tiredness
Tightness
Soreness
Weakness
Numbness

in legs, provoked by walking and relieved by rest

Is the Limb Pain Vascular?

Historical Clue	Vascular Etiology	Neurogenic Etiology
Onset	Predictable	Variable
Only With Walking?	Yes	No
Relief With Stopping/Standing?	Yes	Variable
Absent Pedal Pulses at Rest	Variable	Variable

Differential Diagnosis of PAD

- Intermittent Claudication
  - Atherosclerosis
    - Stenotic
    - Embolic
  - Non-Atherosclerotic
    - TAO/Buerger's
    - PAES
    - CAD of the Popliteal Artery
    - FMD
    - Vasculitis
- Neurogenic Causes
  - Lumbar Canal Stenosis
  - Peripheral Neuropathy
- Venous Claudication

- Musculoskeletal Causes

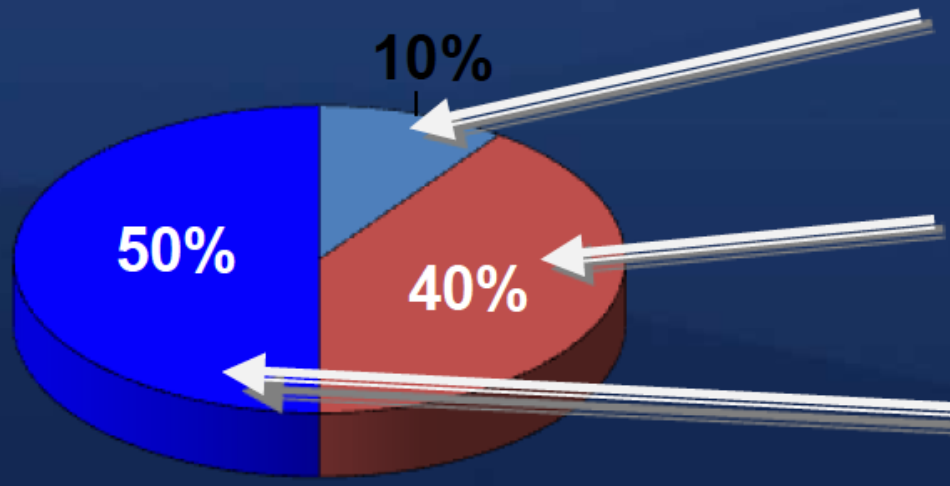
Arthritis
Bursitis
Tendonitis
Tight hamstring/ quadriceps musculature

- Podiatric Causes

Plantar Fasciitis
Calcaneal Spurs

PAD Symptoms

Classic Claudication Asymptomatic Atypical Symptoms



- Only 8%–10% of patients with peripheral arterial disease (PAD) have "classic" claudication
- ~40% of patients with PAD have "atypical" leg symptoms
- ~50% of patients with PAD are asymptomatic with regard to the leg

Elevation Pallor/Dependent Rubor

What's Wrong Here?

IMPRESSION:
Cortical irregularity and fragmentation surrounding the fifth MTP joint with adjacent soft tissue swelling, suspicious for septic arthritis.

ACC/AHA PAD Guidelines

Testing Strategies Based on Presentation

Clinical Presentation	Noninvasive Vascular Test
Asymptomatic lower extremity PAD	ABI
Claudication	ABI, PVR, or segmental pressures Duplex ultrasound Exercise test with ABI to assess functional status
Possible pseudoclaudication	Exercise test
Postoperative vein graft follow-up	Duplex ultrasound
Femoral pseudoaneurysm; iliac or popliteal aneurysm	Duplex ultrasound
Suspected aortic aneurysm; serial AAA follow-up	Abdominal ultrasound, CTA, or MRA
Candidate for revascularization	Duplex ultrasound, MRA, or CTA

ARTERIAL TESTING

- Instrumentation
- Indirect Testing
  - Pressure Measurement (ABI, segmental, toe)
  - Treadmill exercise test
  - Plethysmography (PVR, digital)
- Duplex Scanning (Direct Testing)
  - Carotid / Transcranial Doppler (TCD)
  - Abdominal / Visceral (aortic, mesenteric, renal)
  - Lower / upper extremity
  - Special: bypass grafts, vascular masses, IVUS, EVAR

PAD is Defined by the ABI

1. For the left side, divide the left ankle pressure by the highest brachial pressure and record the result.
2. Repeat the steps for the right side.
3. Record the ABI's and place the results in the medical record.

Right Leg ABI

Right Ankle Pressure

Highest Arm Pressure

Left Leg ABI

Left Ankle Pressure

Highest Arm Pressure

ABI Interpretation

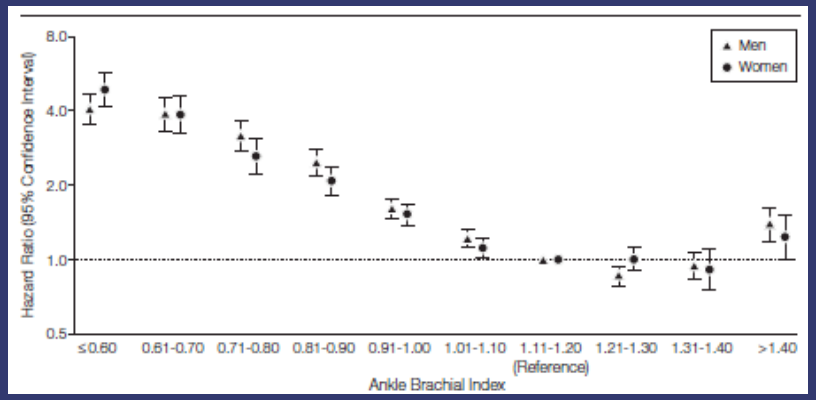
≤ 0.90 is diagnostic of peripheral arterial disease

Hiatt WR. N Engl J Med. 2001;344:1608-1621; TASC Working Group. J Vasc Surg. 2000;31(1Suppl):S1-S296.

Interpretation and Limitations of ABI

ABI Interpretation

>1.30	**Non-Compressible**
>1.0-1.30	**Normal**
0.91-1.00	**Borderline**
0.71-0.90	**Mild PAD**
0.41-0.70	**Moderate PAD**
0.00-0.40	**Severe PAD**



2 Main Limitations

- Calcified ankle vessels result in artificially "normal" ABI (DM, RF)

- Normal ABI in patient with Aortoiliac Disease—only becomes abnormal with exercise testing

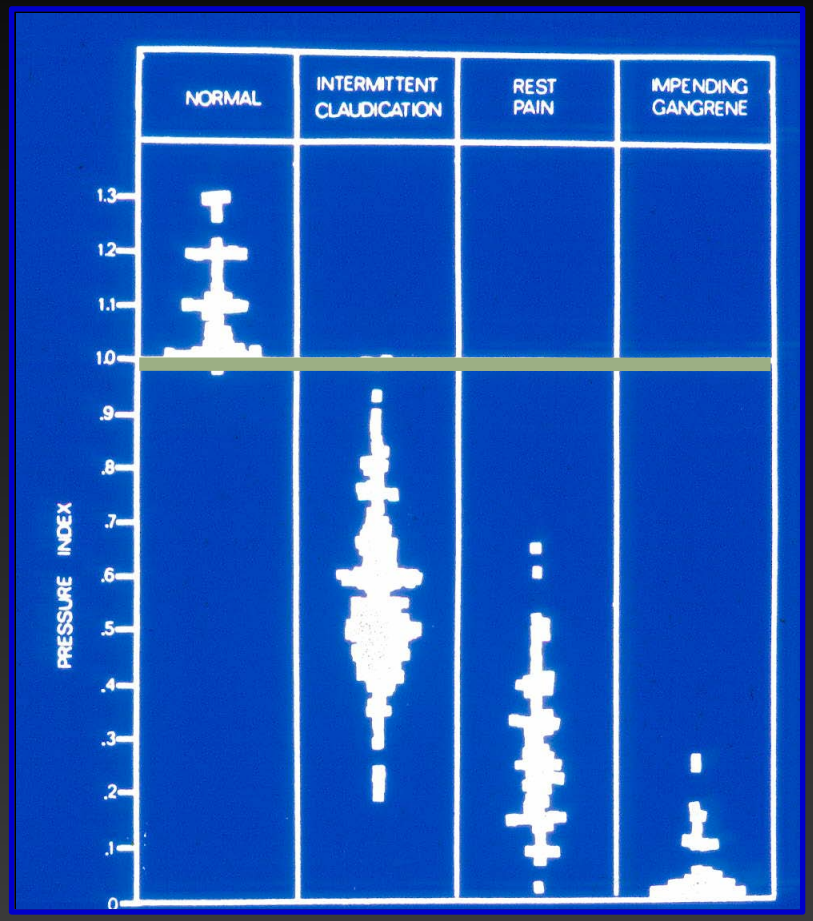
ABI vs. OTHER COMMON SCREENING TESTS

Diagnostic Test	Sensitivity, %	Specificity, %
Pap smear	30–87	86–100
Fecal occult blood test	37–78	87–98
Mammography	75–90	90–95
ABI	95	100

Adapted from Belch, JJ, et al.*Arch Int Med.* 2003;163:884-892

ANKLE / BRACHIAL INDEX (ABI)

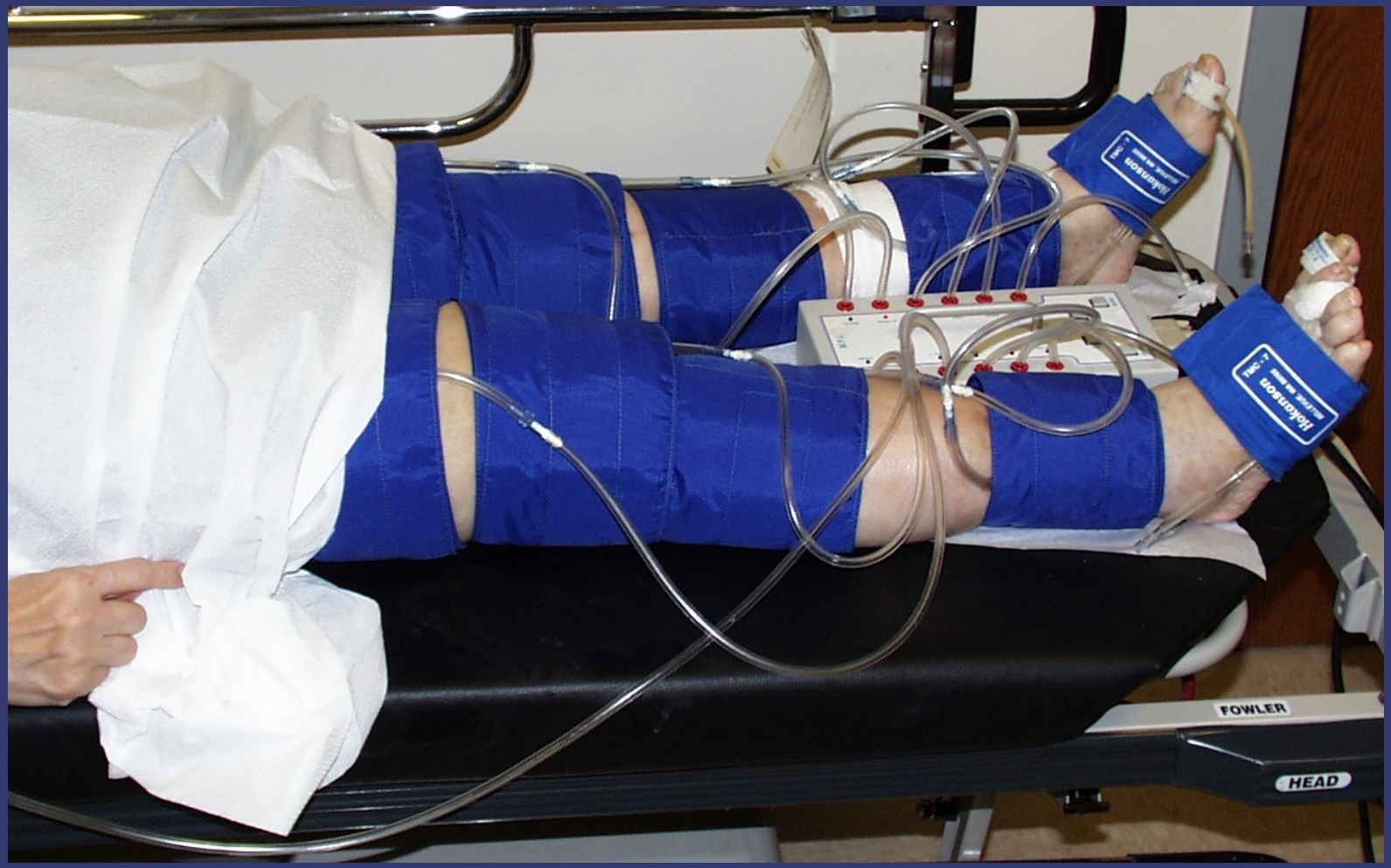
Normal	1.11
Claudication	0.59
Rest Pain	0.26
Impending Gangrene	0.05
Single Level Disease	>0.5
>0.5	
Multilevel Disease	<0.5



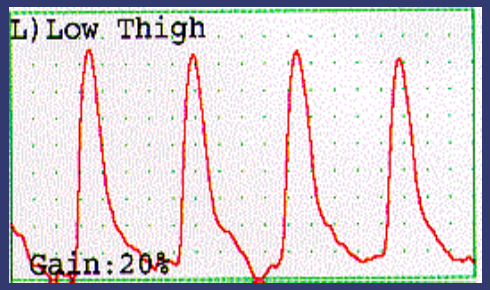
Next Tests in Evaluation of PAD…

- Segmental Limb Pressures
- Pulse Volume Recordings
- Doppler Waveforms
- Exercise Treadmill Testing

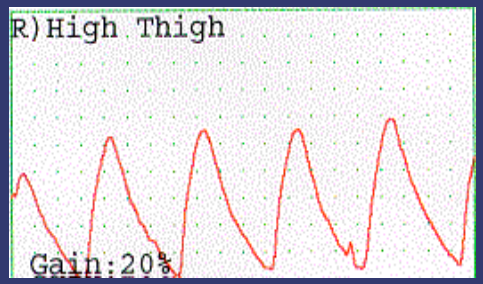
Patient Set Up



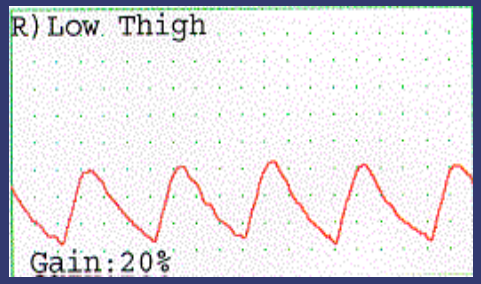
Pulse Volume Recordings (PVR)



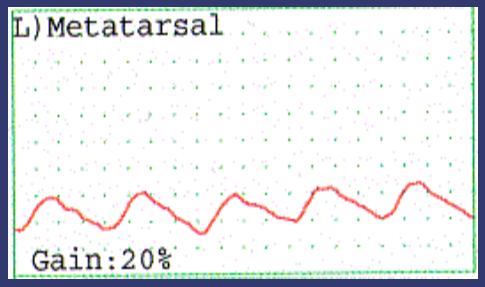
Normal



Mild



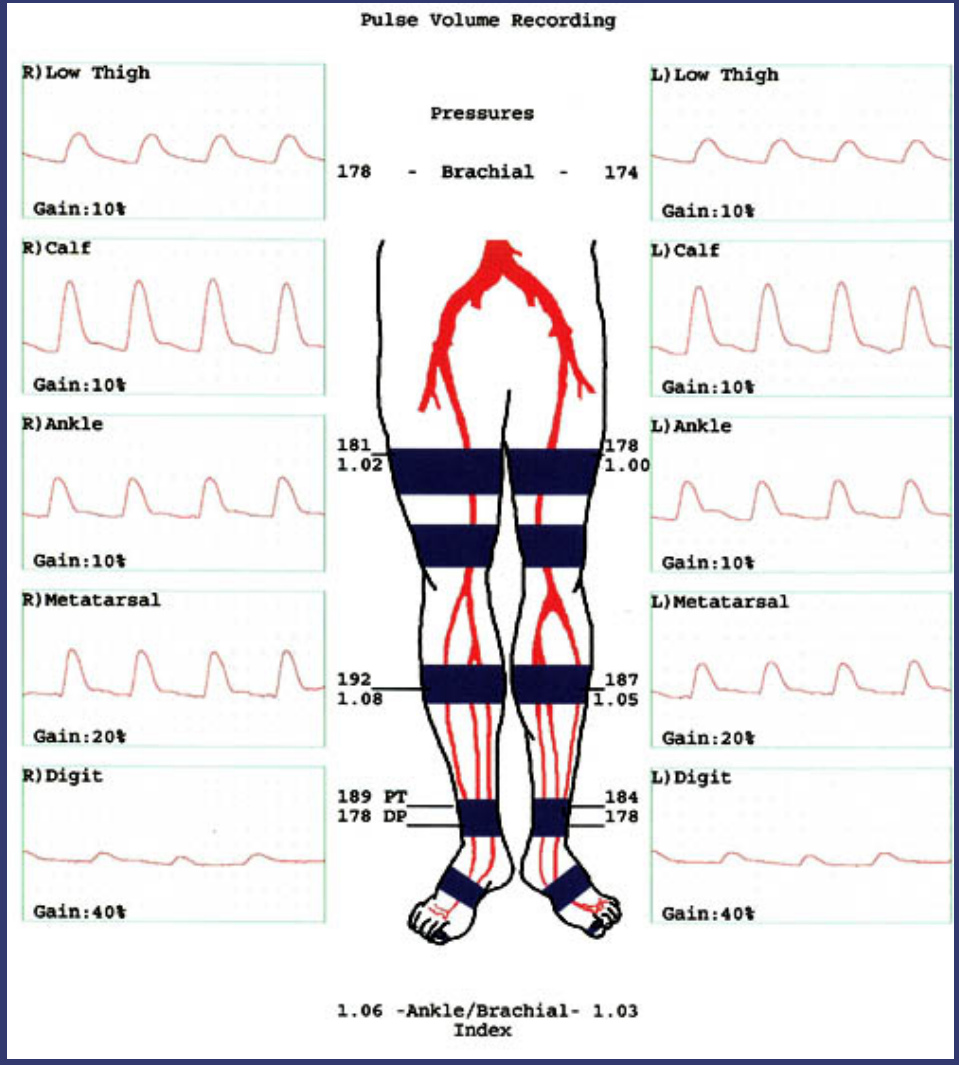
Moderate



Severe

Normal Lower Extremity Arterial Study

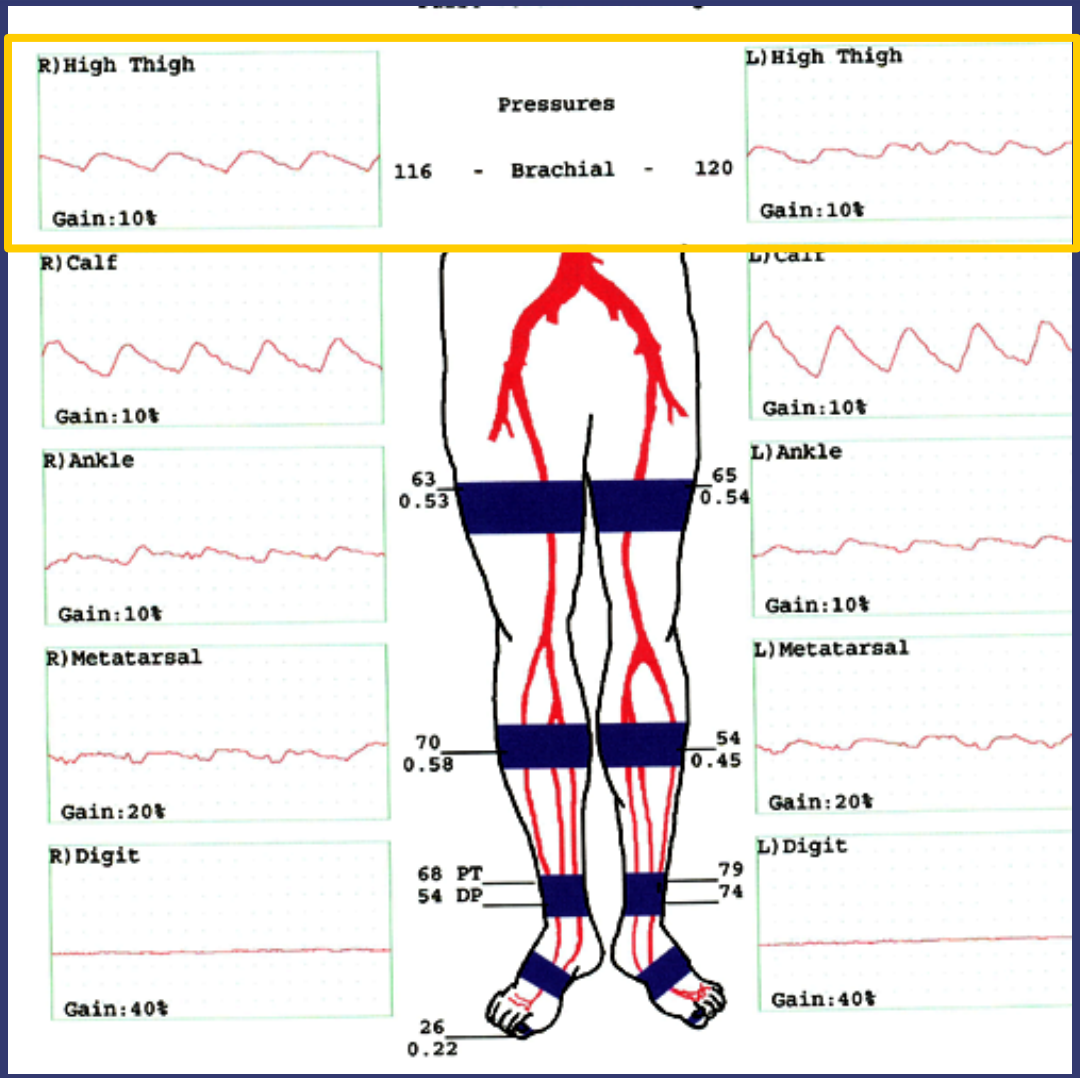
Augmentation of Calf PVR



TREADMILL EXERCISE TEST

- Response of ankle systolic pressure to walking
- Confirm diagnosis of claudication
- Differentiate between claudication and other causes of leg pain
- Quantitate degree of physiologic abnormality

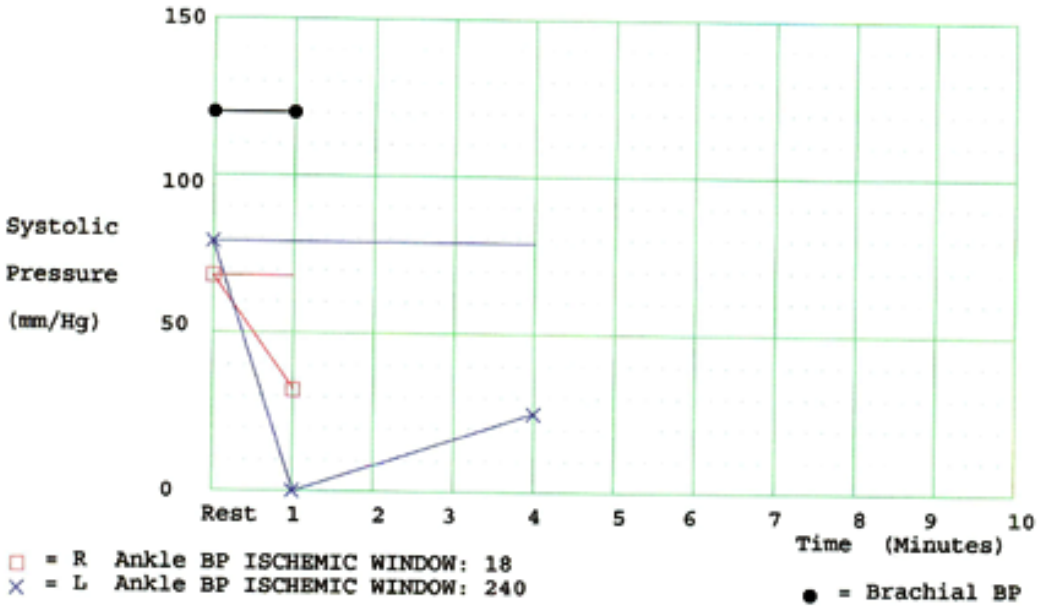
36 yo Female with Low Back and Bilateral Buttock Ache with Walking



Exercise Study

Exercise

	Rest	1	2	3	4	5	6	7	8	9	10
Brachial BP	120	120									
R Ankle BP	68	32									
L Ankle BP	79	00			25						
R ABI	0.57	0.27									
L ABI	0.66	0.00			N/A						



Bilateral calf pain at 40 seconds
Thigh pain at 50 minutes, L > R
2.0 mph 12% Second
L calf tightening at 3:30
R calf tightening at 4:00

Critical Limb Ischemia

TOE/BRACHIAL INDEX (TBI)

- Digital arteries remain compressible in diabetics
- Reliable measure of arterial disease severity in patients with diabetes
- Normal TBI ≥0.70

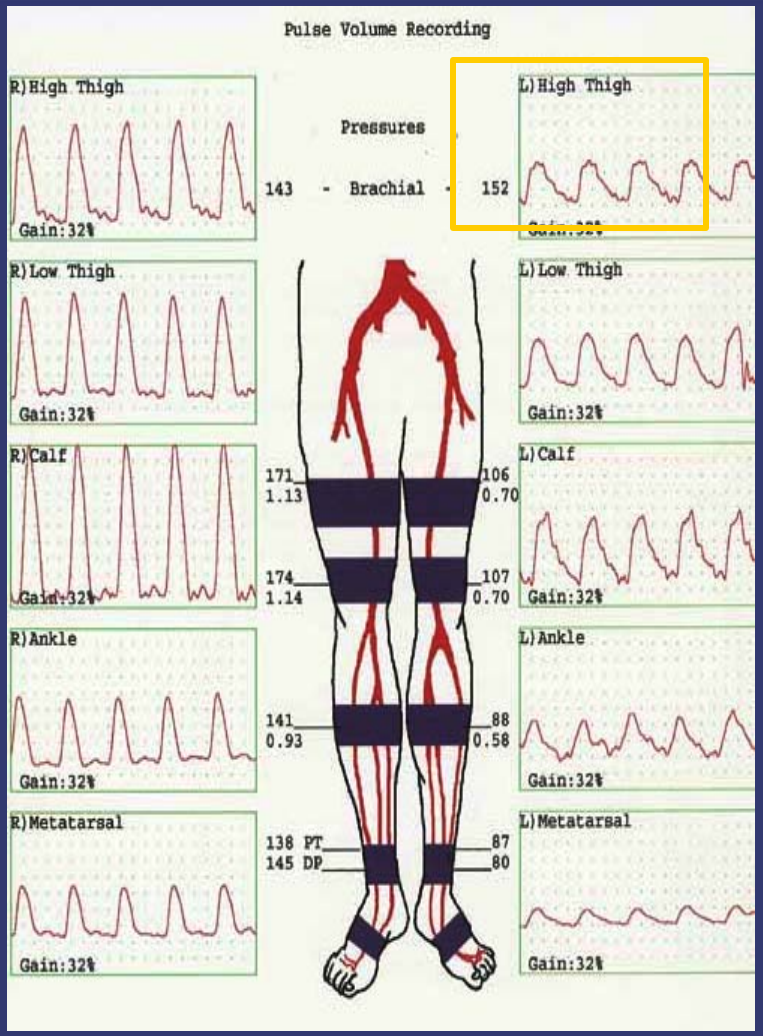
- Absolute toe pressure <30 mmHg - rest pain
- Toe/foot lesions are unlikely to heal if the absolute toe pressure is <20-30 mmHg

DUPLEX INSTRUMENTS

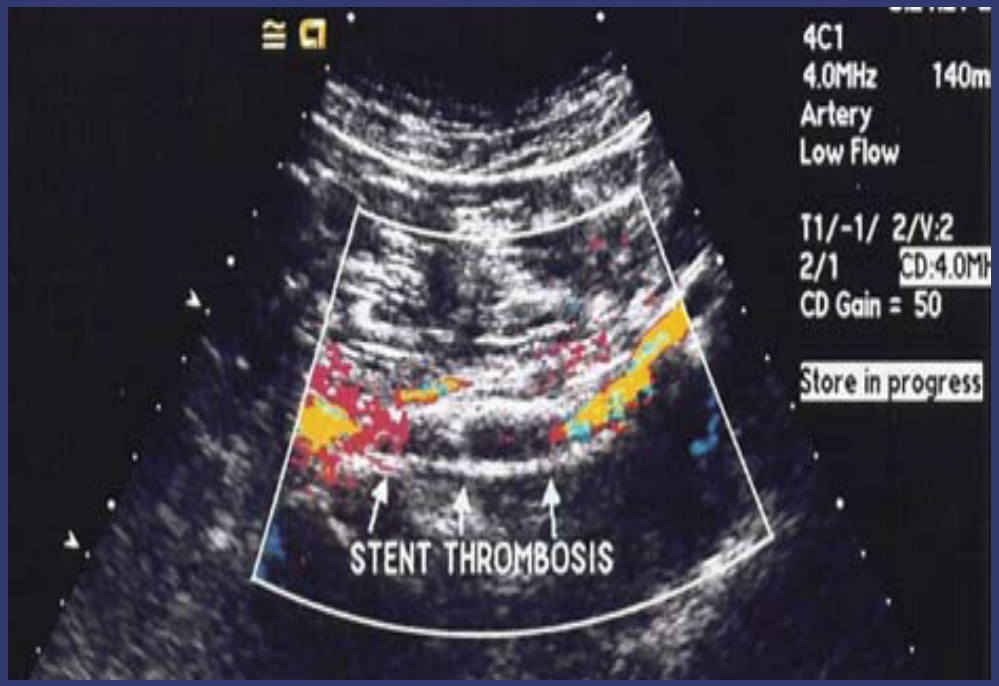
Arterial Duplex Ultrasound Testing — The "Non-Invasive Arteriogram"

- Reproducible, reliable, accurate
- Painless, risk-free, *relatively* inexpensive
- Predicts ideal access for intervention
- Direct visualization and characterization of arterial stenosis, occlusion, injury
- Excellent method to assess adequacy of revascularization over time

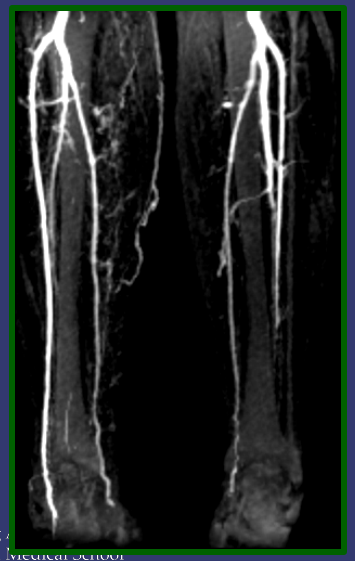
S/P Bilateral Iliac Stents: Recurrent Left Thigh Claudication

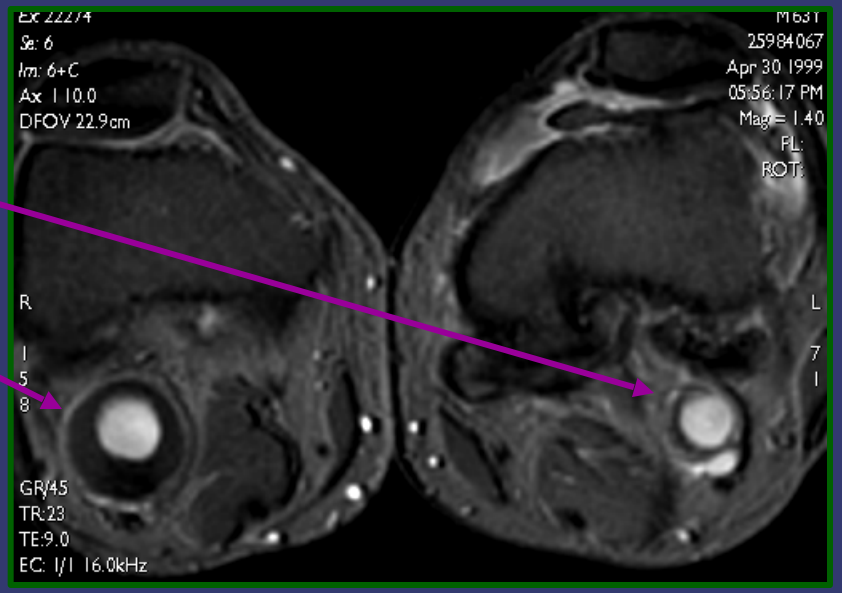


Left Common Iliac Artery



MRA in PAD



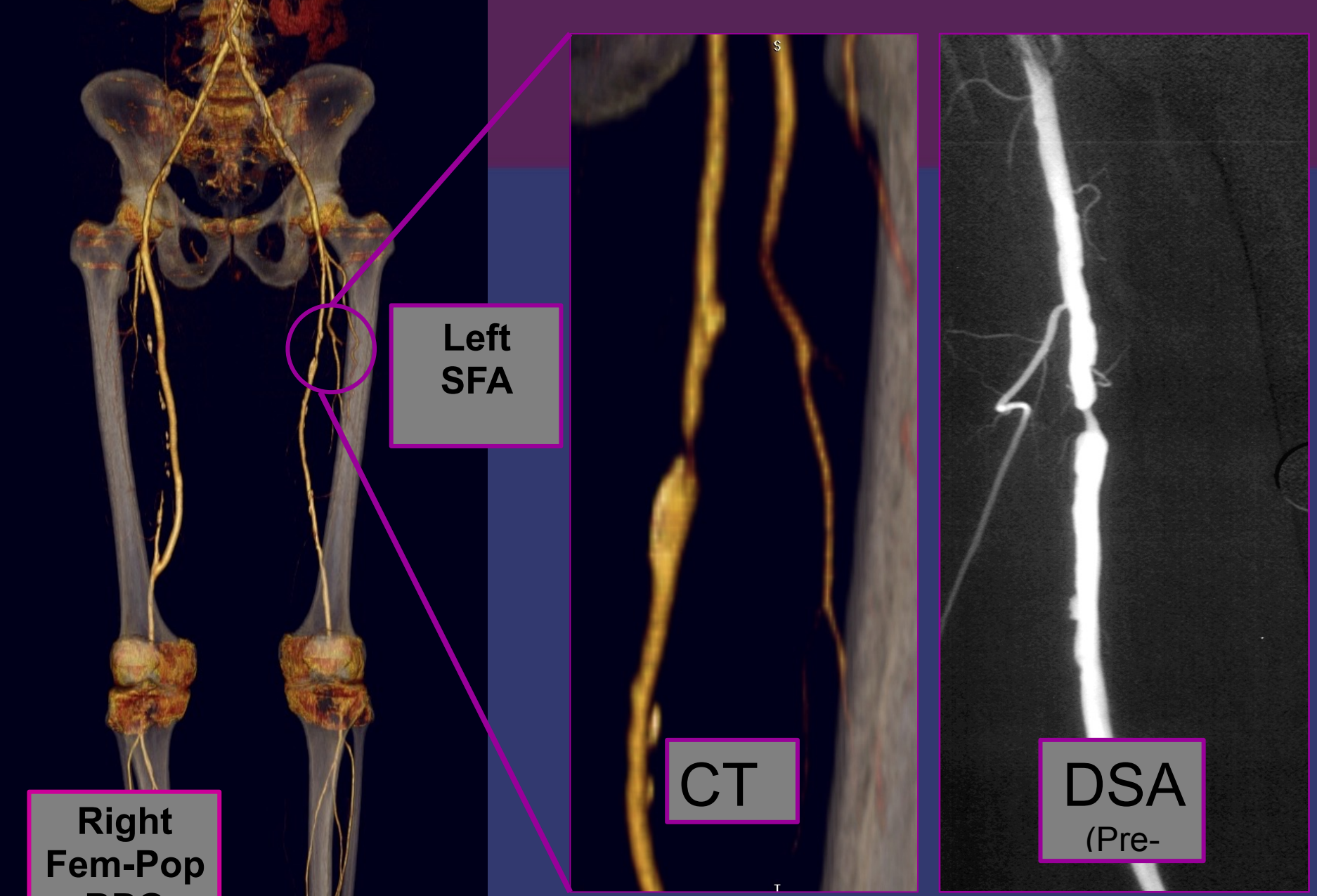

Se: 6
Im: 6+C
Ax 110.0
DFOV 22.9cm
25984067
Apr 30 1999
05:56:17 PM
Mag = 1.40
FL:
ROT:
R
L
GR/45
TR:23
TE:9.0
EC: 1/1 16.0kHz

CTA in PAD

- 100% concordance for presence or absence of disease
- Scan times 48 – 66 secs
- Contrast volume 150cc at 3.5cc/sec
- Four-fold reduction in radiation exposure compared to angiography

Rubin G, et al. Radiology 2001; 221: 146 – 158.

CT Angiography



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CAROTID DUPLEX

Clinical Applications

- Screening
- Asymptomatic bruit
- Hemispheric or ocular TIAs
- Stroke
- Intraoperative assessment
- Follow - up after carotid endarterectomy

CAROTID DUPLEX

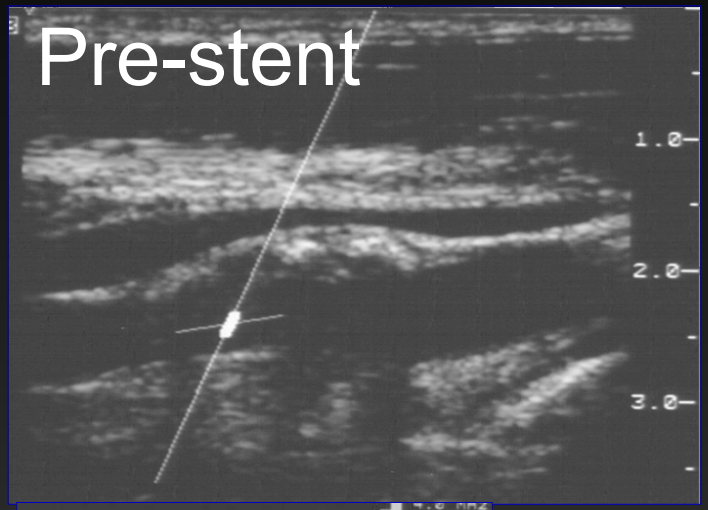
Carotid Criteria Consensus Conference 2002

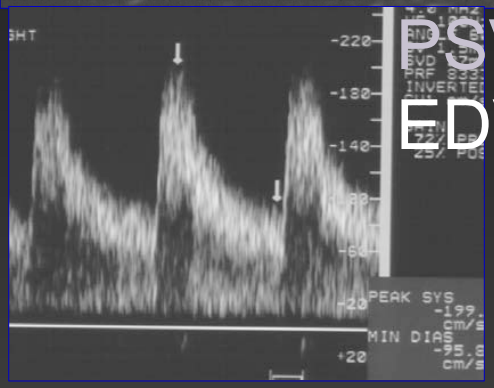
Degree of Stenosis (%)	Primary Parameters		Additional Parameters	
	ICA PSV (cm/sec)	Plaque Estimate (%)*	ICA/CCA PSV Ratio	ICA EDV (cm/sec)
Normal	<125	None	<2.0	<40
<50	<125	<50	<2.0	<40
50–69	125–230	≥50	2.0–4.0	40–100
≥70 but less than near occlusion	>230	≥50	>4.0	>100
Near occlusion	High, low, or undetectable	Visible	Variable	Variable
Total occlusion	Undetectable	Visible, no detectable lumen	Not applicable	Not applicable

Grant EG, et al. *Radiology* 2003; 229:340

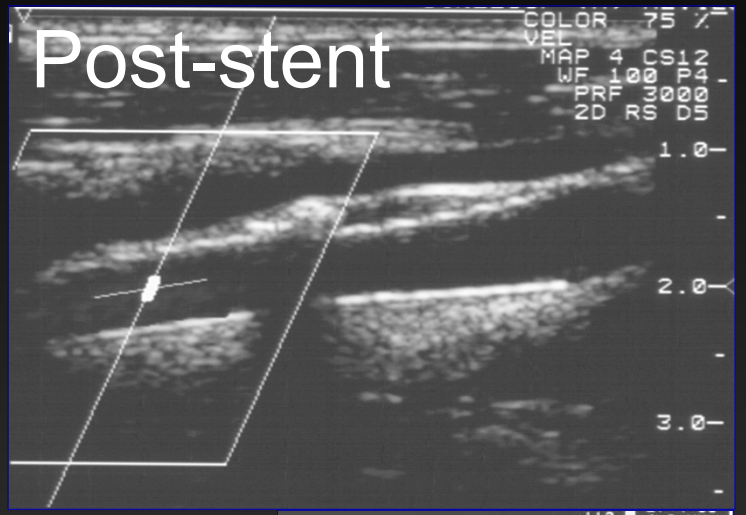
CAROTID DUPLEX

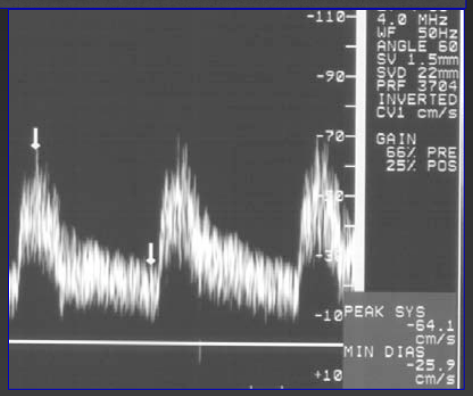
Follow - up of Carotid Stents





PSV 199 cm/s
EDV 95 cm/s





PSV 64 cm/s
EDV 25 cm/s

Contralateral Severe Disease or Occlusion

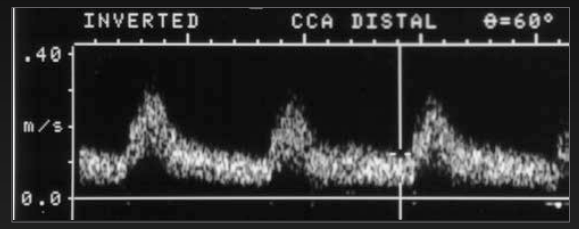
- Contralateral ICA velocities may be falsely elevated due to collaterals
- Correction factors:
  - subtract some velocity (20 cm/sec)
  - ICA / CCA ratio
  - downgrade 1 category
  - recheck after revascularization or grade with CTA, MRA or angiography

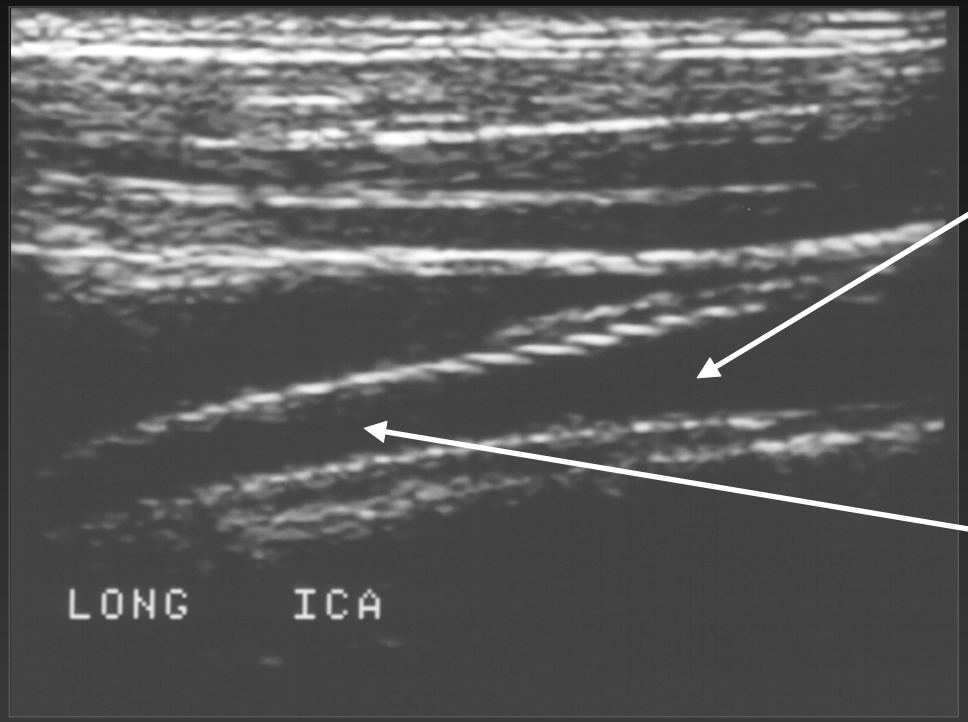
CAROTID DUPLEX

Follow-up of Carotid Stents

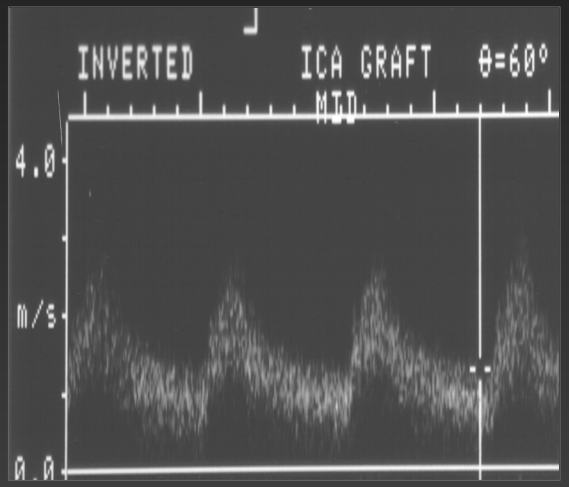
50-79% Stenosis at 12 months?

32 cm/s PSV





274 cm/s PSV

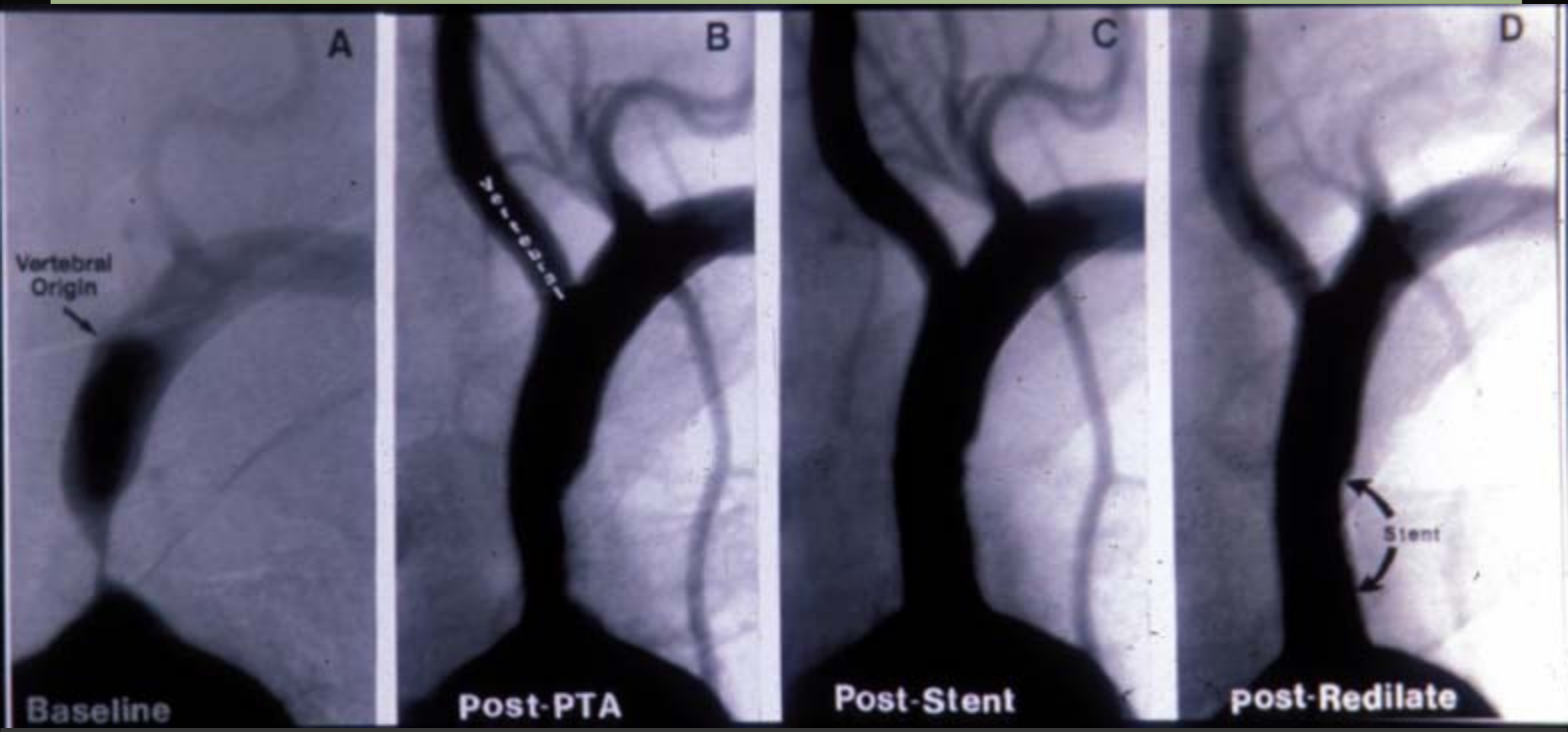


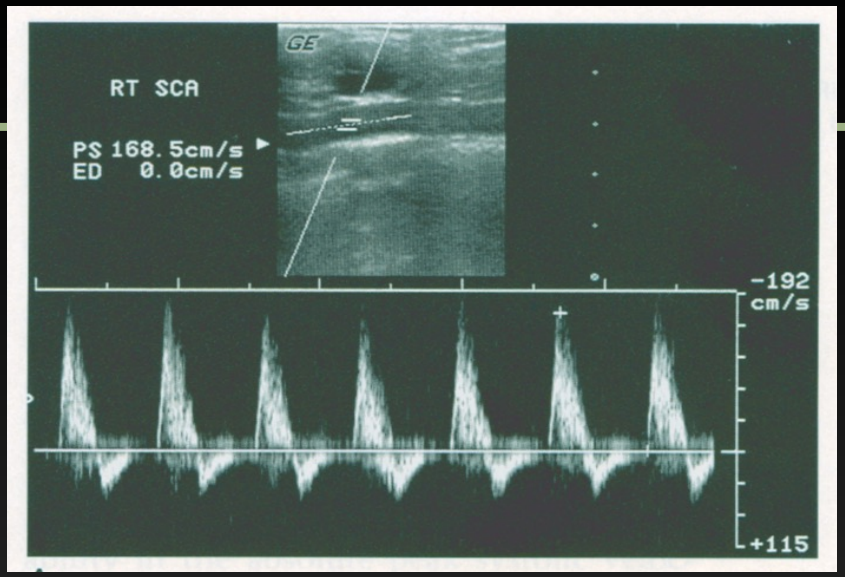
CAROTID DUPLEX

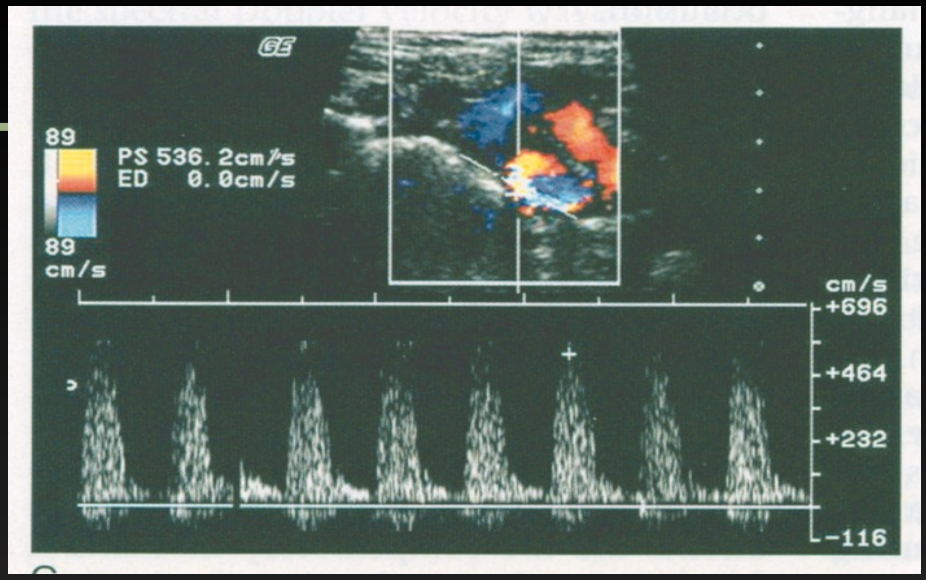
Follow-up of Carotid Stents

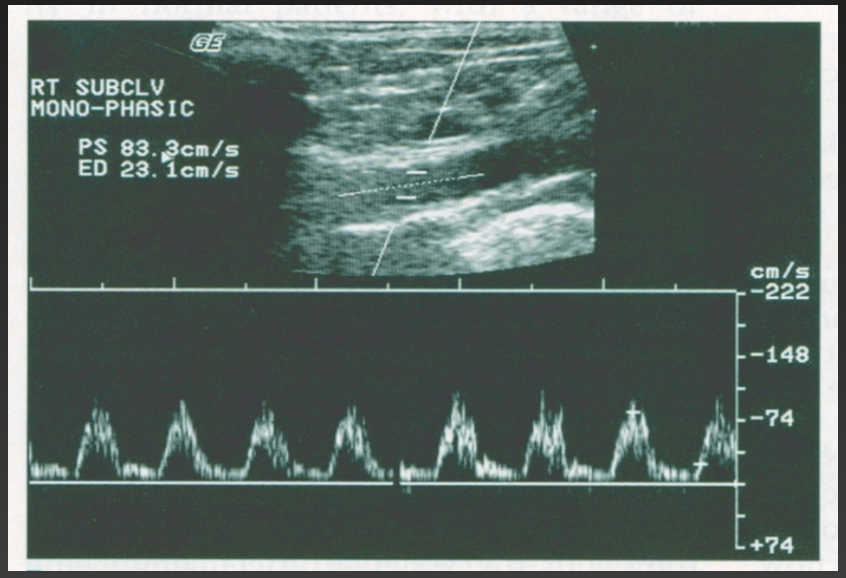
- Peak velocities appear to be higher in widely patent carotid stents than in native normal arteries
- Standard criteria may overestimate the degree of in - stent restenosis
- Specific criteria will be necessary for stented carotid arteries

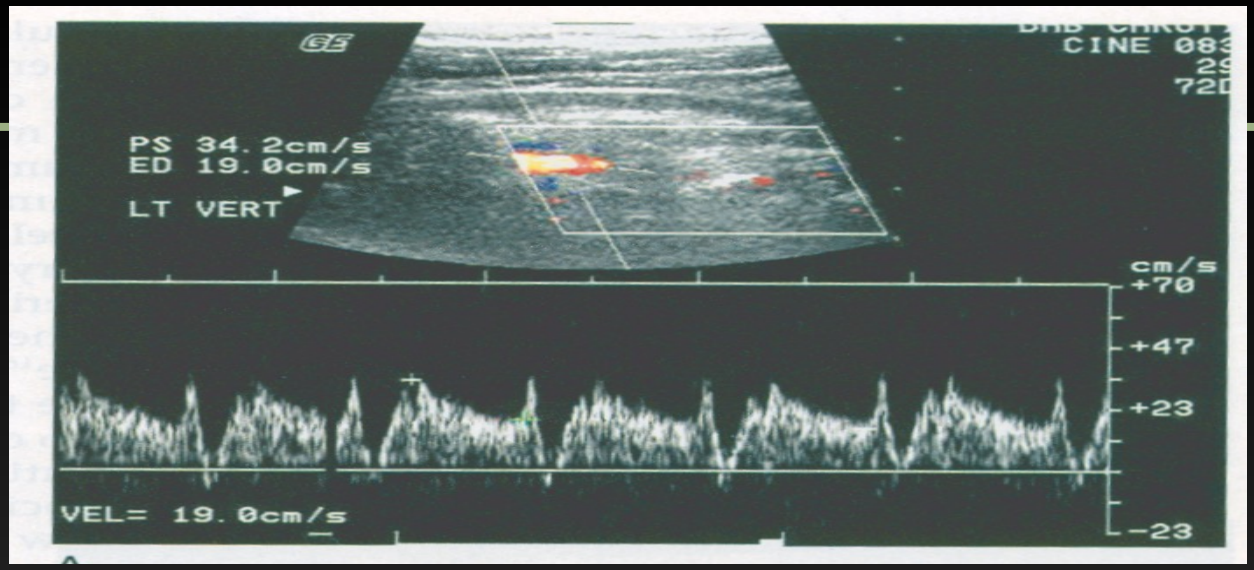
Subclavian Steal Syndrome

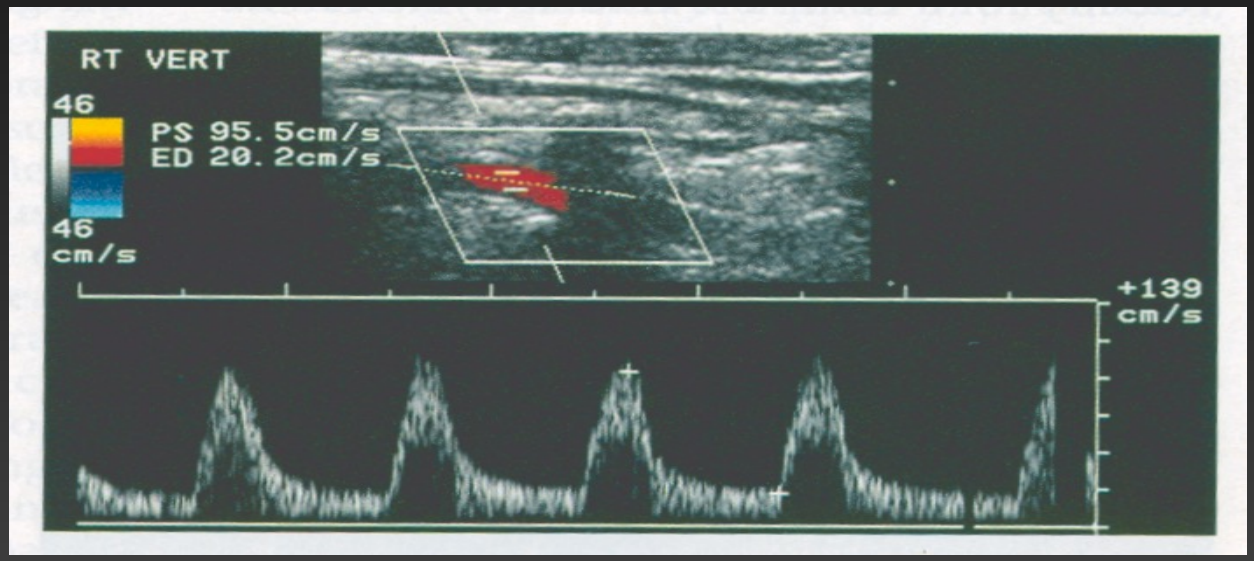



GE
RT SCA
PS 168.5cm/s
ED 0.0cm/s
-192
cm/s
+115

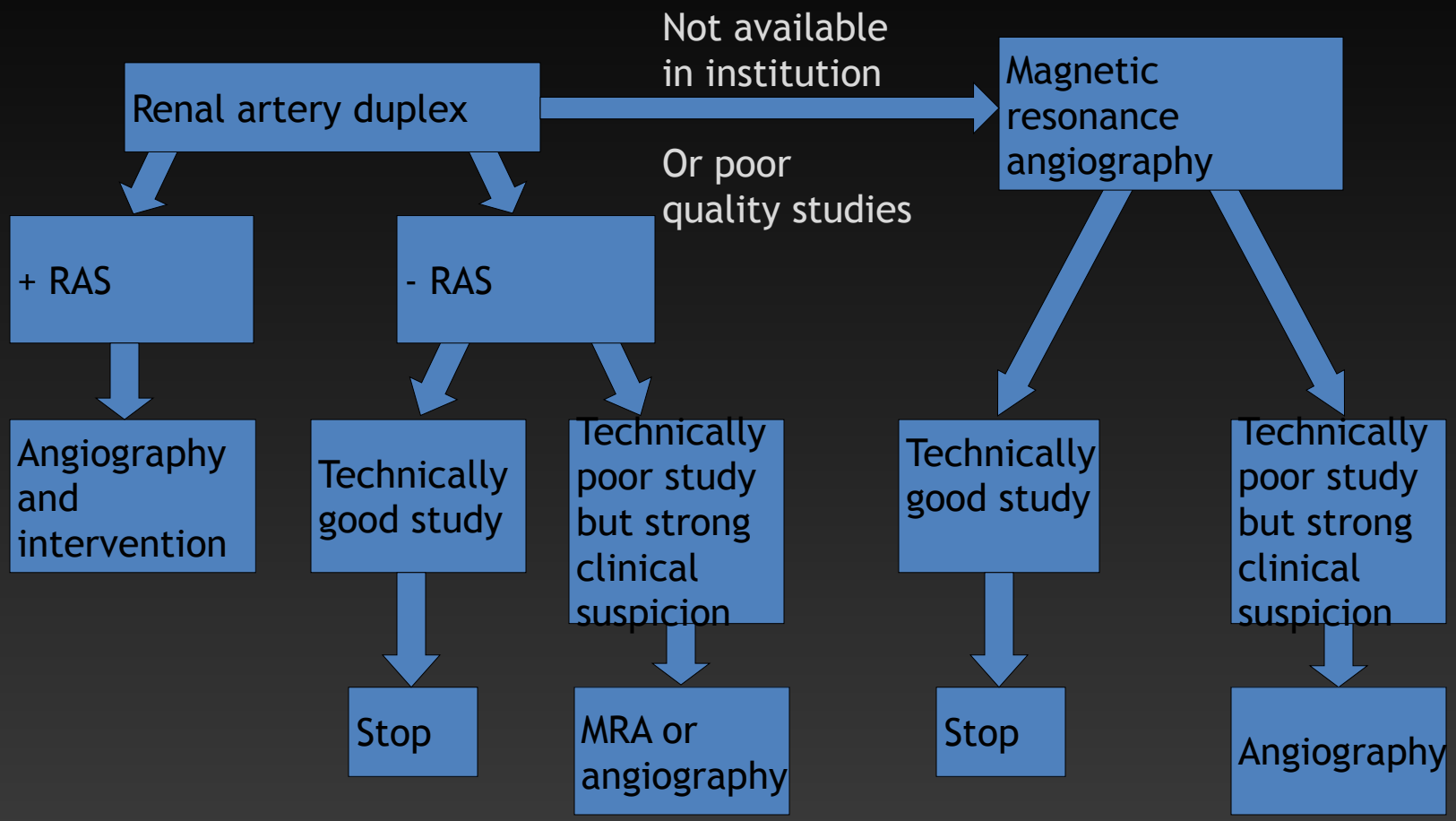

GE
89
89
cm/s
PS 536.2cm/s
ED 0.0cm/s
cm/s
+696
+464
+232
-116


GE
RT SUBCLV
MONO-PHASIC
PS 83.3cm/s
ED 23.1cm/s
cm/s
-222
-148
-74
+74


PS 34.2cm/s
ED 19.0cm/s
LT VERT
cm/s
+70
+47
+23
-23
VEL= 19.0cm/s


RT VERT
46
PS 95.5cm/s
ED 20.2cm/s
46
cm/s
+139
cm/s

Clinical Suspicion of Renal Artery Stenosis

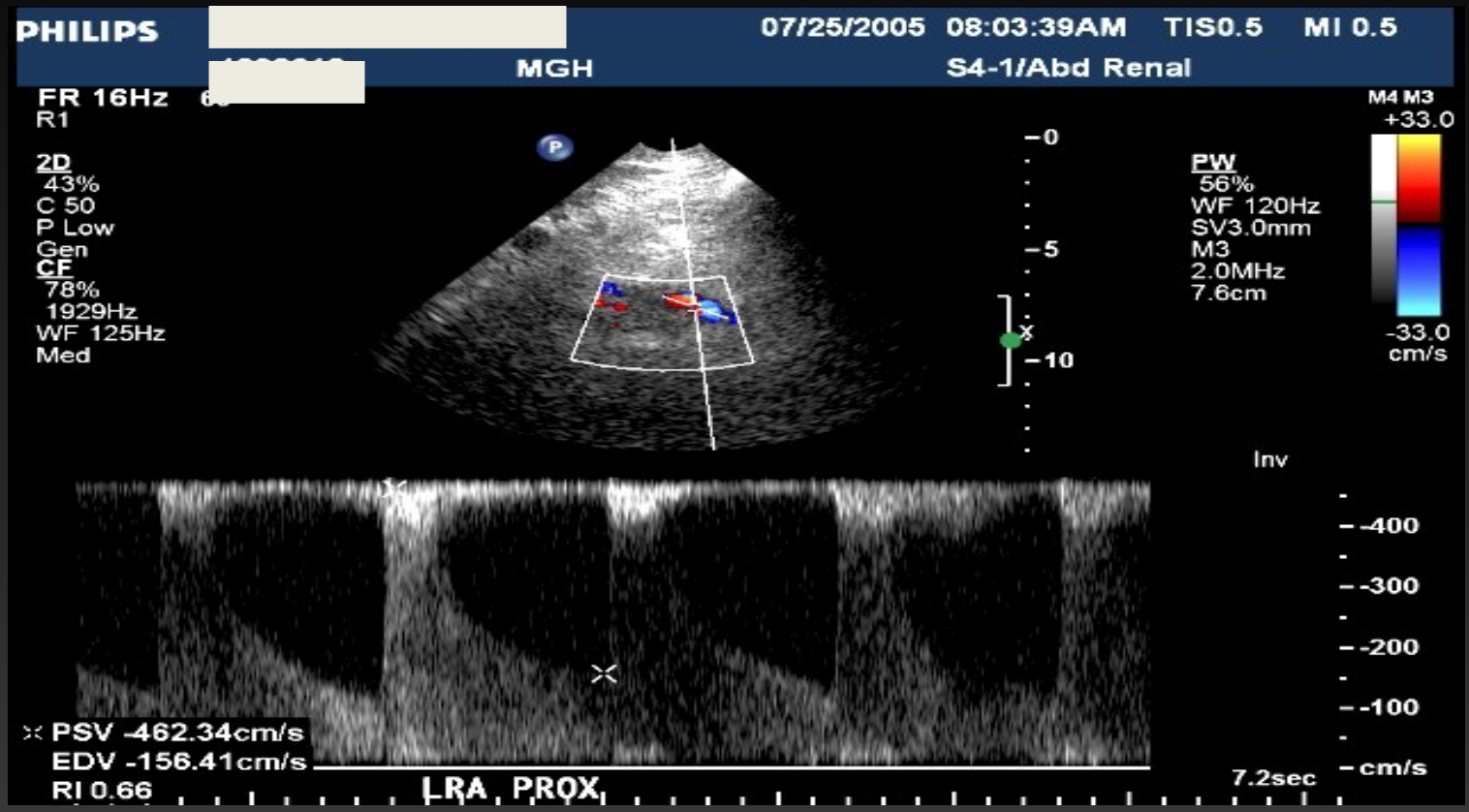


RENAL DUPLEX

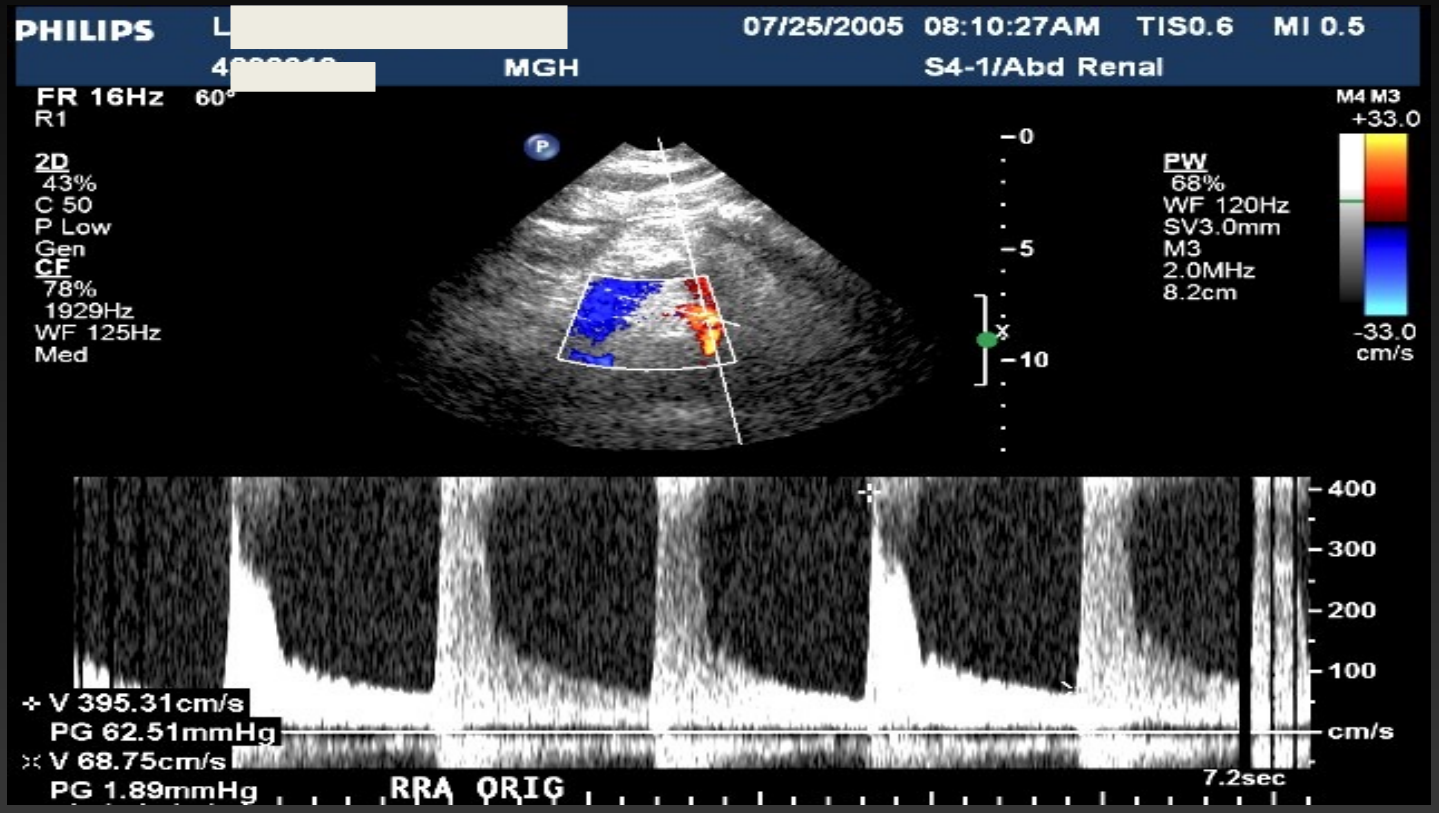
Diagnostic Criteria For Native Renal Arteries

Renal Artery Diameter Reduction	Renal Artery PSV (cm/s)	RAR
Normal	< 180	< 3.5
< 60%	≥ 180	< 3.5
≥60% (≥80%)	≥ 200 (EDV ≥ 150)	≥ 3.5
Occlusion	No signal	No signal

42 year old male with 6 Drug HTN

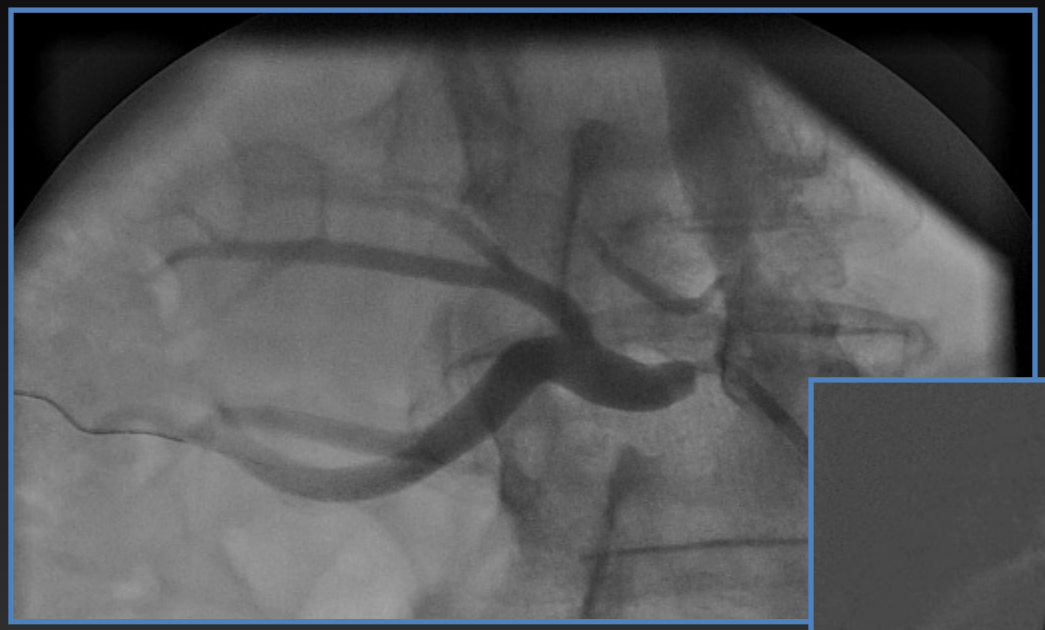


42 year old male with 6 Drug HTN

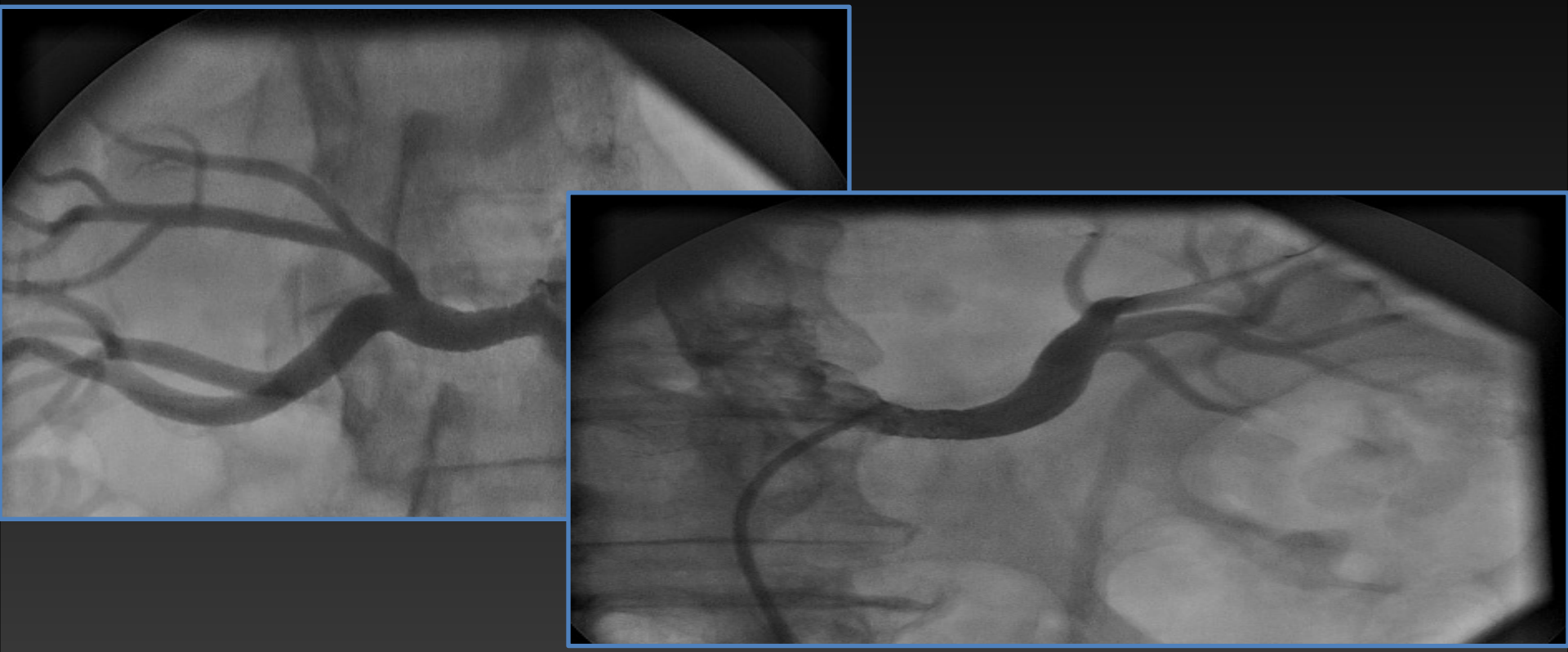


Contrast Angiography

Contrast Angiography

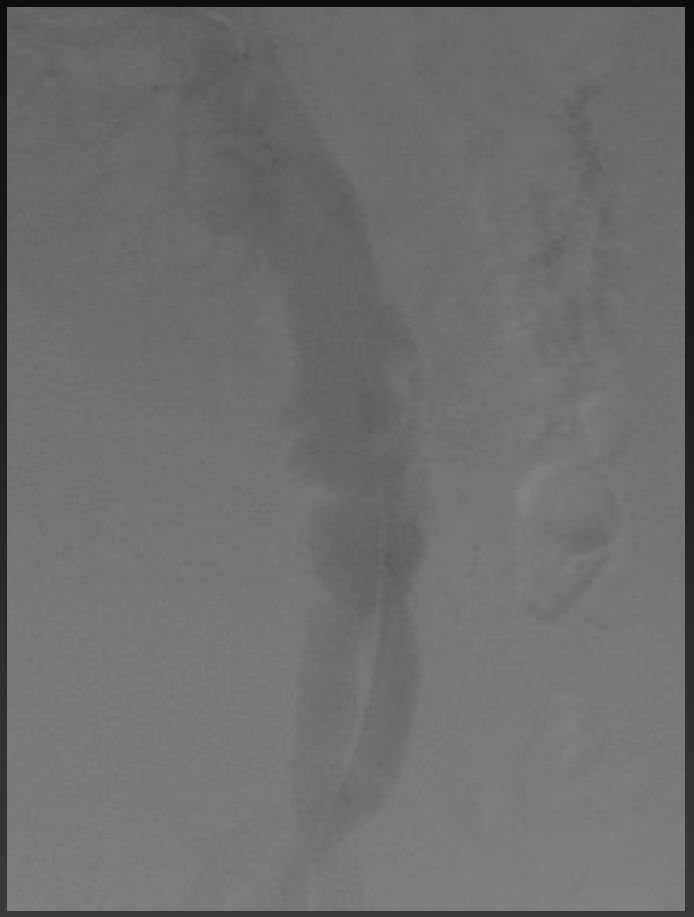


Post - Intervention Angiography

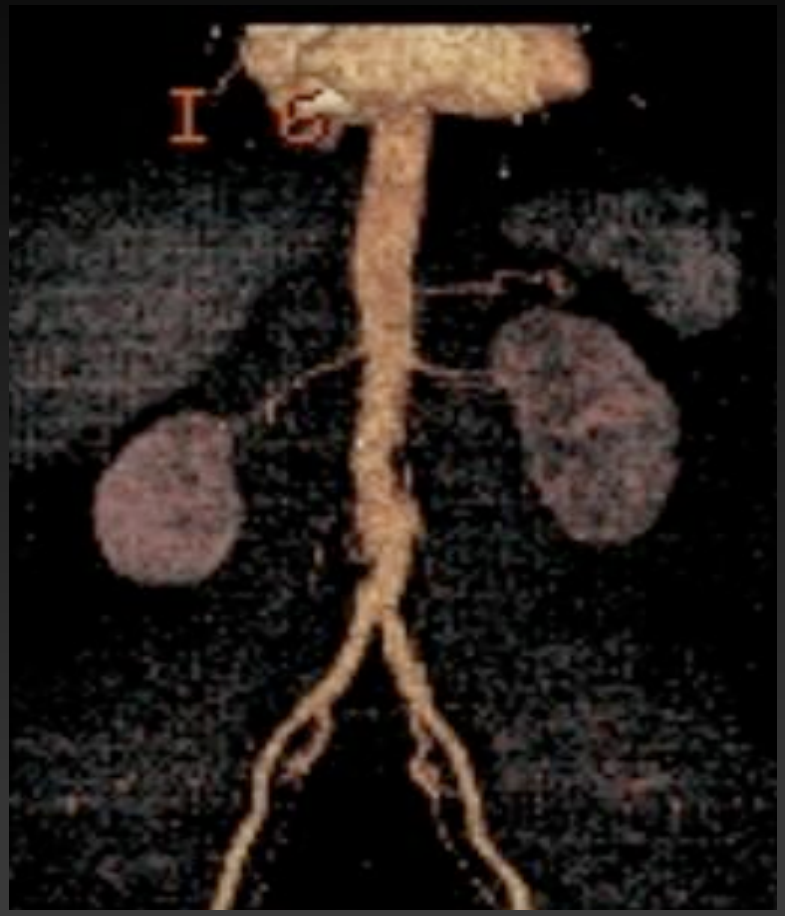


Contrast Abdominal Aortogram

Lateral Abdominal Aortogram

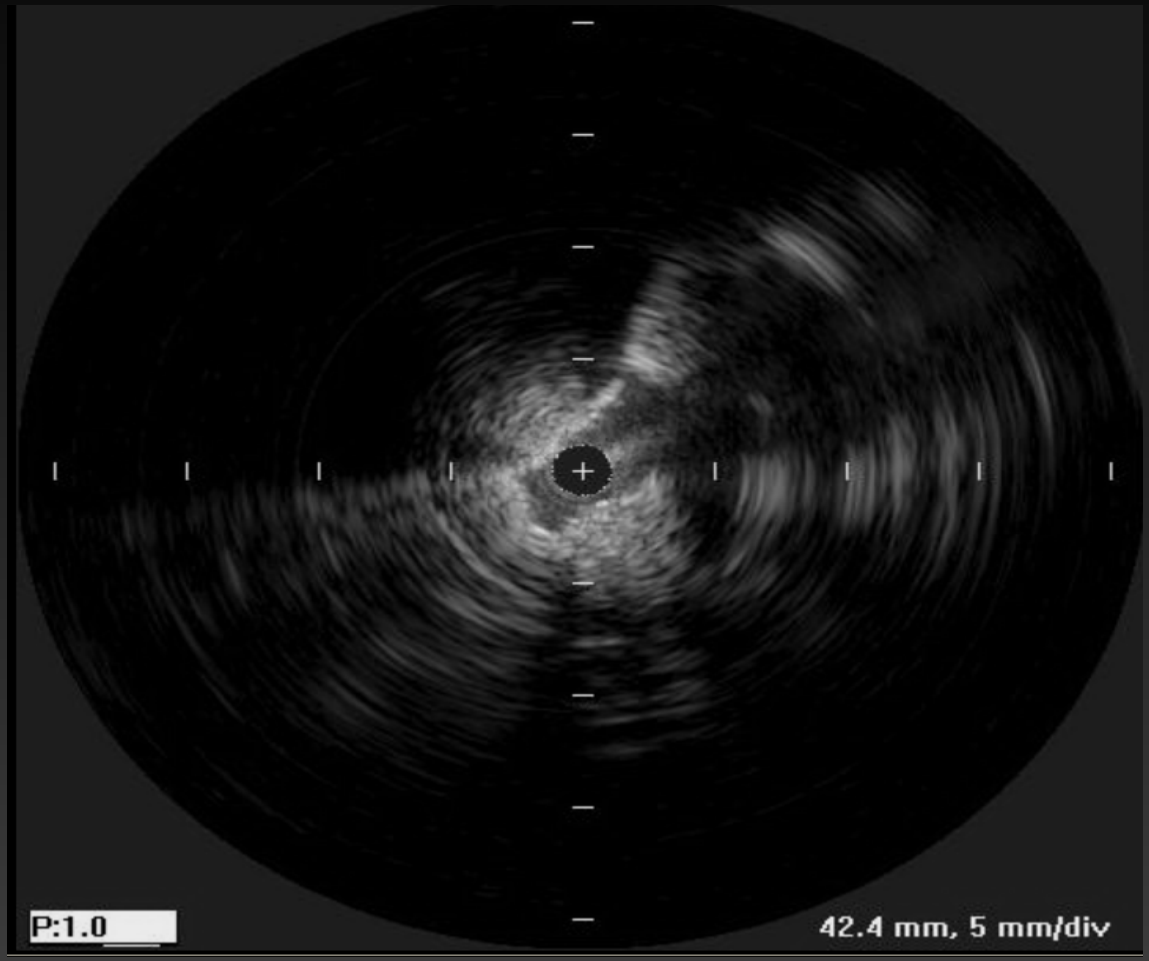


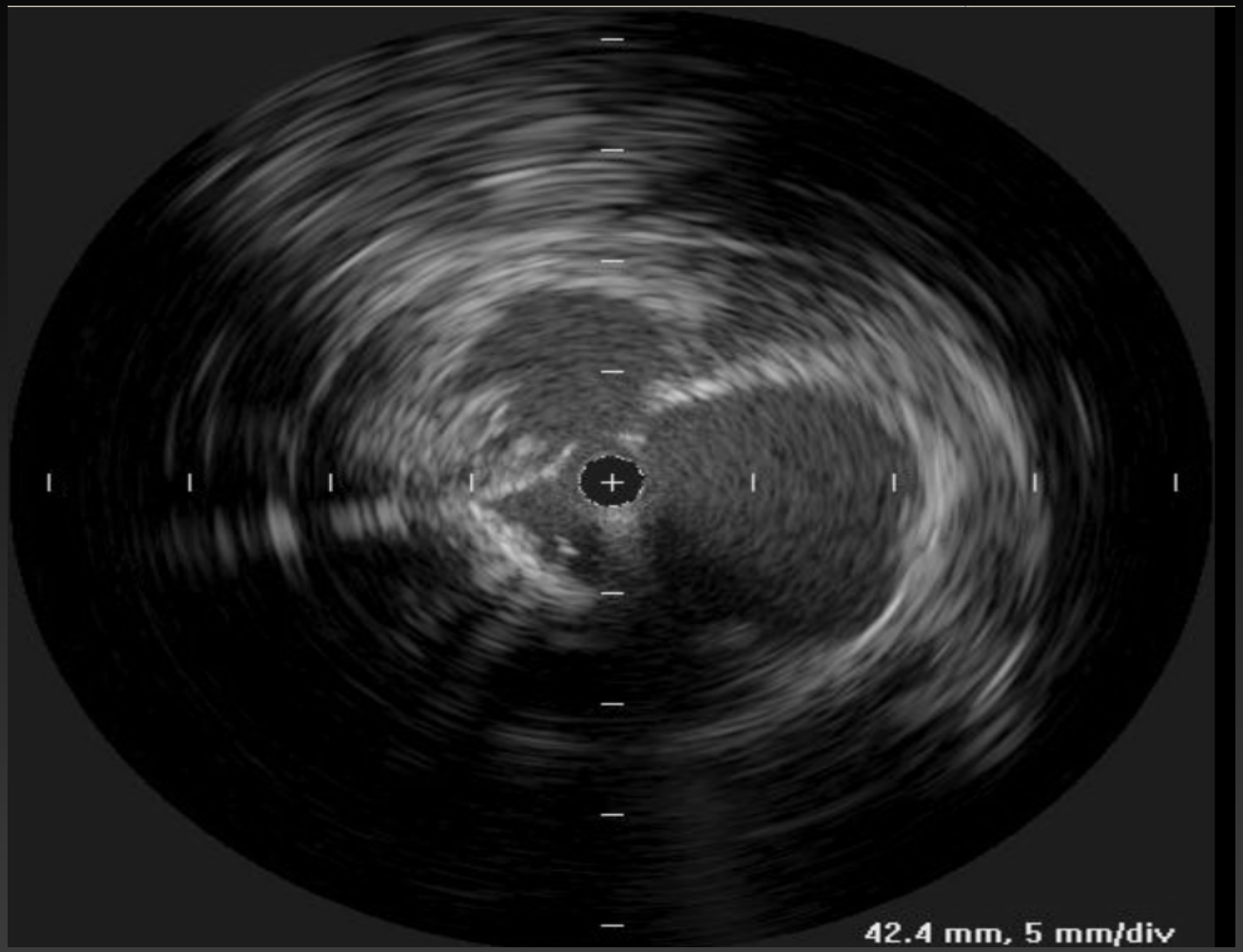
CTA Abdominal Aorta (3-D)



CT Abdominal Aorta

IVUS of Abdominal Aorta



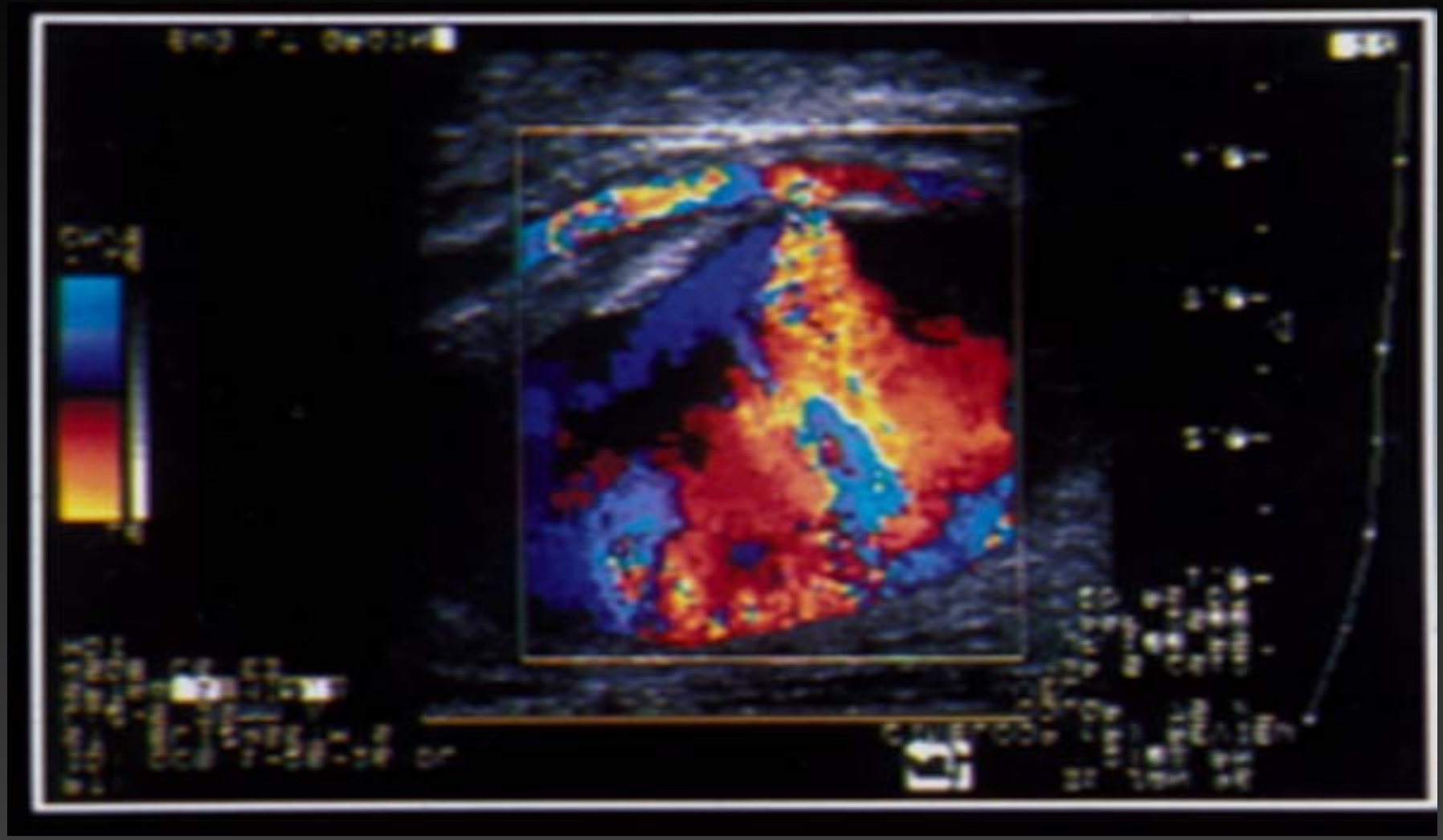

42.4 mm, 5 mm/div

“Hostile Aorta”

Pseudoaneurysms

- Relationship of aneurysm to site of needle or catheter
- Size of aneurysm
- Occluded?
- Candidacy for thrombin injection or UGC

Pulsatile Mass in Groin

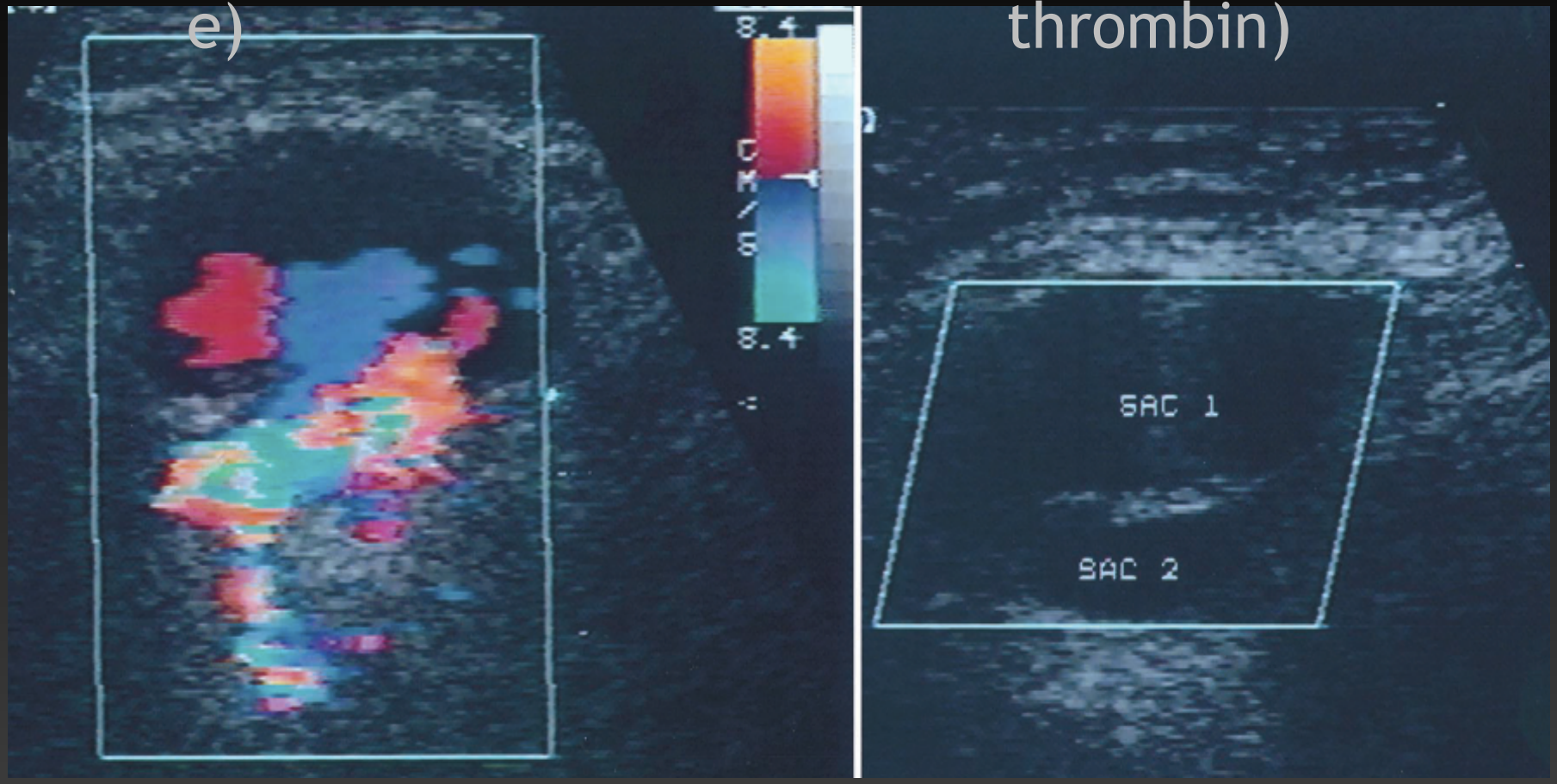


Pulsatile Mass in Groin

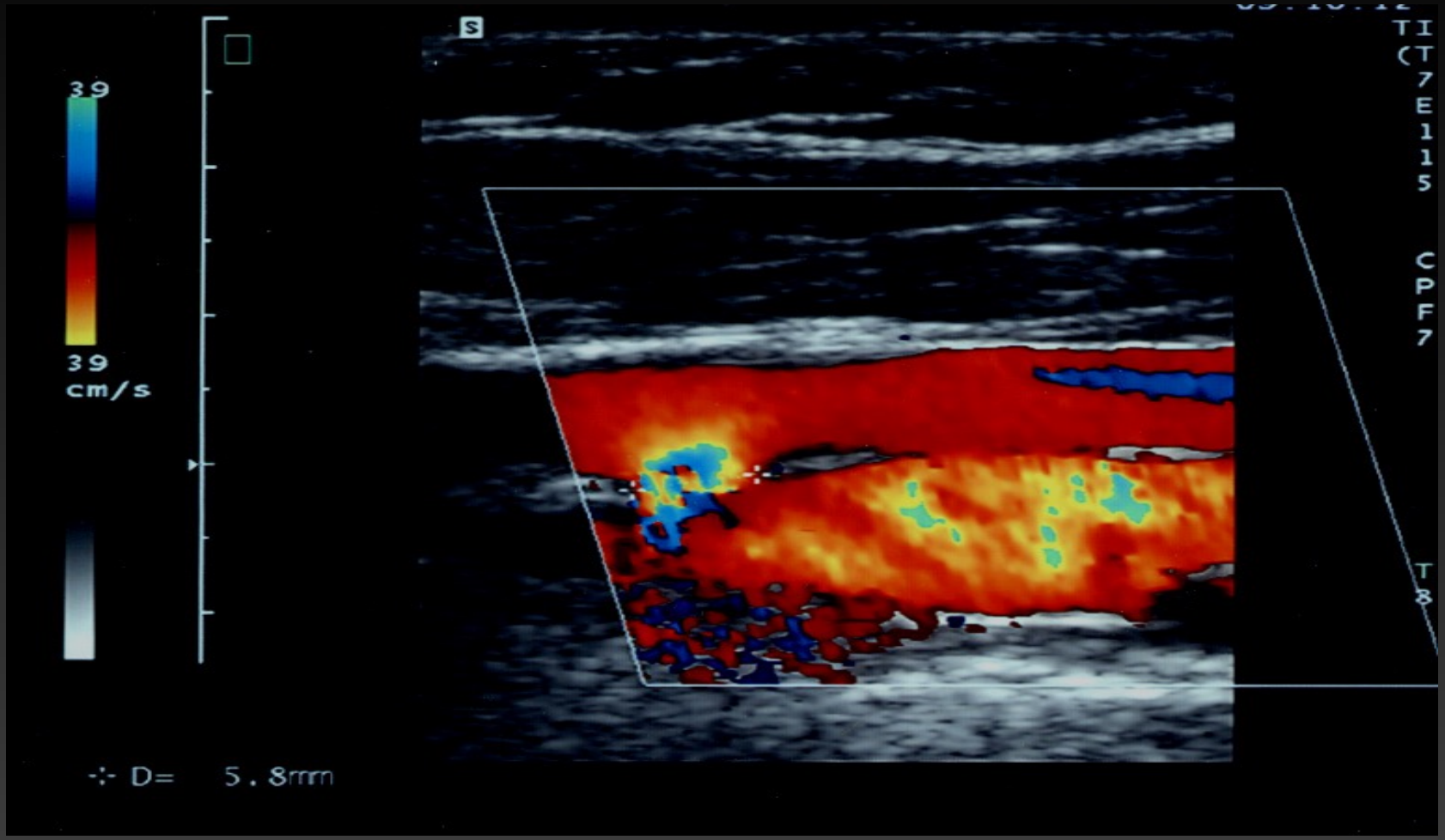
Pseudoaneurysm

(Baseline)

(Post - thrombin)



“Chief, I Hit the Blood Vessel”



“Boston’s Grand Prix”

Question # 1

A 21-year-old lobster fisherman from Maine, presented to the emergency room with a 3 day history of left arm/hand swelling and discomfort, without any obvious antecedent trauma. Duplex ultrasonography of his venous system confirms acute thrombosis of the axillo-subclavian veins extending into the basilic vein. What would be the **most** appropriate management strategy to optimize a favorable clinical outcome?

a. Commencement of anticoagulation with either low molecular weight or unfractionated heparin with concomitant warfarin.
b. Systemic thrombolysis via peripheral intravenous line.
c. Catheter-directed thrombolysis via basilic vein followed by PTA/stenting of residual subclavian vein stenosis.
d. Catheter-directed thrombolysis followed by surgical decompression (1st rib resection) after restoring patency of veins.
e. Anticoagulate for 3-months followed by 1st rib resection of persistently thrombosed axillo-subclavian veins.

Correct Answer: c

Paget-Schroetter syndrome or effort-induced thrombosis may be associated with long-term morbidity due to genesis of post-thrombotic syndrome (PTS), especially in young athletic/vocationally active individuals when it involves the dependent limb. Thus, expeditious diagnosis and recanalization of the vein is of paramount importance. Catheter-directed thrombolysis followed by prompt surgical first-rib resection would be the best strategy to obviate the potential complication of PTS. Anticoagulation alone would not ensure patency of occluded vein and thus, the patient might be plagued with a chronically edematous limb. The same argument holds true with resecting rib after three months, without initially restoring patency of vein. There is no role for systemic thrombolysis in venous disease; it must be catheter-directed to facilitate a favorable outcome.

Question # 2

Which of the following patients are suitable candidates for catheter-directed thrombolysis (CDT)?

a. Submassive PE and unstable with patent foramen ovale on echocardiogram
b. Massive PE who are stable after lysis
c. Submassive PE and poor prognosis
d. Submassive PE with minor RV dysfunction, myocardial necrosis, and stable

Correct Answer c.

Presence of PFO is a contraindication for CDT, open embolectomy with PFO repair is the treatment. Massive PE who are unstable after lysis would benefit from CDT. Stable submassive PE patients do not warrant CDT, unless clinical deterioration or instability.

Question # 3

A 23 year-old pitcher presents with a 3 day history of acute right arm pain, associated with cool/blue digits, pallor of hand, and absent brachial/radial and ulnar pulses. The initial therapeutic intervention appropriate to commence is?

- Anticoagulation with LMWH and concomitant oral AC
- Anticoagulation with direct oral agent.
- Catheter-directed thrombolysis followed by angioplasty and stenting
- Anticoagulation with either LMWH or UFH

Correct Answer d.

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