Vesalius SCALpel™ : Cerebrovascular (see also: vascular folios)

Physiology

internal carotid continuous forward flow (low resistance brain circulation)
    EC reversal during diastole
circle of Willis complete in only 18%
nl. ICP 0-15, treat at 20
75% of cerebral ischemia due to surgically accessible lesion
AVM 2-4% hemorrhage/year
fibromuscular dysplasia associated with intracranial aneurysm

Stroke

3rd leading cause of death
25% hemorrhagic, 75% thromboembolic (20% from carotid a., 50% cardiac/atrial thrombus)
    echocardiogram has replaced cath for Dx of cardiac source of emboli
carotid disease:
    90% atherosclerotic
        bifurcation most common source of platelet emboli from ulcerated plaque
    other: fibromuscular, stenosis, extracranial dissection, decreased flow, thrombosis,
            plaque thrombi, plaque rupture
classification
    TIA: completely resolves 24h
        many are small cerebral infarcts
        amaurosis not as worrisome as hemispheric/contralateral weakness
        repeated symptoms, fluid dynamics carry embolus to same vessel
        nature of plaque most important, friable
        occluded ICA can throw emboli from blind stump
        7% stroke rate/year, 36% 5year
        highest risk first 6 mo, decreases > 3y
        CEA reduces to 1%/y
    stroke in evolution: progressing neurologic deficit without resolution between attacks
        (as opposed to crescendo TIA's: complete resolution between)
    completed stroke: persistent neuro. defecit > 24h
natural hx asymptomatic carotid stenosis
    ACAS data:
        11% stroke risk @5y with medical management
        5% with CEA for > 60% symptomatic stenosis
    30-50% of strokes no antecedent symptoms
    > 75% stenosis: 18-40% neuro event 1st year, 5% stroke/y (justification for doing
        CEA for asymptomatic)
        stenosis with large ulcerated plaque: 7.5%/y
        CEA reduces stroke rate to 0.3%/y
patterns
    anterior/carotid circulation

middle cerebral most common
contralateral hemiplegia and hemianopsia, lat eye deviation, +/- aphasia
anterior cerebral: less common
contralateral leg weakness
posterior circulation:
global symptoms: dizziness, diplopia, vertigo, tinnitus, perioral numbness, drop attacks, paresthesias
hemodynamic form more common (steal syndrome one cause)
brief symptoms, rare stroke, postural
thromboembolic: less common, 30% of cases
stroke more common, high morbidity
multiple arch vessels: global cerebral ischemia

stroke
15-33% initial mortality, 50% 5y mortality
only 30% of survivors have normal cerebral function, many improve
9% recurrent stroke/y, 40% 5y
CEA reduces stroke risk to 2%.y
NASCET data symptomatic > 70% stenosis
medical management: 26% stroke @ 2y
CEA: 9% stroke @ 2y

stroke in evolution: progressive over hrs to days, 3 patterns
1 repeated atheroemboli from friable lesion
2 thromboembolic from distal end of thrombotic column
3 progression to thrombosis

completed stroke: area of brain infarction
embolization: size, composition, location determine outcome
intracerebral thrombus: lo flo causes brain vessel thrombosis
propogation of thrombus
up to ophthalmic (first branch ICA) may be asymptomatic because of collaterals
beyond ophthalmic progress to middle cerebral

Evaluation

risk
symptoms, degree of stenosis, ulcerated plaque, comorbidities
echocardiogram for atrial thrombus

imaging
duplex/US (main modality), angio (gold standard), CT/MRI
duplex: high sensitivity and specificity, 3 components
gray scale: US image of carotid, not very accurate
15-50% stenosis moderate
50-80% severe
>80 ctitical
velocity spectral analysis: wave flow, more accurate
contralateral occlusion increases ipsilateral velocities
with 80% stenosis peak systolic velocity (PSV) > 250cm/sec

- end diastolic velocity (most important) > 140cm/sec
- ratio ICA/CCA > 3.7

- color flow imaging

- cerebral angio
  - not justified for screening
    - 0.1-1.2 incidence stroke/death
  - indications
    - equivocal duplex
    - confirmation of complete occlusion (duplex may miss)
    - bilateral disease
    - contralateral occlusion
    - recurrent disease
    - arch vessel or intracranial disease
    - if considering for angioplasty or stent
  - NASCET/ACAS reporting convention
    - % stenosis = minimum diameter of stenosis/diameter of normal distal ICA

Management

- medical
  - antiplatelet: ASA, ticlopidine, clopedogrel
  - anticoagulation: warfarin
  - stop smoking
  - lower cholesterol (statin)
  - control hypertension
  - surveillance imaging
- interventional
  - thrombolysis
  - angioplasty
  - stent
    - 30d combined stroke and mort < 5%
    - potential indications: inaccessible lesion, recurrence, radiation induced stenosis, fibromuscular disease, hi risk (SAPPHIRE trial: stent with embolic filter can be done safely in hi risk, not inferior to CEA)
    - lower incidence MI than CEA
- surgery
  - carotid endarterectomy (CEA)
  - eversion endarterectomy
  - carotid bypass
  - extracranial/intracranial (EC/IC) bypass
  - ACAS (NIH ‘95) asymptomatic > 60% stenosis CEA v medical management
    - 5y incidence ipsilateral stroke 5.1 surgery v 11% medical
    - recommended CEA if reasonable surgery risk, expected long term survival
  - NASCET: symptomatic, 50 centers w < 5% M & M after CEA, NEJM ’91
    - symptoms: TIA or minor stroke within 3mo

ASA alone v CEA and ASA
lesions classified 30-69% and 70-99%
stopped after 18mo because of significant advantage of CEA
65% relative reduction cumulative strokes
81% relative reduction fatal strokes
for > 70% stenosis in symptomatic pts. TWO year risk of stroke: 9% for treated, 26% untreated, dramatic difference
moderate benefit with 50-69% stenosis
no benefit women, men with diabetes or pts < 50
less benefit pts with retinal symptoms
most benefit symptomatic older male with severe or critical stenosis

carotid endarterectomy (CEA)
contraindications
acute stroke within 2-6w
primary concern: avoid reperfusion injury to ischemic penumbra
theoretical concern: convert non-hemorrhagic to hemorrhagic
large fixed dense stroke (limited residual brain tissue to protect)
total occlusion
meticulous technique
monitor cerebral perfusion
no difference general v regional
shunt
only 10-15% lack adequate collaterals and require shunt
routine shunt does not decrease perioperative neuro events
ICA back pressure < 25-40mm need shunt
3min. test occlusion with local, observe for symptoms, EEG changes with general: shunt will reverse
air embolus potential complication
patch
Dacron most common, no difference v autologous saphenous v, PTFE, bovine pericardium
indications: all patients
advantages: decrease stenosis, restenosis, restore bulb hemodynamics decreases incidence of periop stroke
disadvantages: thrombogenic surface, aneurysm/rupture, infection, time
complications
ICA occlusion: 2-18%, 0.8% symptomatic
only 20% require reoperation
must determine patency of ICA immediately (US, angio, whichever quickest)
if neuro defecit in recovery room, return to OR immediately
urgent < 4h reoperation for thrombosis
> 60% improve after thrombectomy, 17% mortality
anticoagulate once hemorrhage excluded
cerebral edema/hemorrhage (late)
deficit often presents after period of normal function

- BP instability
  - carotid sinus stimulation: baroreceptor in bulb to N of Herring to brain stem to bradycardia, decrease BP
  - associated with stroke and mortality
  - Rx: atropine, lidocaine for bradycardia, correct volume, pressor
- cranial nerve dysfunction
  - 10-15% incidence, 1/3 asymptomatic
  - speech pathologist can detect more, 35%
  - most resolve by 3 mo
  - evaluate cranial nerves before do contralateral
  - vagus/recurrent laryngeal
    - 6-8% incidence, ipsilateral cord paramedian, hoarse
  - hypoglossal: 4-6%, ipsilateral deviation of tongue
  - superior laryngeal: 1-2% (when passing clamp around ECA)
    - voice fatigue, loss of high pitch
  - marginal mandibular (incision too far anterior), droop corner of mouth
  - glossopharyngeal: 1% (with high exposure), significant swallowing morbidity
- cerebral hyperperfusion syndrome: 0.7-5% incidence, 36% mortality
  - increased cerebral blood flow, edema, seizure, hemorrhage, death
  - ipsilateral frontoparietal headache, hypertension
  - disturbed autoregulation
  - risk factors: correction of very hi grade stenosis, especially with contralateral occlusion, hypertension, old/new infarct, poor collateral circ., anticoagulation
  - cerebral imaging: CT shows hemorrhage, MRI/gadolinium more sensitive
  - Rx: antihypertensives, anticonvulsants, D/C anticoagulation, treat cerebral edema
- recurrent stenosis
  - early: technical defect
  - 2y: intimal hyperplasia, smooth surface, less thrombogenic, more common in women, usually asymptomatic
  - 9-20y, 2-4% need reoperation
  - indications for reoperation: neuro symptoms, hi-grade (80%), especially recurrent atherosclerosis
  - must patch if reoperate
  - may need interposition
  - consider PTA/stent

- eversion endarterectomy
  - standard longitudinal incision
  - don’t see endpoint
- combo CABG and CEA
  - only in severe carotid disease (> 80%) or symptomatic carotid disease with coronary artery disease that can’t wait (3 vessel symptomatic disease)

2X stroke and death rate (5% v 2%)

Other cerebrovascular disorders

fibromuscular dysplasia (FMD)
- string of beads, bilat, women more common
- associated with other lesions: atherosclerosis, carotid aneurysm, dissection, **intracranial aneurysm**, renal FMD
- 50% asymptomatic
- natural history relatively benign
- operate only for symptomatic and severe stenosis in asymptomatic (3% of CEAs)
- dilatation/PTA
- periop stroke 1-3%, late 1-4%

tortuous/kinked carotid
- congenital or associated with atherosclerosis in adult, 25% bilateral
- may have symptoms with head turning
- only have to deal with if doing CEA
- surgery only for symptoms
  - resect and reanastomose

extrinsic compression
- mostly vertebral in bony canals
- tumor

radiation-induced stricture: 3 patterns
1 intimal damage leads to thrombosis within 5y
2 fibrotic occlusion 10y
3 accelerated atherosclerosis 20y
- different from atherosclerosis, long narrowing, early age, less associated vascular disease
- endarterectomy more difficult, may need interposition
- consider PTA/stent

vasculitis/giant cell arteritis
- elderly women, medium to large arteries (arch, extracranial)
- flu-like symptoms, headache, jaw claudication, visual changes
- Dx temporal a bx
- Rx: immediate steroids
  - surgery only indicated after disease quiesces

Takayasu arteritis
- young (<40) women
- arch and great vessels
- 3 phases: prodromal, inflammation, burned out
  - complications: stenosis, embolization, occlusion

carotid aneurysm (rare)
- dissection, atherosclerosis, trauma, prior carotid surgery
- rarely rupture unless infected
- embolization common, surgical indication
- resect and reconstruct

consider endovascular

carotid body tumor, neural crest origin
- chemoreceptor responsive to hypoxia, hypercarbia, acidosis
- stimulation results in incr respir, tidal vol., heart rate, increase BP
- 2-5% malignant, 5% bilateral
- asymptomatic neck mass which is mobile laterally but not cranio-caudally
- splaying IC/EC, angle of mandible
- highly vascular, blood supply from ECA
  - pre-op angio +/- embolization (makes surgery easier)
- high exposure for excision
- 5% perioperative stroke, 20-40% cranial nerve injury

external carotid AVM
- total excision; pre-op embolization may reduce blood loss, but not definitive Rx
- high flow may result in congestive heart failure

Carotid trauma

blunt or sudden neck extension causes intimal tear

spontaneous dissection with FMD, Marfans/connective tissue disorders

symptoms
- unilateral headache, delayed cerebral symptoms
- incomplete Horner's (oculosympathetic paresis)
- cranial nerve palsies
- most recover, treat with anticoagulation (coumidin 3-4mo) of symptomatic

penetrating trauma, ABCs
- med Rx: small defect on angio
- surgery: primary repair (best option), graft, ligate
  - ligate with massive hemorrhage, coma, severe cerebral injury, no back-bleeding after thrombectomy

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