

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

### Principles

atherosclerosis: systemic disease, vasculopath

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)

decompensated: 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 claudication <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% (MI), 10y 60%

imaging

duplex US

angio

femoral most useful access site

axillary highest complication rate

axillary sheath hematoma causes 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)

trexal (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 (1<sup>st</sup> > 2<sup>nd</sup> 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 2<sup>nd</sup> 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, mottled, 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 @  $< 30-40\text{mm}$ , 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 immunosuppression  
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  $< 150\text{K}$  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 exposure 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 unfractionated heparin, 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, immobility, 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 cerulea/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)

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