Maine Medical Center
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Introduction to Vascular Disease and Vascular Lab Testing

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Outline

- Peripheral Artery Disease
- Carotid Artery Disease
- Mesenteric Artery Occlusive Disease
- Aortic Aneurysms
- Venous Disease

Peripheral Artery Disease

Presentation

Claudication

- Fatigue or aching of muscle groups during ambulation
    - Usually calf, can be thigh/buttock
- Symptoms are alleviated after a brief period of rest
- Asymptomatic patients with reduced ABI may have objective impairment of leg function.
    - Reduced walking speed, limitation of activities

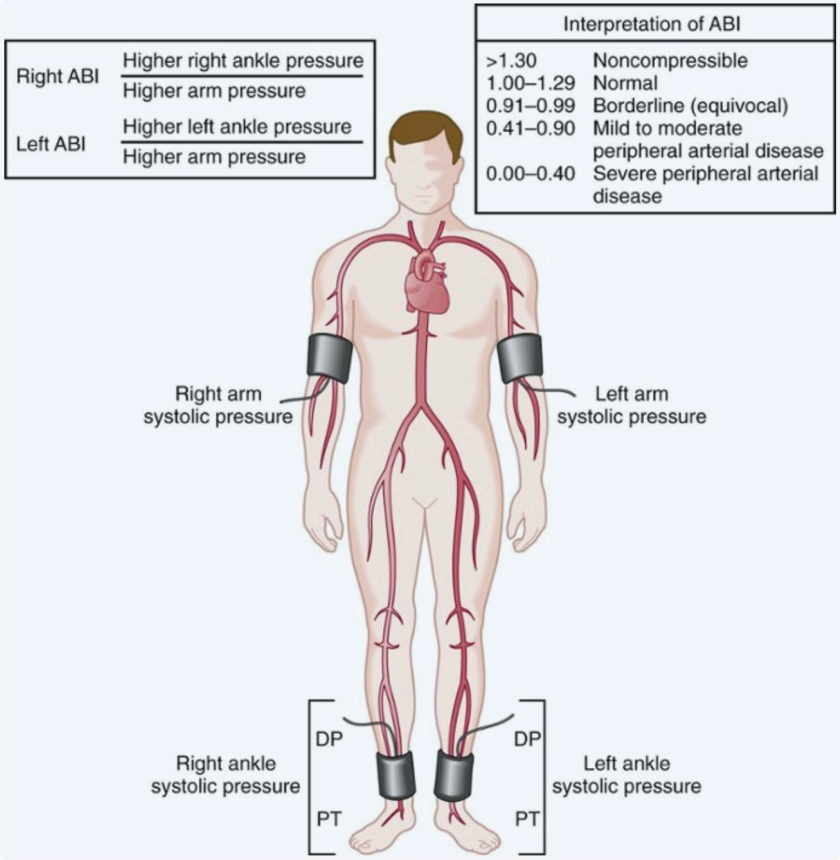
Critical Limb Ischemia

- Rest pain: Burning or uncomfortable coldness or paresthesia
    - Interferes with sleep
    - Worse with elevation, relieved by placing limb in dependent position
- Ischemic ulcers: result from mild, repetitive soft tissue trauma with erosion of overlying skin.
    - Shallow, non-healing, pallid erosion of skin in the distal foot
    - Aching/burning pain as a result of exposure of sensory nerves
- Ischemic gangrene: Occurs when resting limb blood flow is insufficient to maintain cellular viability

Diagnosis

- Full history should include family history, smoking history, surgical history (specifically ask about stents), and past medical history (co-morbidities are important in determining treatment).
- Physical exam should include full pulse exam (femorals, popliteals, DP/PT as well as radial and brachial pulses, check for aortic pulse)
    - If pulses are not easily palpable, they should be checked with a doppler.
- Non-invasive studies are the first line in diagnosis.

Vascular Lab Testing – Ankle-Brachial Index



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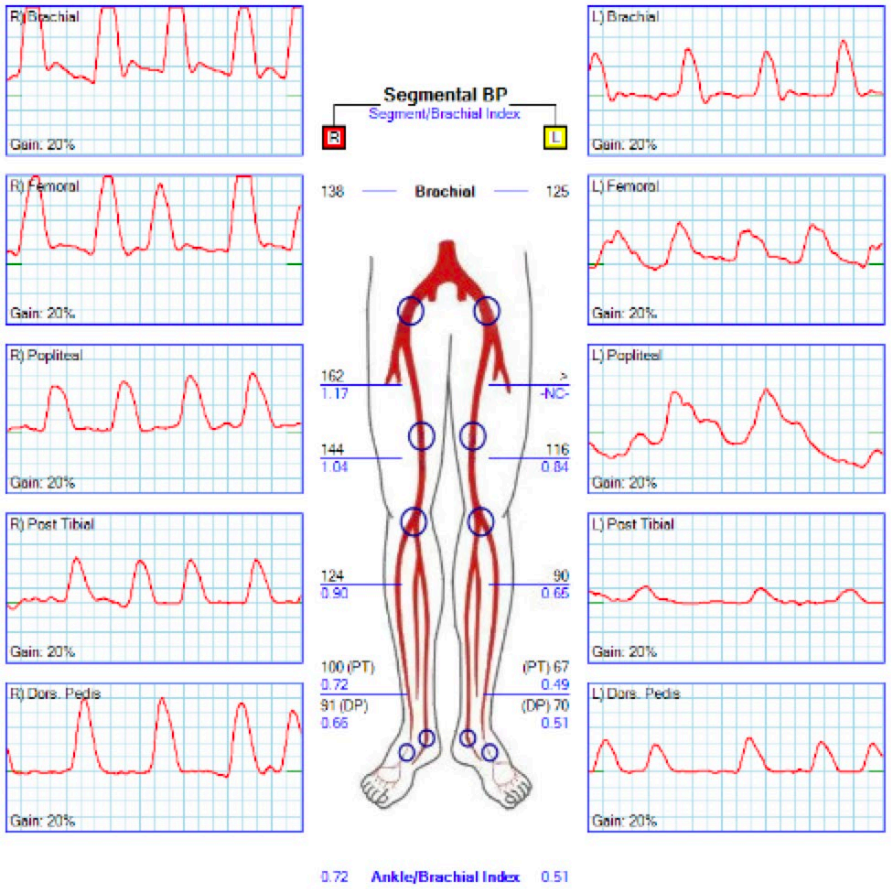
- First test to evaluate for PAD.
- Patients with claudication symptoms may have normal ABIs – treadmill exercise testing may be warranted in cases of high suspicion.
- Patients with diabetes may have falsely elevated ABIs due to non-compressible vessels, Toe-Brachial Index may be useful
  - TBIs <0.7 are considered abnormal
  - Foot lesions usually heal with a toe pressure >40mm Hg (slightly higher in diabetics)

Vascular Lab Testing – Segmental Pressures



- Measurement of pressures and pulse volume recordings throughout the lower extremity.
    - High thigh, low thigh, calf, ankle.
- A drop of >20mmHg between segments indicates significant stenosis.

Vascular Lab Testing – Arterial Duplex

- 76-86% sensitive and 93-96% specific in detecting hemodynamically significant stenosis.
- Consists of B-mode ultrasound, color-flow doppler, and velocity measurements.
- Allows for more specific anatomic definition of lesions than ABIs alone.
    - Normal arteries have PSV <150cm/s and a triphasic waveform
    - Arteries with 50-75% stenosis have PSV from 200-400cm/s and a velocity ratio of 2-4 with a monophasic waveform.
    - Arteries with >75% stenosis have PSV >400cm/s and a velocity ratio >4.
    - Occluded arteries will have no identifiable flow on duplex ultrasonography.
- Some surgeons will base interventions off of arterial duplex alone, very uncommon.

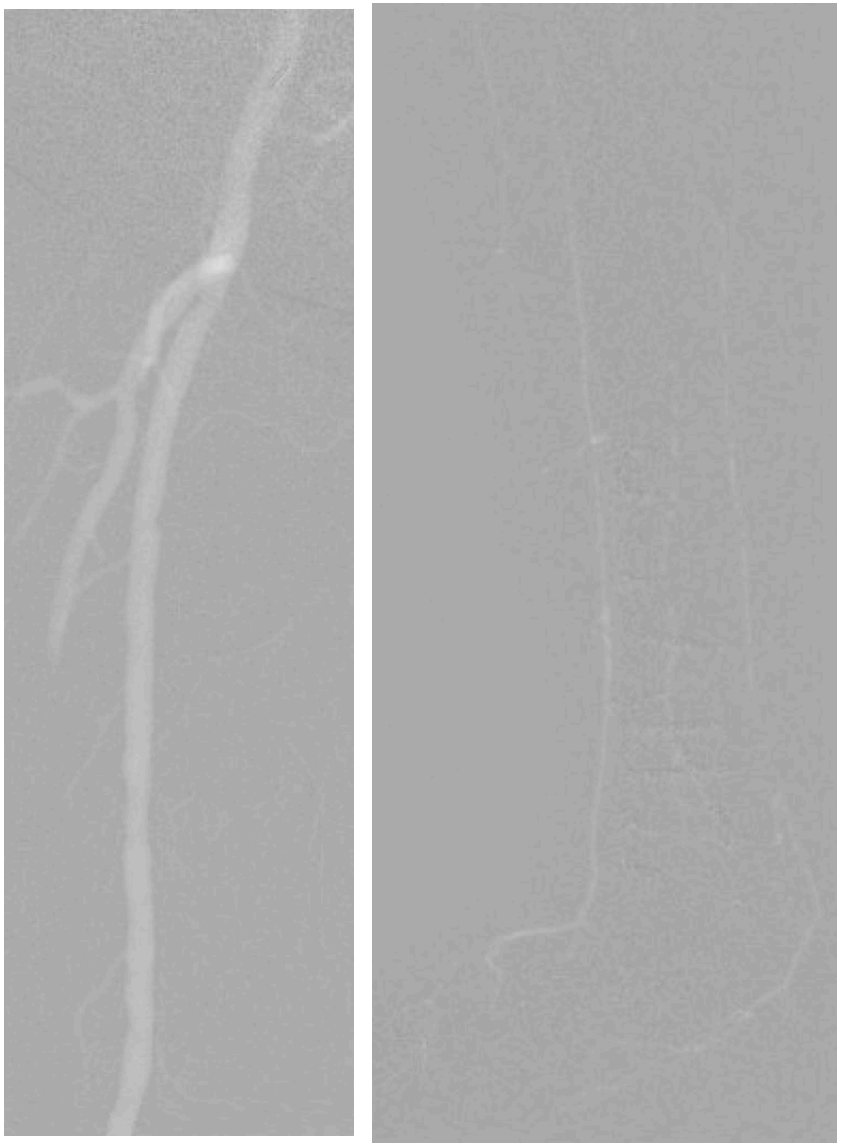
Other Imaging Modalities

CTA

- Excellent anatomic definition, relatively non-invasive.
- Can have poor definition of tibial and pedal vessels.
- Requires the use of a nephrotoxic contrast agent.
- Imaging study of choice for aortoiliac occlusive disease.

Angiography

- Excellent anatomic definition, great at visualizing tibial vessels.
- Can be done without a nephrotoxic contrast agent (CO_2 angiography)
- Can treat some lesions
- Invasive, can have complications related to arterial access.



Treatment – Decision Making

Claudication

- Even asymptomatic patients with an ABI less than 0.9 have higher morbidity and mortality than age-matched controls.
- Reduced physical activity correlates with increased mortality and cardiovascular events.
- Patients experience slow progression to shorter walking distances.
- Risk of major amputation is 5% in 5 years.

Critical Limb Ischemia

- Patients with CLI have a 40% risk of limb loss and 20% death rate within 6 months of onset.
    - Revascularization leads to limb salvage rates of 87% at 12 months and 82% at 3 years.
- 5 and 10 year mortality rates are 50% and 70% respectively.
    - Statin use isassociated with increased 1 year survival after LE bypass and aggressive CV risk management can decrease morbality by ½ in diabetic patients.

Conservative Management – Exercise Therapy

- Best initial treatment for intermittent claudication.
- 5-year cardiovascular event-free survival is 80.5% in structured exercise programs vs. 56.7% in controls.
    - Minimum of 30-45 minute session 3-4x/week
    - Supervised exercise therapy is associated with an improvement in maximal walking distance at 6 and 12 months compared to unsupervised programs, but there was no difference in quality of life.
- Effectiveness is applicable to 1/3 of patient with intermittent claudication.
    - 1/3 of patients cannot participate due to co-morbidities, 1/3 of patients refuse to participate

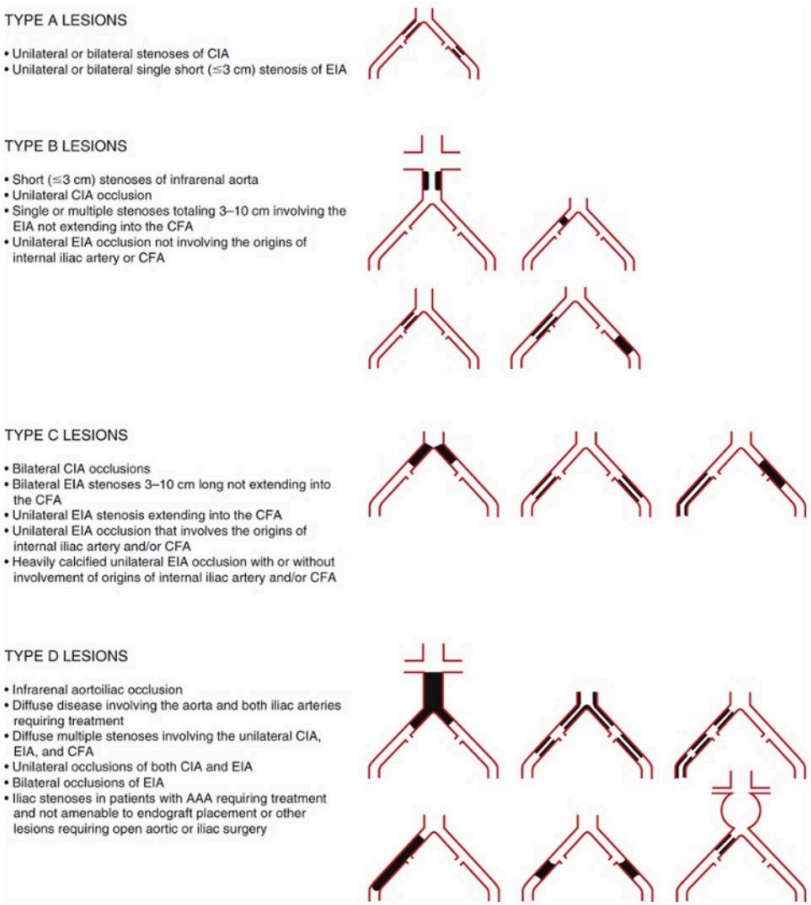
Medical Management

- Smoking Cessation
    - There is a 3-fold increase in graft/stent failure in patients who continue to smoke.
    - Smoking cessation reduces both the risk of cardiovascular events and PAD progression.
- Cilostazol
    - Approved by the FDA in 1999 for treatment of intermittent claudication.
    - Phosphodiesterase III inhibitor, increases cAMP, inhibits smooth muscle cell contraction and platelet aggregation
    - Controlled clinical trials have shown up to 50% increase in maximal walking distances and significant improvements in health-related QoL measures
    - Contraindicated in patients with CHF
- Antiplatelet Agents
    - Aspirin should be started to aid in overall cardioprotection.
- Statins
    - Statins are associated with plaque stabilization, independent of cholesterol levels.

Surgical Management

- Offered for lifestyle limiting-claudication symptoms in patients who have quit smoking and failed conservative management.
- Should be offered to patients with critical limb ischemia regardless of smoking status.
- Many factors go into the decision to over open or endovascular management.

Surgical Decision Making



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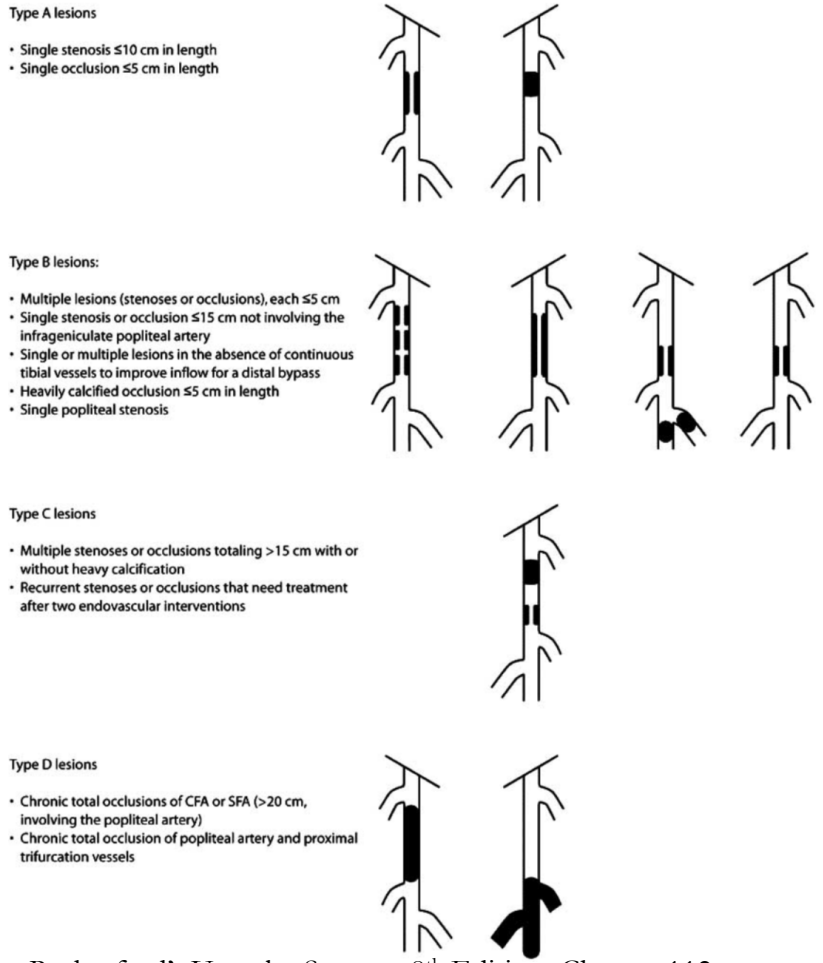

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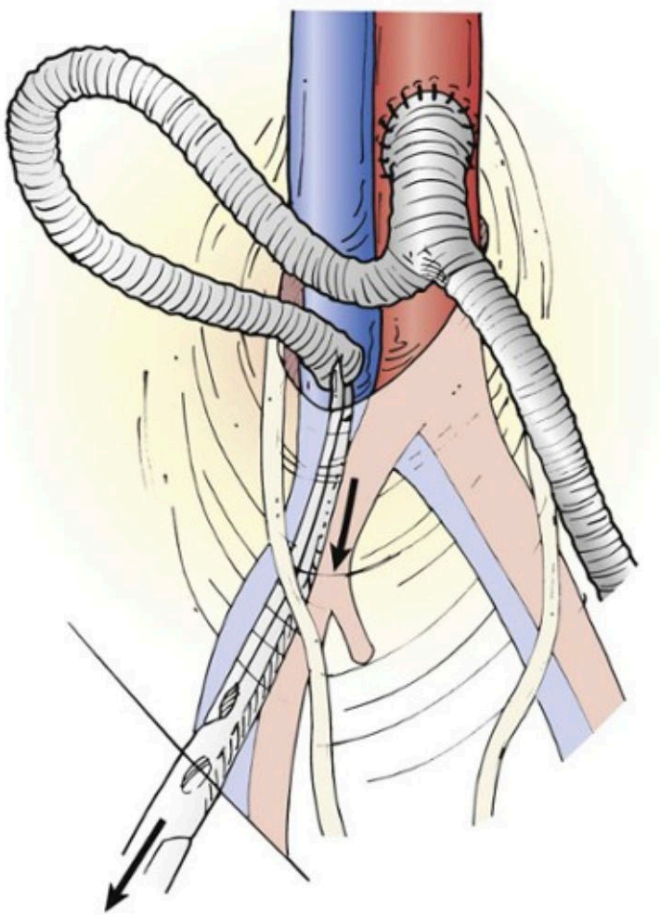
Open Surgery – Aortoiliac Occlusive Disease



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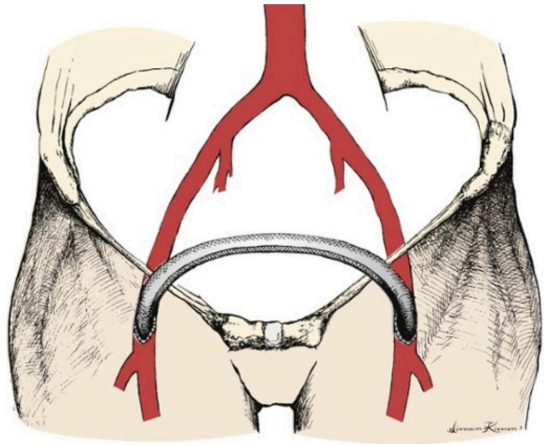

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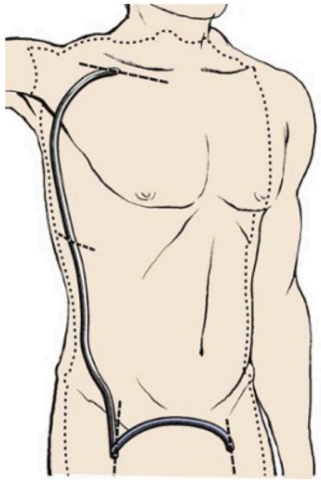

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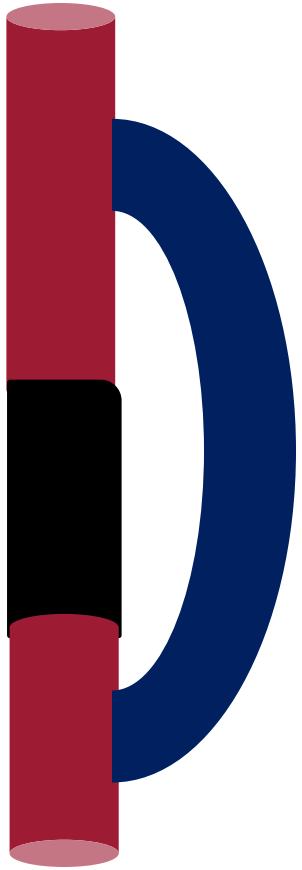
Open Surgery – Infrainguinal Disease

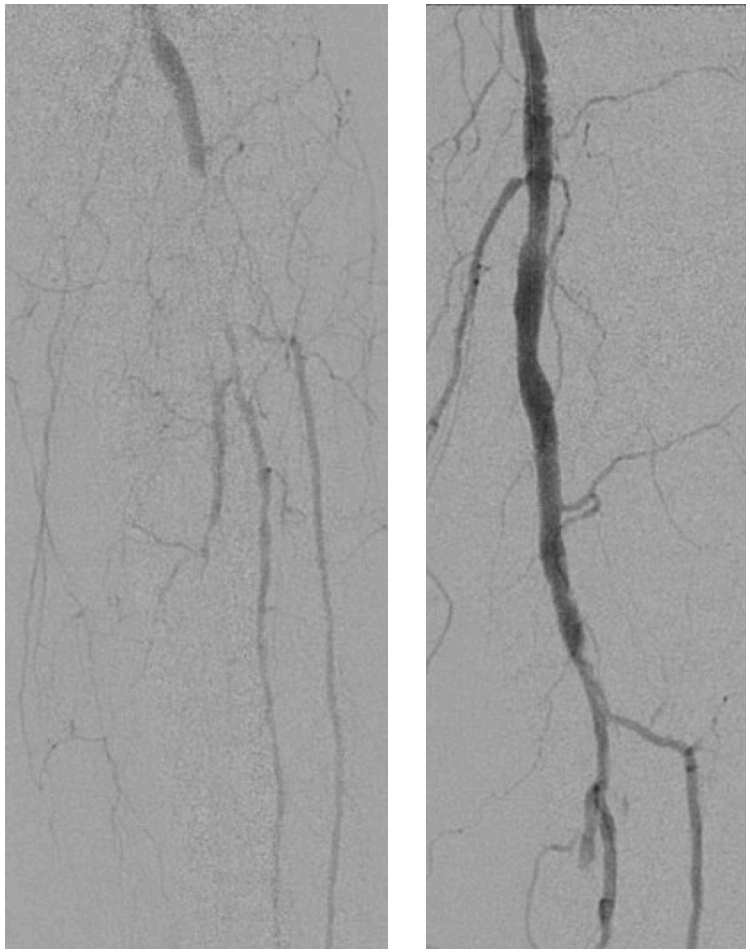
- Inflow, outflow, conduit!
- Vein > prosthetic
    - In-situ, reversed, non-reversed
    - PTFE, Propaten (heparin bonded)
    - Cryo-preserved vein



Aortoiliac Disease – Endovascular Treatment

- Excellent patency rates with endovascular intervention for aortoiliac occlusive disease.
- EVAR grafts and aortic cuffs can be used to treat aortic disease in select patients.
- Consider using covered stents in very calcified iliac vessels.
- Can be done in conjunction with open infra-inguinal intervention to improve inflow.

Infrainguinal Disease – Endovascular Treatment



- SFA interventions have better patency than more distal interventions, generally stents have better patency than angioplasty.
- Some stents are approved for popliteal lesions (I still prefer angioplasty!)
- Endovascular tibial interventions have very low long-term patency but can be considered to heal a wound.
- VERY limited use for common femoral interventions.

Duplex Surveillance after Interventions

- It is recommended that any intervention undergo routine surveillance to improve patency rates.
    - 30 day to get baseline and check for technical errors
    - 6 month to check for intimal hyperplasia
    - 1 year, then yearly to check for progression of disease
- Vein Bypass Surveillance
    - >50% stenosis: PSV > 180 cm/s, Velocity Ratio >2, No change in ABIs
    - >70% stenosis: PSV >300 cm/s, Velocity Ratio >3.5, No change in ABI
        - If drop in ABIs >0.15 or flow through graft <45cm/s, this can indicate high risk for impending occlusion
- Stent Surveillance
    - Threshold criteria for repeat intervention include PSV > 300 cm/s, a Velocity Ratio > 2, and a decrease in ABI > 0.15.

Acute Limb Ischemia - Etiology

Embolic

- Cardiac Source
  - History of a-fib, recent interruption in anticoagulant therapy.
  - TEE to check for cardioembolic source
- Atheroembolic Source
  - CTA chest/abdomen/pelvis
  - Proximal embolic source may need treatment (can be endovascular)

Thrombotic

- Thrombosed popliteal artery aneurysm
- Thrombosed bypass graft or stent
- In-situ thrombosis of a previous lesion

Acute Limb Ischemia - Presentation

- Presentation depends on etiology.
- Embolism to otherwise healthy vessels may be more serious than in-situ thrombosis as patients will not have collateral flow.
- Important to take a good history, including previous interventions, any recent instrumentation, and cardiac history.

Category	Description / Prognosis	Findings		Doppler Signals	
		Sensory Loss	Muscle Weakness	Arterial	Venous
I. Viable	Not immediately threatened	None	None	Audible	Audible
II. Threatened					
a. Marginally	Salvageable if promptly treated	Minimal (toes) or none	None	Inaudible	Audible
b. Immediately	Salvageable with immediate revascularization	More than toes, associated with rest pain	Mild, moderate	Inaudible	Audible
III. Irreversible	Major tissue loss or permanent nerve damage inevitable	Profound, anesthetic	Profound, paralysis (rigor)	Inaudible	Inaudible

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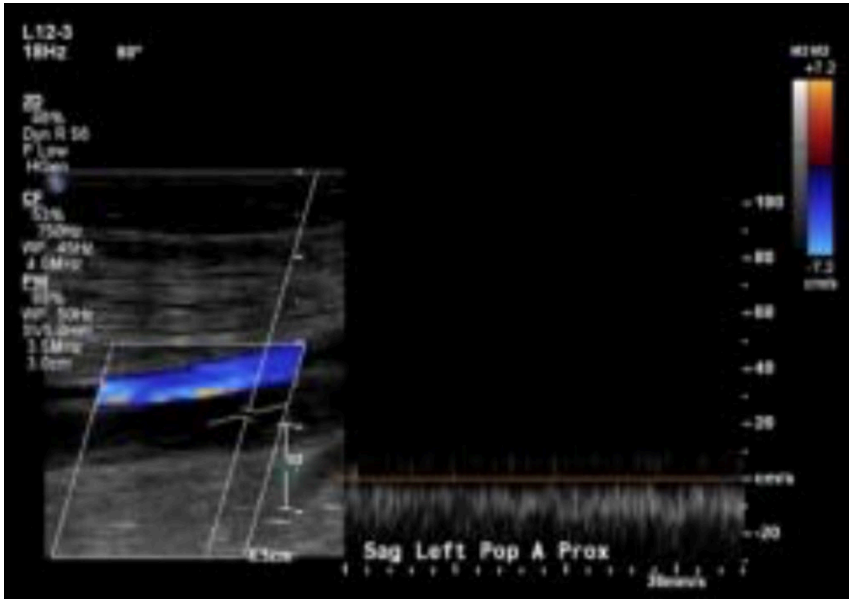
Acute Limb Ischemia – Vascular Lab Testing

- Duplex ultrasonography is extremely useful in this setting!
- Can identify occlusions, outflow, and collateral flow.
- Does not require contrast.



Acute Limb Ischemia - Treatment

- Lysis
    - Useful in patients with prior endovascular interventions, thrombosed popliteal artery aneurysms, prior byass.
    - Can better identify outflow after lysis.
    - 1% risk of hemorrhagic stroke
- Embolectomy/Thrombectomy
    - Useful in acutely threatened limb
    - Quickest way to restore patency
- Bypass
    - Certain patients may benefit from a primary bypass.

Carotid Artery Disease

Stroke – Definition and Epidemiology

- Stroke (Cerebral Infarction): acute development of a focal neurologic deficit caused by disruption of blood supply to an area of the brain
  - May be ischemic (due to blood vessel occlusion) or hemorrhagic (due to blood vessel rupture)
- 87% of strokes in the US are ischemic in etiology
  - 16.7% Large vessel cervical or intracranial
  - 16.3% Lacunar infarcts
  - 29.9% Cardioembolic
  - 37.1% Unknown

Stroke and Carotid Artery Disease

- Most important indicator of future stroke risk is the presence of recent (within 6 months) ipsilateral neurologic symptoms.
  - Highest risk in the first month after the initial event
  - Stroke risk reduction from 26% to 9% in 2 years with CEA vs. medical therapy for patients with >70% stenosis (NASCET)
  - Still benefit for symptomatic patients with 50-69% stenosis, but not as great
- Degree of carotid artery stenosis is directly related to stroke risk.
  - Stroke risk reduction from 11% to 5% in 5 years with CEA vs. medical therapy for patients with 80-99% stenosis (ACAS)

Carotid Artery Disease - Presentation

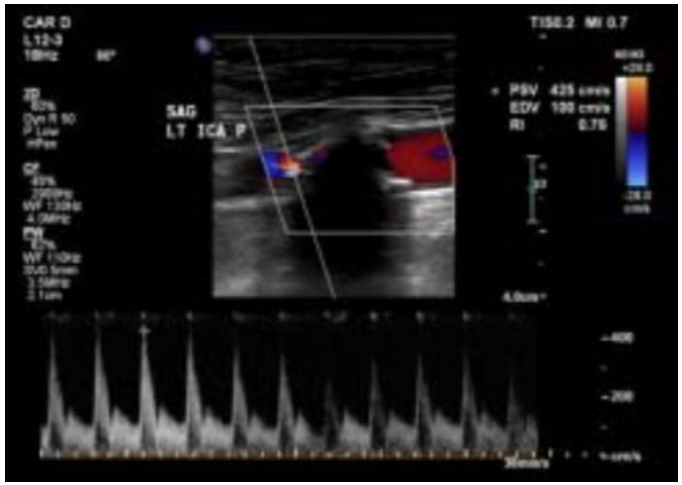
- Symptomatic Disease
  - Amaurosis Fugax
  - TIA
  - Stroke
- Asymptomatic Disease
  - No guidelines recommend routine screening for asymptomatic carotid artery stenosis
  - Duplex done for bruit on physical exam or prior to coronary intervention

Carotid Artery Stenosis – When to Treat

- Carotid revascularization is recommended for symptomatic patients with >50% carotid artery stenosis and for asymptomatic patients with >80% carotid artery stenosis.
- Indications for combined carotid-CABG:
    - 80-99% stenosis with contralateral occlusion
    - Bilateral 80-99% stenosis
    - >50% symptomatic stenosis
- Argument over whether or not asymptomatic disease should be treated at all.
    - Advances in medical therapy
    - CREST 2 Trial
    - Should have a 5-year life expectancy to see the benefits from treating asymptomatic disease

Vascular Lab Imaging and Surveillance

- Duplex ultrasonography is the mainstay of diagnosis, surveillance, and post-operative surveillance.
- CTA useful in cases where duplex is non-diagnostic, or in planning for carotid artery stenting.
- PSV, EDV, and velocity ratios are obtained in the CCA, ICA, and ECA.
- There are currently no consensus guidelines on estimating degree of stenosis on duplex ultrasound.
- Spectral broadening with no velocity changes indicates <50% stenosis.
- PSV>125cm/s indicates >50% stenosis
- Criteria for >80% stenosis may include PSV>400cm/s, Ratio > 4, or EDV >100cm/s

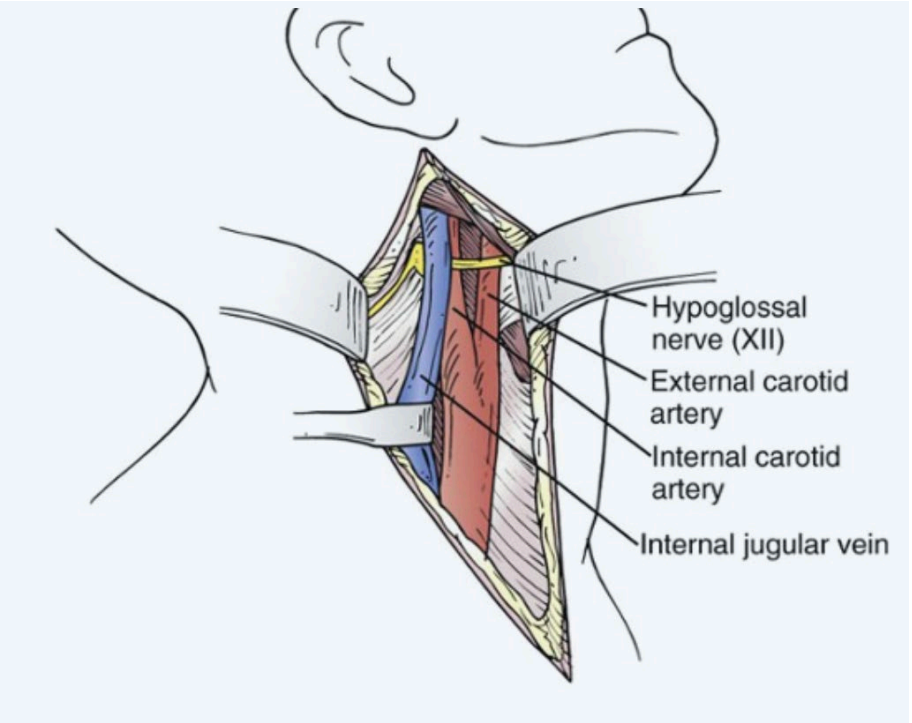


Treatment – Medical Therapy

- Optimization of blood pressure management
- Statin medication (even if no hypercholesterolemia), aimed toward aggressive anti-lipid management
- Weight loss
- Smoking cessation
- Exercise
- Diabetes management

Treatment – Carotid Endarterectomy

- Neuromonitoring vs. Shunting
  - EEG Monitoring
  - Awake Carotid
  - Stump Pressures
  - Routine Shunting
- Completion doppler/duplex



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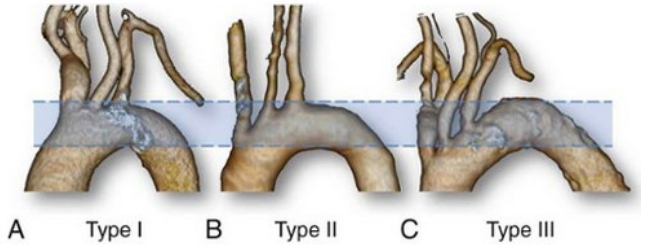
Treatment – Carotid Artery Stenting

- Currently, transfemoral carotid artery stenting is only covered for symptomatic patients.
- Studies show a higher incidence of MI with CEA, but higher incidence of stroke with CAS.
- Higher risk if age > 80, contraindication to antiplatelet therapy, aortoiliac occlusive disease, calcified arch, Type II or III arch
- Requires crossing of lesion to deploy distal embolic protection device



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Treatment - TCAR

- CAS demonstrates higher periprocedural stroke risk (including contralateral stroke)
  - Embolization during unprotected catheterization of the aortic arch
  - Suboptimal embolic protection
- TCAR: hybrid approach based on temporary occlusion of the CCA and reversal of antegrade flow in the carotid.
  - Avoids endovascular manipulation within the aortic arch
  - Provides robust flow reversal in advance of any lesion manipulation

TCAR - Results

- MAE in 5 patients
- One patient was intolerant of high-flow reversal rate
- 2 deaths: 1 respiratory failure and 1 fatal MI
- 2 strokes: both in asymptomatic patient, one major protocol violation (tandem MCA lesions)
- 1 MI: troponin elevation + non-specific ECG changes (general anesthesia)
- 1 CN injury – recurrent laryngeal branch of X – hoarseness resolved at 6 months (0.7%)
- 8 arterial dissections (2.1%) - 5 did not require treatment
  - 1 converted to CEA at index procedure
  - 1 received a second stent
  - 1 repaired surgically
- 1 area of severe stenosis at arteriotomy site (pre-placed suture closure)
- 5 limited hematomas (3.5%, no intervention)
- 1 hematoma requiring evacuation
- 1 femoral vein access site hematoma

Post-operative surveillance

- Duplex ultrasound at 1 month to assess for technical error and to get baseline exam
- Duplex ultrasound at 6 months to assess for intimal hyperplasia
- Duplex ultrasound at 1 year, then yearly to assess for recurrence of disease.
- No good guidelines on intervening for re-stenosis, managed largely like primary disease.

Aortic Aneurysmal Disease

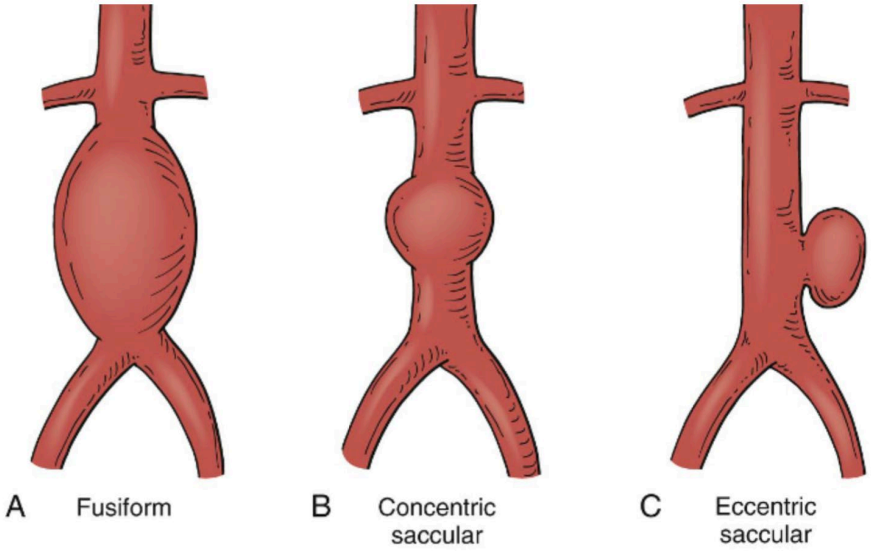
Background

- Definition: "Focal dilations at least 50% larger than the expected normal arterial diameter"
    - Native aorta is larger in men, black race, increasing height/weight/BMI
    - AAA: Transverse diameter of 3cm or greater
    - "A greater than 50% enlargement over the diameter of the adjacent, non-aneurysmal segment"

Anatomy

- 5-15% are suprarenal
- 25% involve iliac arteries
- 12% also have a thoracic aneurysm
- 4% also have popliteal aneurysms
- 50% of patients with a thoracic aneurysm also have an AAA
- 50% of patients with a popliteal aneurysm also have an AAA

- Aneurysms can be either fusiform or saccular



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Epidemiology

- 5-15% are suprarenal, 25% involve the iliac arteries, 12% also have a thoracic aortic aneurysm, and 4% also have peripheral aneurysms.
- Incidence is 3.5-6.5 per 1000 person-years, 2-6x more common in men
- Ruptured AAA is the 15th leading cause of death
    - 10th in men >55
- Overall mortality is 80-90%
    - 30-50% die before reaching the hospital
    - 30-40% die after hospital arrival
    - 40-50% operative mortality
- Elective surgical mortality: 5%

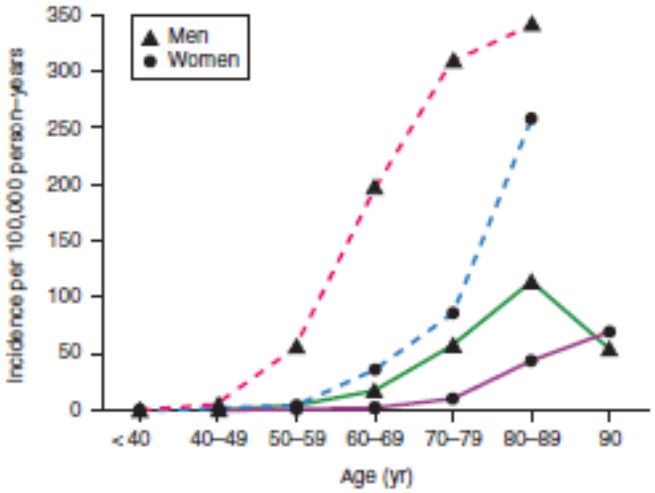

Figure 127-1 Incidence of clinically apparent and ruptured abdominal aortic aneurysms (AAAs) from population-based studies. *Dashed lines*, incidence of all AAAs; *solid lines*, incidence of ruptured AAAs.

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Risk Factors

Risk Factor	Odds Ratio*	95% CI
INCREASED RISK		
Smoking history	5.1	4.1-6.2
Family history of AAA	1.9	1.6-2.3
Older age (per 7-yr interval)	1.7	1.6-1.8
Coronary artery disease	1.5	1.4-1.7
High cholesterol	1.4	1.3-1.6
COPD	1.2	1.1-1.4
Height (per 7-cm interval)	1.2	1.1-1.3
DECREASED RISK		
Abdominal imaging within 5yr	0.8	0.7-0.9
Deep venous thrombosis	0.7	0.5-0.8
Diabetes mellitus	0.5	0.5-0.6
Black race	0.5	0.4-0.7
Female gender	0.2	0.1-0.5

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Diagnosis

- Most are asymptomatic – discovered incidentally
- Pulsatile abdominal mass
    - Thin patients may notice a pulse in their abdomen
- Large AAAs may cause compression symptoms
- Ill-defined back/abdominal pain
- Ischemic symptoms from distal embolization

Screening Guidelines: SVS

Overall, the probability of AAA in the general population is low, but is increased when certain risk factors are present. These include increasing age, male gender, white race, smoking, family history of aneurysms, history of other vascular aneurysms, hypertension, atherosclerotic diseases, cerebrovascular disease, and high cholesterol.

–One-time ultrasound screening for AAA is recommended for all men at or older than 65 years. Screening men as early as 55 years is appropriate for those with a family history of AAA

–One-time ultrasound screening for AAA is recommended for all women at or older than 65 years with a family history of AAA or who have smoked

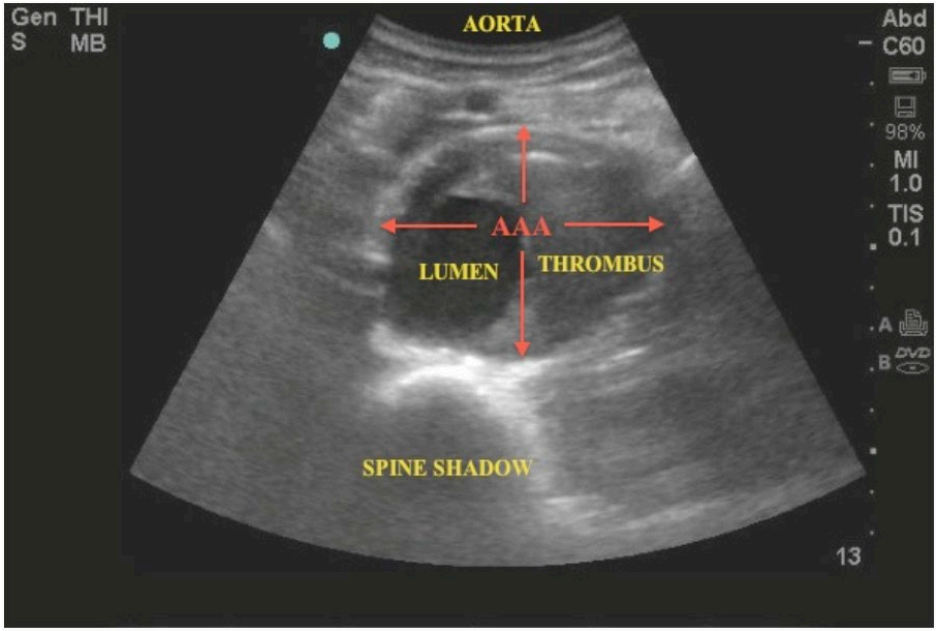
–Re-screening patients for AAA is not recommended if an initial ultrasound scan performed on patients 65 years of age or older demonstrates an aortic diameter of <2.6 cm

Screening Guidelines: USPSTF

The Task Force recommends one-time AAA screening for men ages 65–75 who have ever smoked (B recommendation). For men ages 65–75 who have never smoked, the Task Force recommends discussion with one's health care provider about whether one-time AAA screening is appropriate based on health history and potential benefits/harms of screening (C recommendation). The Task Force determined that current evidence is insufficient to weigh benefits and harms of screening for AAA in women ages 65–75 years who have ever smoked (I statement) and recommends against routine screening for AAA in women who have never smoked (D recommendation). These findings form the basis of a draft recommendation statement, which is available for comment from January 28–February 24, 2014.

Imaging Studies: Ultrasound

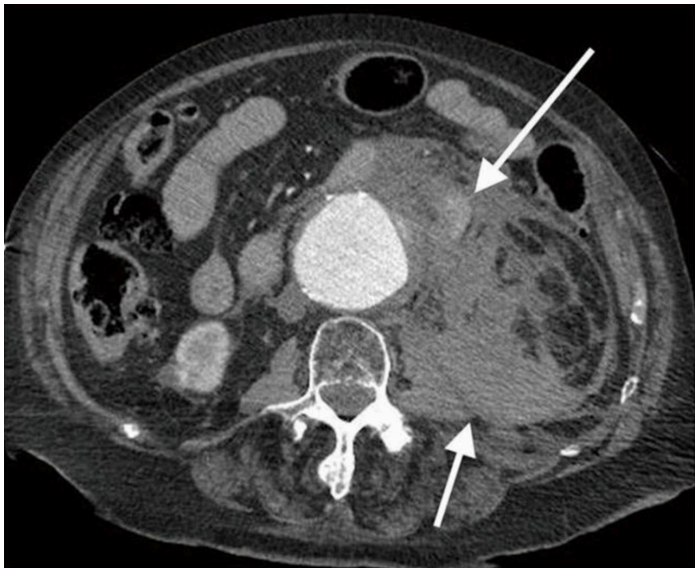
- Non-invasive, no radiation
- Useful for screening
- Useful for surveillance
- Limited by body habitus, bowel gas
- Limited anatomical information



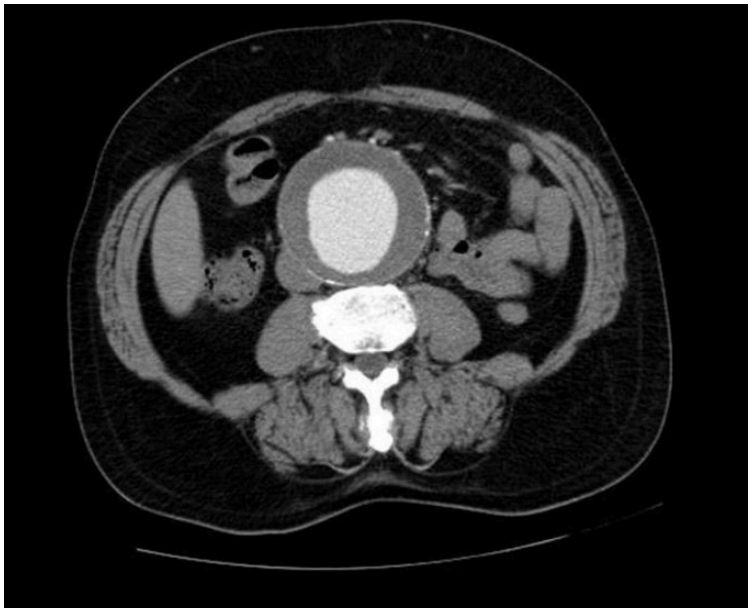
http://www.em.emory.edu/ultrasound/ImageWeek/Abdominal/belly_pain.html

Imaging Studies: CTA

- Excellent anatomic definition
- Requires iodinated contrast (nephrotoxic)
- MRA may be used as an alternative
- Angiogram is not generally useful



Kumar et. al. 2017



https://radiopaedia.org/articles/abdominal-aortic-aneurysm

Medical Management

- SMOKING CESSATION!
    - Smoking is thought to contribute ~0.4mm/year in expansion rates
- Angiotensin II Receptor Blockers
    - In patients with Marfan's Syndrome, ARBs have been shown to decrease the rates of aneurysm growth
- Statin therapy
    - 2 large meta-analyses demonstrated decreased aneurysm growth rates in patients on Statins
    - Analysis of patients presenting with ruptured AAA found statin use to be associated with a decreased risk of ruptured AAA and lower fatality following rupture

Surgical Treatment: EVAR vs. Open

- Lower 30-day mortality with EVAR (1.6% vs. 4.6%)
- Lower severe complication rates with EVAR
- Similar all-cause mortality at 2 years
- Higher rates of secondary interventions with EVAR
- Higher cost at 4-year follow up

Open Surgical Repair

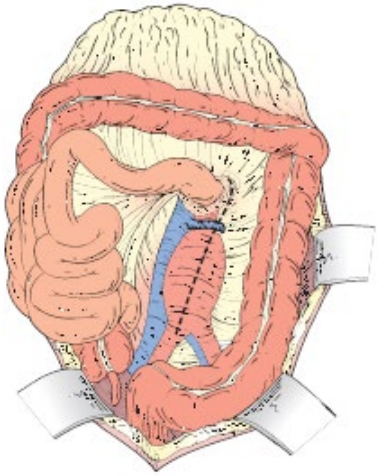
Advantages

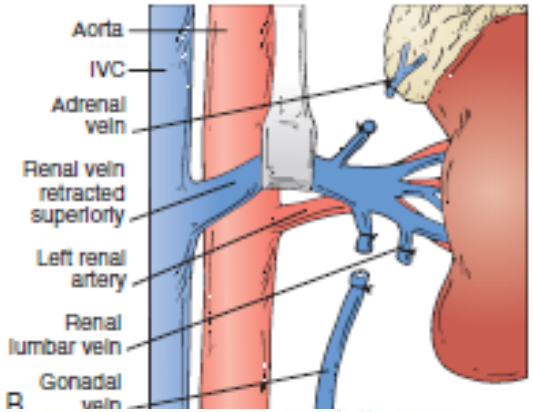
- Long-term, durable repair
- Less anatomical limitations
- Less follow-up

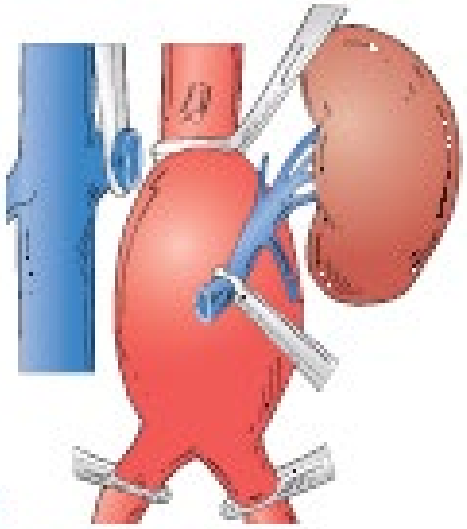
Approaches

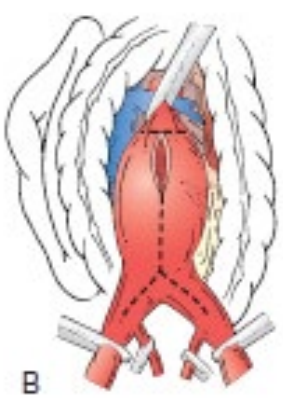
- Transabdominal: most traditional approach, allows for rapid exposure during ruptures
- Retroperotineal: Useful in patients with a hx of multiple abdominal operations

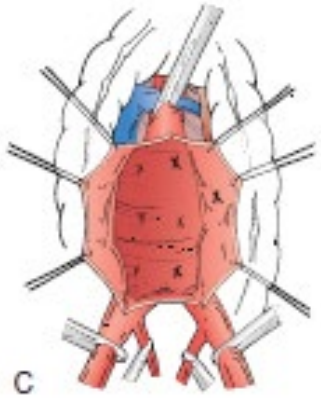
Open Repair - Technique

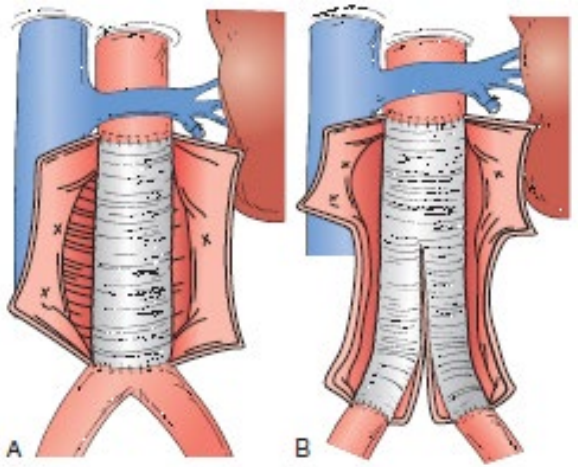












Endovascular Repair

Advantages

- Lower operative mortality
- Default procedure for AAA repair

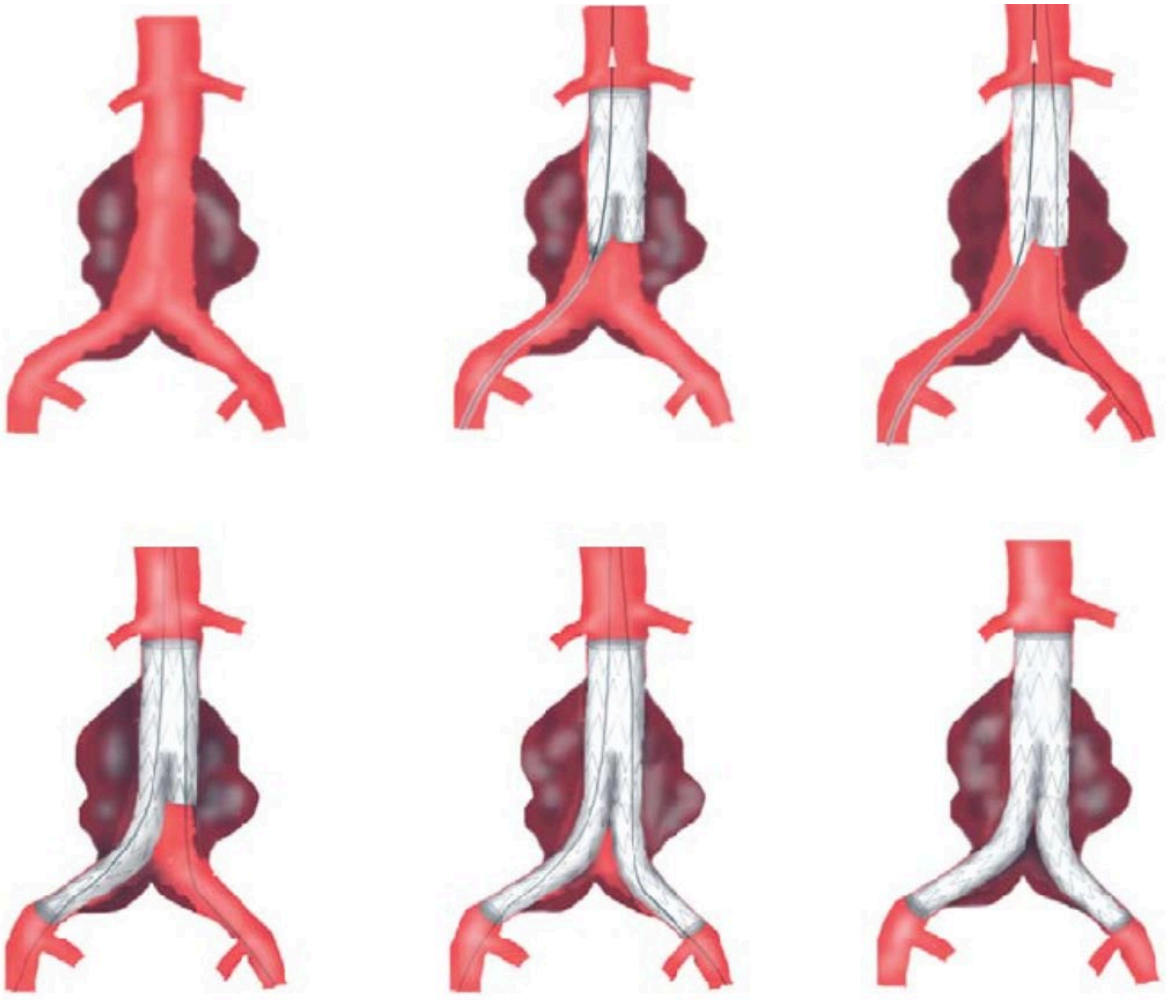
Disadvantages

- Requires long-term follow-up and clinical imaging

As of 2012, >80% of elective infrarenal AAA repairs are performed using EVAR.

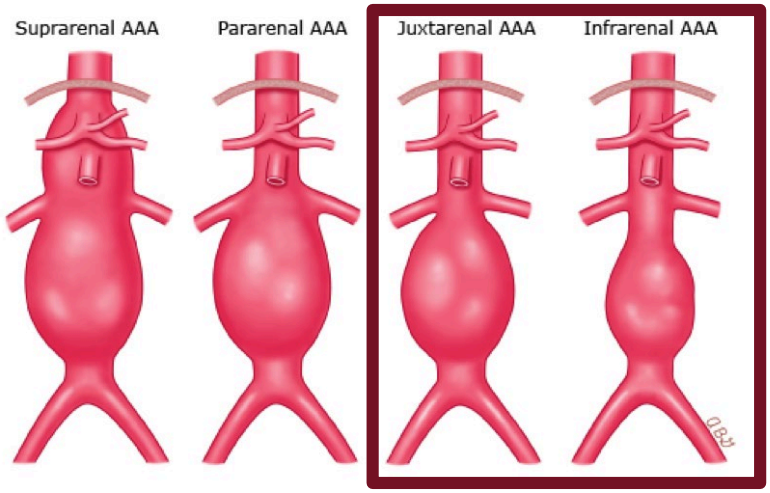
	DREAM Trial NEJM October, 2004		EVAR Trial I Lancet, September 2004	
	EVAR	**Open**	**EVAR**	**Open**
Mean Operative Time (min)	135	151	182	205
Mean EBL (mL)	394	1654		
Mean Blood Products Transfused	0.09 units	0.44 units	164mL	896mL
Mean Length of ICU Stay (days)	0.67	3	0.7	2.4
Mean Overall Length of Stay (days)	6	12	10.3	15.7
Perioperative Mortality	1.2%	4.6%	1.7%	4.7%

EVAR - Technique

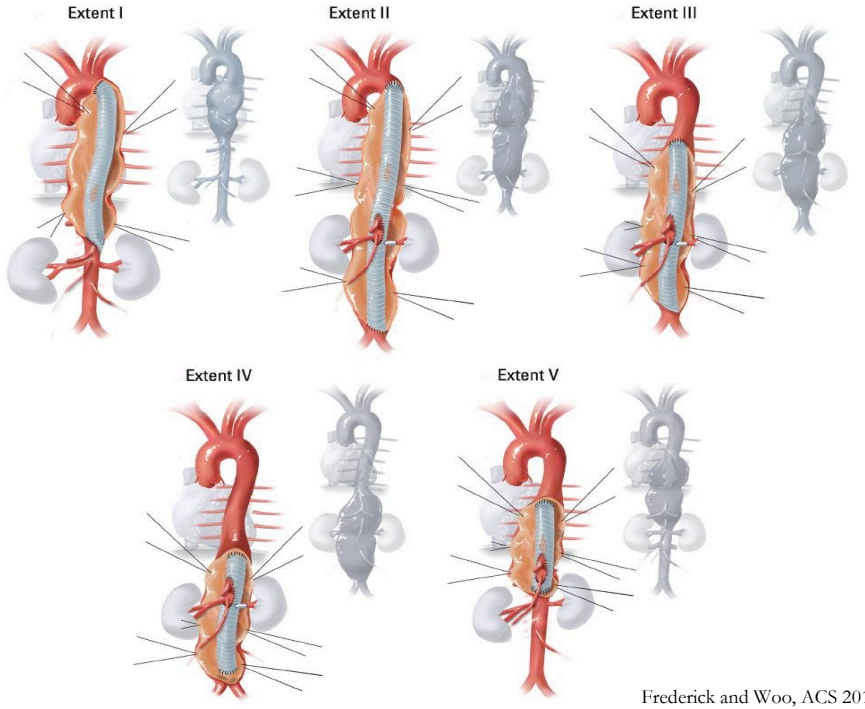


https://www.researchgate.net/figure/Endovascular-aneurysm-repair-EVAR-The-endovascular-procedure-is-performed-under_fig1_236057894

What are the limitations of current EVAR technologies?

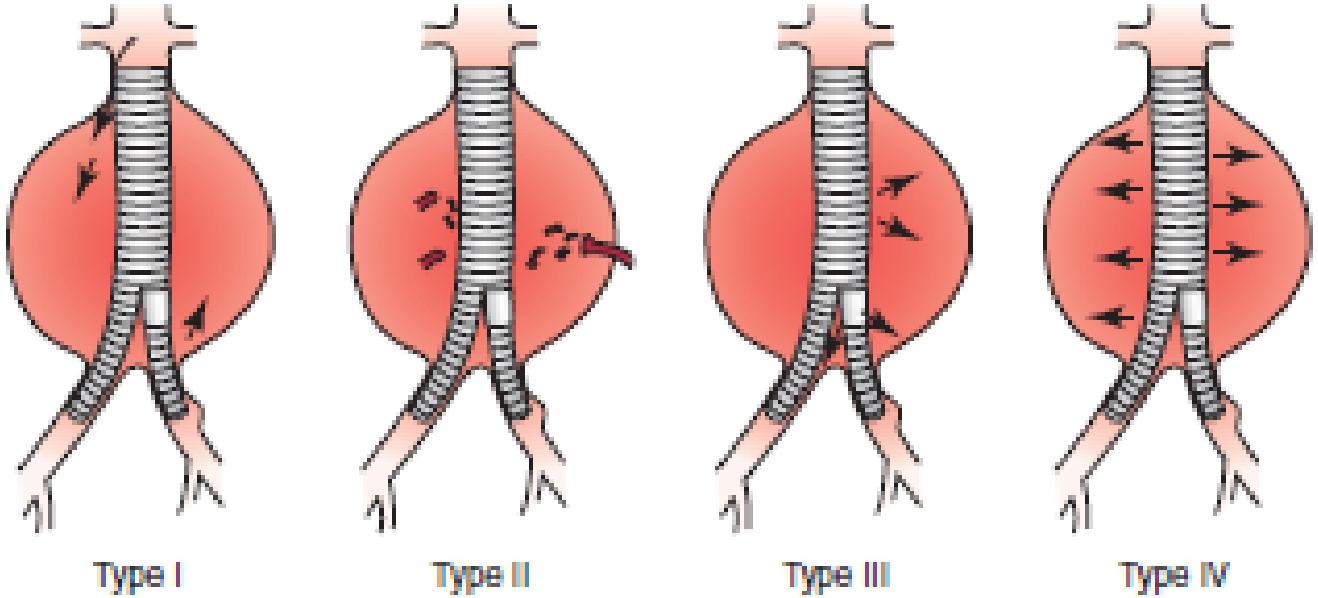


Short-term mortality after open repair ranges from 5-34%.



Frederick and Woo, ACS 2012

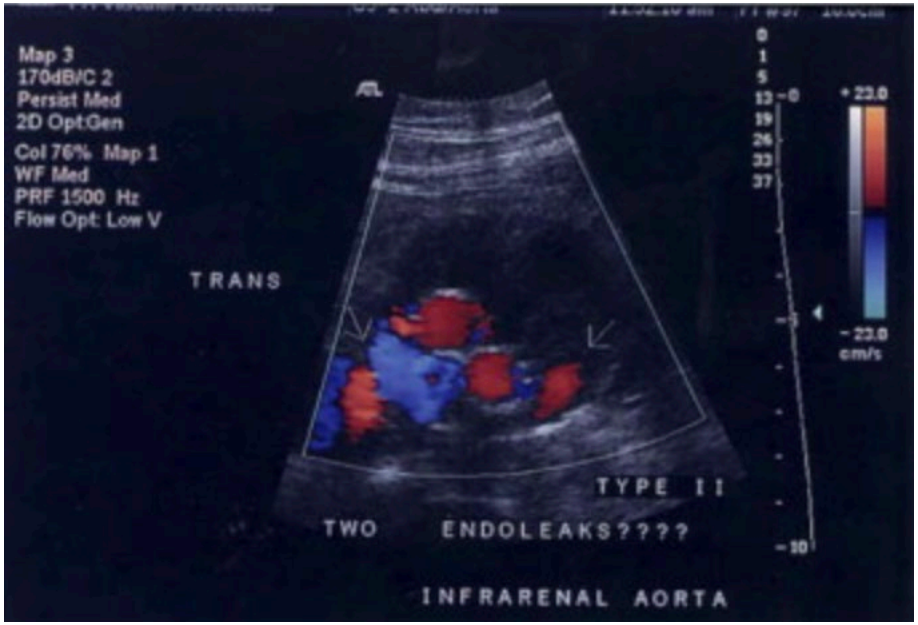
Endoleaks



Rutherford's Vascular Surgery, 8th Edition, Chapter 132

Surveillance after EVAR

- Infrarenal EVARs can be followed with duplex ultrasonography.
- Color and power doppler are used to identify flow in the aneurysm sac.
- Velocity measurements
    - <80cm/s = more likely to thrombose
- Sensitivity: 77-98%
- Specificity: 88-95%
- Only useful for infrarenal repair.
- CTA still needed for operative planning.



Beeman et. al. 2010

Mesenteric Occlusive Disease

Chronic Mesenteric Ischemia - Pathophysiology

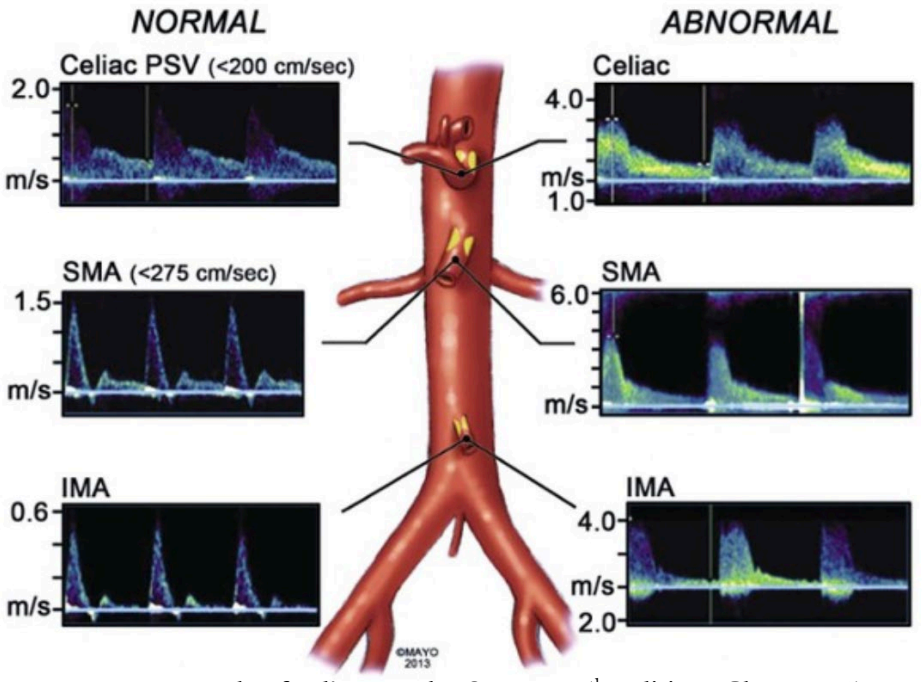
- In resting conditions, ~20% of the cardiac output goes to the mesenteric arteries.
- After meals, blood flow increases to levels 100%-150% of normal.
- Patients with mesenteric ischemia can't reach the hyperemic response required to supply oxygen for necessary metabolic processes.
- Lack of ATP metabolism -> Failure of intestinal mucosal transport pathways -> Contracture of muscular layer with inadequate relaxation -> Malabsorption and Pain

Chronic Mesenteric Ischemia – Clinical Presentation

- Classic triad of symptoms: abdominal pain, weight loss, and food fear
- Abdominal pain begins ~15-30 minutes after meals and can last as long as 5-6 hours.
- Progressive weight loss
- Physical exam is often non-specific, can hear abdominal bruit.
- 3-4:1 female:male ratio
- Many patients have seen multiple other doctors before presenting to a vascular surgeon.

Diagnosis – Mesenteric Duplex

- 6-8 hour fast prior to exam
- Celiac: increase in PSV after deep expiration indicates MALS



Rutherford's Vascular Surgery, 8th Edition, Chapter 152

Treatment

- Indications: all patients with chronic ischemia should undergo revascularization
  - Reduce pain
  - Restore nutritional status
  - Prevent bowel infarction
- Endovascular vs. Open
  - Open has superior long-term patency rates
  - Endovascular procedures are associated with less morbidity and mortality

Treatment

Endovascular

- Femoral, brachial, or radial access.
- Systemic heparinization with goal ACT > 250s prior to manipulation of mesenteric vessels.
- Treatment of SMA and Celiac lesions if they are both present.
- Primary stenting is recommended.

Open

- Generally only done after failure of attempts at endovascular revascularization.
    - Pre-op CTA necessary to define clamp zone and targets.
- Antegrade bypasses have a hemodynamic and anatomic advantage.

Post-Operative Surveillance

- Duplex ultrasound is recommended at 1 month, 6 months, 1 year, and then yearly afterwards to assess for re-stenosis.
- 1 month baseline is important as there are often elevated velocities seen after mesenteric stenting.

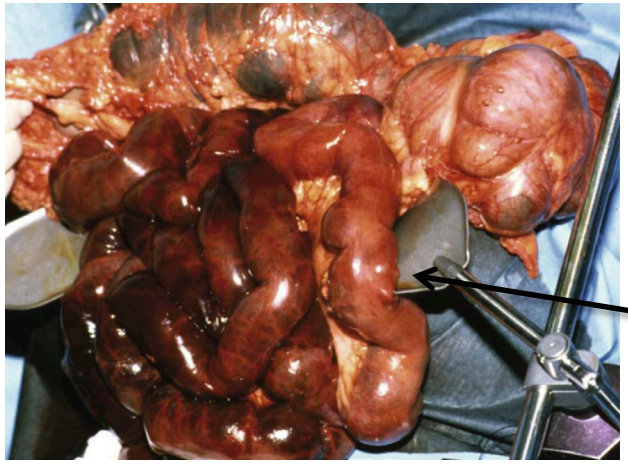
Acute Mesenteric Ischemia - Presentation

- Sudden onset of abdominal pain
- Nausea, vomiting, diarrhea, distention
- Pain out of proportion to physical exam!
- Guarding and rebound in late stages
- Leukocytosis, metabolic acidosis, hyperamylasemia, elevated LFTs, lactic acidosis

Acute Mesenteric Ischemia - Etiology

Embolic

- Embolism to the SMA, aortic or cardiac source (40-50%)
- Most common final destination for emboli is SMA (usually distal to middle colic artery)



Rutherford's Vascular Surgery, 8th Edition, Chapter 153

Thrombotic

- Arterial thrombosis (20-35%)
- Usually preexisting atherosclerosis affecting visceral vessels
- Affected segment is usually at the artery's origin
- Usually have preexisting CMI

Before the OR

- CTA is generally necessary for operative planning.
- Aggressive fluid resuscitation, correction of electrolyte imbalances, invasive monitoring
- Broad spectrum IV antibiotics, IV heparin
- Avoid pressors if possible!
- Surgical treatment – revascularization first, unless there is bowel perforation.
- Stenting or open bypass procedures can be used.
  - Vein conduit if bowel perforation.
  - Single bypass to the SMA can be done if patient is unstable and needs to get off the table

Venous Disease

Chronic Venous Insufficiency - Presentation

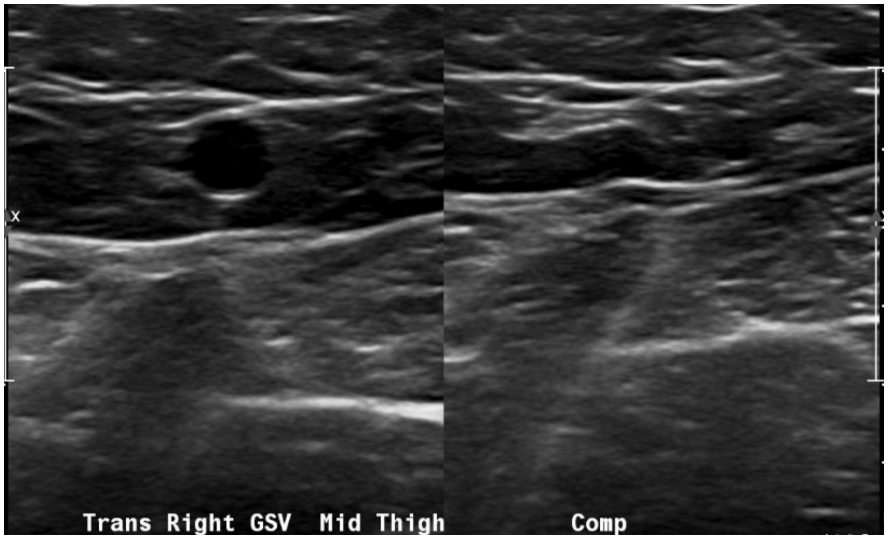
- Bulging varicose veins
- Pain, itching, throbbing over prominent varicosities
- Hemosiderin deposition
- Venous ulcers
- Bleeding from varicosities
- Superficial venous thrombosis

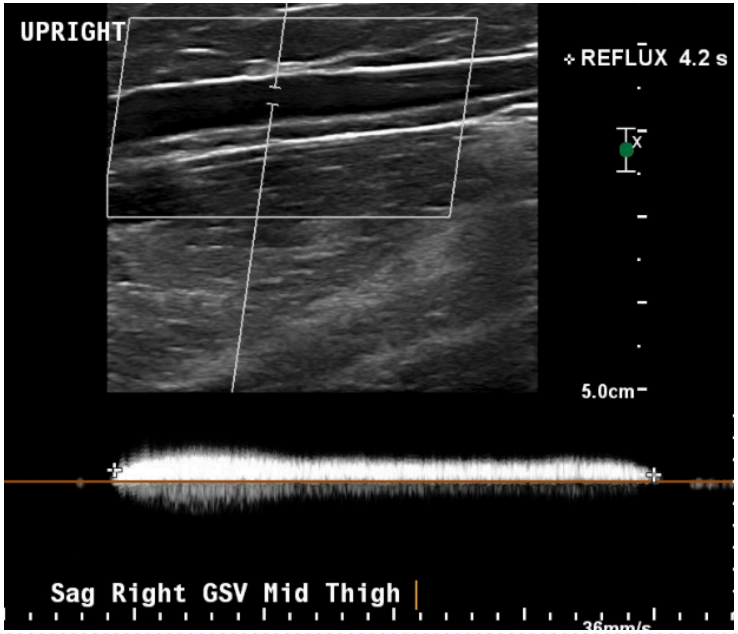
CEAP Classification

- Clinical Classification
  - 0: No visible signs
  - 1: Telangiectases
  - 2: Varicose Veins
  - 3: Edema
  - 4: Skin changes
  - 5: Healed ulcer
  - 6: Active ulcer
- Etiologic Classification
  - C: Congenital
  - P: Primary
  - S: Secondary
  - N: None identified
- Anatomic Classification
  - S: Superficial
  - D: Deep
  - P: Perforator
  - N: None identified
- Pathophysiologic Classification
  - R: Reflux
  - O: Obstruction, thrombosis
  - R,O: Both
  - N: None identified

Vascular Lab Testing

- Venous duplex imaging is the study of choice to confirm diagnosis of venous reflux
- Allows for identification of DVT as well as reflux
    - Acute DVT: Hypoechoic, non-compressible vein. No flow identified using color or doppler.
    - Chronic DVT: Hyperechoic, non- to partially compressible vein, thickened walls, may identify flow due to recanalization.





Treatment

- Compression therapy is the mainstay of treatment
    - 30-40mmHg, especially with ulcers
- Endovenous ablation is currently the preferred surgical therapy
    - Less invasive
    - EHIT as potential complication
- Ligation and stripping if veins are large, close to skin, tortuous
    - More invasive, often requires general anesthesia
- Stab phlebectomies of symptomatic varicosities
- Surgical treatment results in improvement of QoL scores as well as decreased ulcer recurrance

Take Home Messages

- There are a wide variety of vascular disorders, smoking cessation is important in all of them!
- Medical management should focus on overall cardio-protection and cholesterol management.
- Vascular laboratory testing is an excellent first-line diagnostic test and extremely useful in post-operative surveillance.
- Don't forget about venous disease!

References

- Kumar, Yogesh et. al. "Abdominal aortic aneurysms: pictorial review of common appearances and complications". Annals of Translational Medicine. Vol 5 No 12 (June 2017)
- Beeman, Brian et. al. "Duplex ultrasound factors predicting persistent type II endoleak and increasing AAA sac diameter after EVAR". Journal of Vascular Surgery. Vol 52, Issue 5. (November 2010)
- Cronenwett, J & Johnston, W. (2014), *Rutherford's Vascular Surgery.* Elsevier Saunders, Philadelphia, PA.

Thank You!

Questions?