Vesalius SCALpel™: Peripheral Vascular Disease (see also: vascular folios)

Principles

atherosclerosis: systemic disease, vasculopaths
risk factors: smoking, diabetes, hyperlipidemia (hi LDL, low HDL), obesity
AHA guidelines:
  major clinical predictors of perioperative risk
  unstable: coronary syndrome (MI < 30d, unstable angina)
decompenated: congestive heart failure
significant arrhythmia: hi grade A-V block, symptomatic ventricular arrhythmia
supraventricular tach w rapid ventricular response
severe valve disease
intermediate risk
  mild angina
  prior MI
  compensated CHF
  diabetes
  renal insufficiency
  all vascular surgery

hypercoagulable states
  antithrombin III (ATIII) deficiency, factor V Leiden (APC resistance), protein C and S deficiency,
  anti-phospholipid/anticardiolipin syndrome, prothrombin 20210, hyperhomocysteniemia:
  factor V Leiden, activated protein C (APC-R) most common congenital hypercoagulable disorders
protein C, S: K-dependent liver anticoagulation proteins
AT-III major plasma inhibitor of thrombosis, rare deficiency
smoking most common cause acquired hypercoagulable state

ankle/brachial index (ABI)
  normal 0.9-1.2
  each level of obstruction decreases ABI 20-30%
  iliac or superficial femoral: 0.6-0.7
  iliac and superficial femoral: 0.3-0.4
high ABI means vessels calcified, incompressible, classic diabetes
toe pressure 60% of ankle: <30-40% delayed healing, especially diabetics
hemodynamic changes @ 50% of diameter, less over longer length

inflow: aortoiliac,
  Leriche syndrome: absent femoral pulse, buttock/thigh claudicaion, erectile dysfunction,
  buttock atrophy
outflow: fem-pop, superficial femoral a (@ Hunter’s canal), tibioperoneal (esp diabetics)
  asymptomatic (ABI > 0.9), 10% of 55-75 yo males
intermittent claudication (“to limp”): pain due to increased demand on exercise in the face of fixed stenosis, ABI 0.5-0.7
majority do not need surgery to prevent amputation
7% 5y amputation risk, rare
5y survival with claudiation <70%
<50% have 3 vessel coronary disease
smoking worsens symptoms (cessation improves), obesity, hypertension, diabetes, hyperlipidemia (keep LDL < 100)
exercise improves skeletal muscle metabolism
marker for future cardiovascular events, stroke, infarction
5y mortality 30-50%
treat with antiplatelet agents
rest pain
night, dependent position helps
heparin releases NO, vasodilation
ulceration/gangrene
microembolization (blue toe)
differential Dx leg pain
circulatory:
arterial: workload related, reproducible
venous: gravity dependent, worsens when upright, relieved with elevation
neuro: sporadic, unpredictable
musculoskeletal: worst in AM when first stand up
natural hx claudication (“to limp”)
70-80% remain stable
respond to non-operative Rx, smoking cessation
20-30% progress
2-3% gangrene risk per year
5-7% amputation risk @ 5y, 12% @ 10
ABI < 0.5 best predictor of amputation
5y mortality 30% (M1), 10y 60%
imaging
duplex US
angio
femoral most useful access site
axillary highest complication rate
axillary sheath hematoma casues hand neurologic changes, explore
delayed Dx can result in permanent damage
MRA, CTA: 100cc contrast
medical Rx
risk factor modification, exercise
meds: ASA (no effect on symptoms but prevention for secondary cardiovascular events)
trental (older, acts on RBC deformability, fibrinogen & platelets), rarely used
plectal/cilostazol: phosphodiesterase III inhibition (contraindicated in pts. with CHF)

**Aortoiliac disease**

aortobifemoral bypass gold standard
- 80-90% 10y patency
- transabdominal equivalent to retroperitoneal approach
- 16X8, 18X9 most common sizes
- tunnel retroperitoneal limbs posterior to ureter to prevent obstructive uropathy
- distal end to side allows retrograde pelvic blood flow
- contraindications: intraabdominal sepsis, hostile abdomen (malignancy, pancreatitis)
  - alternative: ax-fem + fem-fem, thoraco-bifemoral

aortoiliac endarterectomy
- disease confined to common iliac, not external
- young male with small femoral a’s
- desire to avoid synthetic graft (e.g. w bowel perforation)

autogenous in situ reconstruction
- deep femoral vein (Claggett)
- cryopreserved aorta, expensive

endovascular replacing open aortofemoral bypass

unilateral aortoiliac occlusion
- aorto-fem, ilio-fem, fem-fem
- iliac endarterectomy

endovascular: angioplasty, stent, endograft
  - better results in common iliac than external

complications of aortofemoral surgery
- infection 1-2%
  - gold standard: graft excision and extraanatomic bypass
  - (rare in situ reconstruction in selected patients)
- aortoenteric fistula <1%
- pseudoaneurysm 2-4%
  - usually due to arterial degeneration
  - most common: mycotic aneurysm @ femoral anastomosis in groin
  - related to synthetic graft
- lymph leak 2-4%
- bleeding
- occlusion: thrombosis 5-10% @5y, embolism <1%
- colon ischemia 1-2%
- spinal cord ischemia <0.1%

**Infrainguinal**

medical therapy before consider bypass, surgery or endovascular for severe disease only (~1/3)

conduit
- greater saphenous: highest patency, no difference in-situ v excised
- most common cause of in-situ graft failure is retained valve
other autogenous: lesser saphenous, arm vein, deep femoral v
synthetic: PTFE, polyester, no difference
other: cryopreserved: poor (25%) 1y patency, infection; umbilical: aneurysm

patency
primary patency: time to failure
secondary patency: patency after thrombolysis or thrombectomy
assisted patency: intervention prior to occlusion
asymptomatic stenosis detected in surveillance

infrainguinal results
above knee autogenous and synthetic equivalent @2y
venous graft patency is directly proportional to diameter (do not use vein < 3.5mm)
inversely proportional to length, and graft generation (1st > 2nd etc.)
limb salvage: 60% 5y patency, 80% limb salvage

multilevel
inflow disease treated first
simultaneous inflow and outflow only for tissue loss with inadequate collaterals
hi morbidity
only 20% of pts with combined aortoiliac and fem-pop disease go on to have second stage (don’t need 2nd stage)

assessing adequacy of inflow
aortogram appearance: < 50% stenosis
any resting pressure gradient implies > 50% stenosis
pressure gradient with vasodilatation
pharmacological (Papaverine 30mg)
tourniquet induced ischemia, increases flow rate across stenosis, becomes evident
exercise: increased flow demand
duplex waveform: delayed upstroke time (> .144 sec)
femoral artery aneurysm: rupture least likely complication

popliteal entrapment
young men without risk factors for atherosclerosis
congenital fibromuscular entrapment of neurovascular bundle at knee
most common type: popliteal medial to insertion of medial head of gastroc.
symptoms elicited by active plantar foot flexion, knee extension
MRA best test, axial images
simple release (young) v bypass depends on degree of damage to popliteal
long segment occlusion after many years of trauma require bypass

popliteal aneurysm
most frequent (70%) peripheral aneurysm
50% bilateral
AAA present in 8% of patients with unilateral pop. aneur, 50% with bilateral
(1% of patients with AAA have pop aneur)
30-50% are bilateral
35% thromboembolic complications within 4y, 25% amputation after complication
most complications in >2cm, operate on >2cm asymptomatic
14% risk of symptoms/year
rare rupture
blue toe emboli, acute limb ischemia
symptoms: pain, numbness, paresthesia, venous engorgement, edema
anticoagulation has no effect on compressive symptoms
exclusion and bypass outside or in bed of aneurysm
ligate geniculate vessels from within sac, may allow continued growth of aneurysm
after bypass
embolization or clot of distal vessels complicates bypass
thrombolytic Rx: primary treatment prior to bypass in patients with acute thrombosis
and viable limb
angio to ID patent distal vessels, increase bypass patency
80% 5y patency
questionable durability of stent in popliteal location

adventitial cystic disease
5M:1F, 20-40yo with rapid onset claudication
myxomatous, mucinous cyst in wall of artery with luminal compression
cyst fills quickly causing pain
claudication, distal pulses disappear with passive flexion, pushes cyst into lumen
scimitar sign on angio, accentuated with flexion
treatment is interposition graft (not aspiration or surgical drainage)

Buerger’s/thromboangiitis obliterans:
20-40yo smoker, M>F
must involve >1 limb for diagnosis
r/o atherosclerotic, diabetes, embolic, autoimmune, hypercoagulable state
inflammation (different from giant cell arteritis), thrombotic occlusion small and medium
vessels upper and lower extremity, especially hands and feet
if completely stop smoking averts (50% decrease) major limb loss, if not 80-90%
amputation
corkscrew collateral vessels
superficial thrombophlebitis associated

polyarteritis nodosa
vasculitis of medium arteries, slow onset
fever, nodules, ulcerations, digital ischemia (especially lower extremities)
multiple visceral involvement, CNS, heart
Rx steroids, cyclophosphamide

fibromuscular dysplasia: 25% associated with intracranial aneurysm

persistent sciatic artery
M=F
Cowie’s sign: no femoral pulse in the presence of pedal pulses
continuation of internal iliac
aneurysm formation with sciatic pain common presentation
buttock pain, rupture with sitting

**Acute limb ischemia**

multi-level more likely tissue loss
sudden onset pulseless leg
Ps: pulseless, pallor, paresthesias/paralysis, poikilothermic (cool), pain
classification
viable: no sensory loss, weakness
threatened
mild: absent pulses, asymmetric temp, preserved motor and sensory
severe: loss motor and sensory, cool, cyanotic
advanced ischemia: no movement or sensation, cool, motled, deep muscle tenderness, blisters, rigor
surgical intervention between threatened and advanced

embolism v thrombosis
embolism: sudden, more pain, no history
echocardiogram to identify cardiac source
IV heparin 5-10K U bolus followed by drip
embolectomy with local
left atrial embolus to common femoral most common
thrombosis: progressive onset, history of peripheral/coronary artery disease
treatment
hx consistent with embolus: emergency surgery without angio
complications of revascularization:
cardiac arrest/arrhythmia
compartment syndrome with myonecrosis, pigment nephropathy
prolonged ischemia or compartment press. > 30mm Hg do 4 compartment fasciotomy
most other: pre/intraop angio indicated
anticoagulate with full dose 100u/kg heparin
history < 14d & limb viable do wire test: if wire passes consider thrombolysis, if not to OR revascularization should not be done for advanced ischemia

trauma
hard signs: pulsatile bleeding, expanding hematoma, bruit, distal ischemia
soft signs: history of bleeding, stable hematoma, nerve injury, hypotension
angio findings:
intimal defect < 50% diameter with distal flow: observe
extravasation, pseudoaneurysm, A-V fistula, occlusion: surgery
wide prep and prep donor limb
prox and dist control
perforation: primary repair if possible or autogenous tissue
consider covered stent if no significant branches
autogenous reconstruction, ligation option if unsalvageable
completion angio
frostbite: rapid rewarming in warm water

Compartment syndrome

muscle blood flow stops @ < 30-40mm, difference of < 30 compartment v diastolic
Muscle necrosis: hyperkalemia; Rx insulin/glucose, bicarb, fasciotomy

Diabetic foot

may have significant arterial stenosis with normal foot pulses and ABIs (stiff calcified vessels)
25% could be treated with angioplasty with improvement in ulcer healing
10% require arterial bypass
78% limb salvage
15% develop ulcers (arterial ulcer foot, toe; venous medial malleolus)
15% of these result in osteomyelitis
signs and symptoms (fever) decreased because of diabetic immunosupression
probe for sinus tracts, abscess, bone, joint, 89% accurate
MRI sensitive but not specific
WBC scan > 80% specificity
mixed infection 3-5 organisms: staph, strep, enterobacter, bacteroides
cover broad spectrum
Rx: avoid wt. bearing, drain/debride (delay increases risk of major amputation, morbidity and mortality), control glucose, treat ischemia (negative pressure dressing does not increase blood flow)

Anticoagulation

unfractionated heparin
accelerates interaction antithrombin III with thrombin (IIa)
indirect thrombin inhibitor
needs ATIII to act (can increase ATIII with FFP)
low molecular wt heparin (LMWH)
inhibits Xa, down-regulates production of thrombin
(central regulatory enzyme in hemostasis)
heparin induced thrombocytopenia (HIT), 5% incidence with any form/route of heparin
pl <150K or 50% of baseline
onset 4-14 days after start heparin therapy, two types
mild form: 4d, minimal decrease platelets, direct effect of heparin on platelets
not immunological, no thrombosis, resolves without discontinuing heparin
severe/immune HIT: 4-14d, (within hrs if prior xposure to heparin,
usually due to IV unfractionated heparin
delayed recognition poor outcome
antiplatelet antibody + pl factor 4 -> pl activation/aggregation, XS thrombin generation, venous and arterial thrombosis
Rx: stop unfract hep, replace with direct thrombin inhibitor (argatroban, lepirudin)

warfarin/coumadin
inhibits vitK-dependent carboxylation of II, VII, IX, X in liver
hirudin
from saliva of medical leeches, recombinant production
direct thrombin inhibitor
not dependent on ATIII
used as alternative anticoagulation in patients with heparin-induced thrombocytopenia

Venous disease

greater saphenous vein stripping below knee risk saphenous N injury
axillary-subclavian vein thrombosis (Pagett-Schrotter’s disease)
young, 2M:1F, debilitating symptoms, painful arm swelling, venous hypertension (effort thrombosis)
also frequently associated with central venous catheterization
treat acute with anticoagulation, elevation, catheter thrombolysis, does not alter stenosis
80% have persistent symptoms, treat underlying problem
superior thoracic aperture compression: decompress (first rib resection) and circumferential venolysis
balloon angioplasty of stenosis not durable, early recurrence
surgical bypass procedures option
stents not an option, break in this location
upper extremity venous gangrene extremely rare

May-Turner syndrome
compression of L common iliac v by R common iliac artery
pain and edema before thrombosis
catheter-directed lysis before metallo-stent

DVT
risks: obesity, varicosities, immobity, malignancy, thrombophlebitis, idiopathic thrombosis, diabetes, pregnancy, general anesthesia (20-50%), knee, hip joint replacement (50%)
 systemic heparin to oral anticoagulation X 3-6mo, decreases PE, recurrent DVT
3mo for known transient reversible risk factor, longer for permanent risk iliofemoral higher risk for post-thrombotic syndrome
thrombectomy only for phlegmasia cerulia/alba (secondary arterial ischemia) dolens, major obstruction subclavian, iliac, femoral
recurrence common
catheter-directed lytic Rx 80% success, 11% major bleeding complication,1% PE
better overall results than heparin alone
TPA/urokinase contraindicated within 4w of major surgery, trauma
DVT found in only 25-35% of patients with PE
serum D-dimer
rapid simple test eliminates 80% of pts with suspected DVT/venous thromboembolism
degradation product of cross-linked fibrin
increased during thromboembolic event
also increased after non-thrombotic events, eg surgery
screening, eliminate need for further diagnostic tests
spiral CT for PE requires contrast

venous stasis ulcer
differentiate venous (gaiter distribution) from arterial insufficiency (distal, dorsum, tips of toes) ulcers
site of first perforator 11cm above heel medially (above medial malleolus)
not painful, covered w granulation tissue v arterial ulcer
hemosiderin/brown brawny edema
large, serpiginous v small deep punched out arterial
1% of population, 1/3 remain unhealed
25% due to saphenous insufficiency, stripping and compression increases healing
evaluate proximal/saphenofemoral junction incompetence v full length
valve transplant not beneficial for saphenous (has been used for deep)
m most common etiology: post-thrombotic syndrome, incomplete recanalization, loss of valves deep system
ineffective calf muscle pump function
50% occurrence after DVT (especially recurrent episodes) within 5y
bed rest, compression, anticoagulation, analgesia
increased risk with obesity, inherited coagulopathies
dilation of major deep veins leads to incompetence, if not resolved within several mo
permanent valve damage, permanent obstruction of venous segments
chronic edema pain, dermatitis, ulceration
unna boot compression superior to stockings, hydrocolloid (DuoDerm) dressing 70%
healing
intermittent pneumatic compression plus elastic superior to elastic alone

primary lymphedema
< 1y of age with family hx = Milroys
praecox: < 35yo, most common, (Meigs w family hx)
tarda: > 35