Vertebral Artery Revascularization

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Case Presentation

65M c/o lightheadedness and numbness over forehead and left face when he lifts his arms or leans his head back

PMHx: HIV, HCV, DM, seizure disorder, cirrhosis, b/l carotid artery occlusion

PSHx: Cranioplasty (1975)

NKDA

40 pack-year smoker, + EtOH and IVDA
Occluded RICA

Occluded left proximal and distal LICA

Moderate stenosis of proximal RECA

Probable stenosis of right vertebral artery
ICAs occluded bilaterally

Reconstitution of supraclinoid segments from collaterals from ophthalmic arteries and posterior communicating arteries

Circle of Willis otherwise intact

Atherosclerotic change with severe focal narrowing of origin of left vertebral artery and right external carotid artery
Severe bilateral cerebral vascular disease with *chronic bilateral total occlusions* of proximal ICAs and high grade stenosis of left vertebral artery.

Predominant pathway for intracerebral perfusion is through the vertebral *arteries* and bilateral collateral pathways through the external carotid arteries.
1.5 years pass...
Complete occlusion of bilateral ICAs with reconstitution of flow intracranially at the clinoid and supraclinoid segments

Mild short segment narrowing RCCA

Moderate to severe focal stenosis origin of RECA

Moderate to severe focal stenosis origin left vertebral artery
Left Vertebral Artery Transposition

Placed supine with head turned to the right

Intraoperative EEG monitoring

Supraclavicular incision and exposure

Vertebral artery transposed into left subclavian artery
Supraclavicular Approach

Transverse incision 1 cm above the clavicle from head laterally 7-8 cm

Carried through clavicular head of SCM
Supraclavicular Approach

**Carotid sheath** mobilized medially

**Omohyoid muscle, external jugular vein, and thoracic duct** are divided

Caution to avoid injury to vagus nerve and sympathetic chain
Supraclavicular Approach

Dissection of **scalene fat pad** from medial to lateral exposes

- sympathetic chain
- anterior scalene muscle
- phrenic nerve
- inferior thyroid artery
- vertebral vein
Supraclavicular Approach

Division of the inferior thyroid artery and vertebral vein expose the artery
Postoperative Course

Transferred to the floor

Clears on night of POD0

No dizziness, facial numbness or weakness, left arm neurovascularly intact

Advanced to regular POD1

Discharged POD2 on ASA and statin
Follow-up

Dizziness improved

Mild left ptosis and miosis

Likely traction injury to sympathetic chain during dissection
Vertebral Artery Disease

Anatomy

Vertebrobasilar disease

Indications for revascularization

Evaluation

Treatment

Complications

Summary
Vascular Supply to the Brain

Circle of Willis - intact in 20%

Anterior circulation - carotid arteries

Posterior circulation - vertebral arteries

Anatomic variability explains variability of clinical presentation
Vertebral Arteries

Originate from subclavian arteries
(Aortic arch in 3-5%)
Commonly asymmetric (R>L)

V1: subclavian to transverse foramina of C6 (or C5)

V2: C6 to C2 (invested within intertransversarii muscle)

V3: C2 to foramen magnum (penetrates dura)
Maximal cervical mobility -> vulnerable to injury

V4: intracranial, atlantooccipital membrane to basilar artery
Etiology of Vertebrobasilar Disease

Posterior cerebral ischemia less common

25% TIAs

5-10% risk of stroke or death at 1 year

20-30% Mortality from posterior circulation stroke

- Atherosclerosis (most common)
- Trauma
- Fibromuscular dysplasia
- Takayasu’s arteritis
- Osteophyte compression
- Dissection
- Aneurysm
Pathogenesis

**Hemodynamic** - Symptoms from postural changes or transient decrease in cardiac output

- HTN meds, arrhythmia, large vessel atherosclerosis, orthostatic
- Short-lived, repetitive, predictable
- Rarely result in tissue infarction
- Coincide with vertebral artery stenosis

*For symptoms to occur, significant pathology must be present in both vessels, pt must have incomplete circle of willis, or have proximal artery occlusion*
Pathogenesis

Embolic - Symptoms unpredictable

- Atherosclerotic lesions, trauma, dissections
- Majority result from intracranial pathology (V4)
- Infarcts in brain stem, cerebellum, PCA
Indications For Revascularization

1) Hemodynamic source: >60% stenosis in both, or >60% unilateral if contralateral is hypoplastic, ends in PICA, or is occluded

   *Single normal vertebral artery is sufficient to perfuse the basilar artery*

2) Embolic source: posterior circulation ischemia from microembolism and source lesion in vertebral artery

3) Symptomatic aneurysms and asymptomatic aneurysms > 1.5 cm

   *Contraindicated in asymptomatic patients*
Evaluation

H&P

Symptoms are nonspecific - dizziness, vertigo, diplopia, numbness, dysarthria, dysphagia, tinnitus…

Review medications

Triggering events

Cardiac evaluation

Imaging: arteriography (dynamic, delayed), MRA/CTA, duplex
Revascularization

Location of disease dictates type of surgical reconstruction

Majority of procedures relieve V1 stenosis at orifice or stenosis, dissection, or occlusion of intraspinal components (V2, V3)

Outcomes differ for proximal vs distal repairs

- Proximal repairs have excellent long-term patency (91% at 10 years)
  80% of patients report relief of symptoms

- Distal repairs also have good long-term patency (82% at 10 years)
  71% of patients are cured
Transposition of proximal vertebral artery into common carotid

Bypass with saphenous vein

Subclavian artery endarterectomy
Rarely accessed surgically

Most common indication for exposure is for hemorrhage

If unable to treat endovascularly -> proximal and distal ligation of the artery
Performed at the C1-C2 level

Saphenous vein bypass from common carotid, subclavian, or proximal vertebral
Suboccipital Segment

Vertebral artery can be accessed above the level of the transverse process of C1
Requires resection of the transverse process of C1
Reconstruction is limited to saphenous vein bypass
Technically demanding, rarely required
Complications

Perioperative mortality is low (< 5%) - increased for combined carotid disease

Horner’s syndrome (10-20%)

Chylothorax (5%)

Lymphocele (4%)

Vagus or recurrent laryngeal palsy (2%)

Immediate thrombosis (1.4%)
Endovascular Therapy

2005 Cochrane Review

313 interventions for vertebral artery stenosis, half with stent placement

Technical success rate 95%

30-day stroke and death rate 6.4%

Although angioplasty/stenting is feasible, currently insufficient evidence to support routine application
Endovascular Therapy

CAVATAS 2001

Randomized controlled comparing endovascular therapy vs. medical

Subset of 16 patients

No 30-day strokes or death in either group

25% of endovascular patients experienced TIA's post-op

After 4.5 years, no posterior circulation strokes in either group
Conclusion

Vertebral artery disease is an underdiagnosed cause of posterior circulation ischemia

Revascularization is a viable option

Treatment is dependent of the anatomic location of the lesion

Open techniques have proven clinical durability

Endovascular techniques are viable but have less proven durability