Fundamentals of Operative Techniques in Neurosurgery

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Ophthalmic Artery Aneurysm

INDICATIONS

- ophthalmic aneurysm:
  - ruptured
  - unruptured: may consider nonoperative management if patient is very elderly or sick, especially if lesions are very small; these lesions may have a more benign natural history than other unruptured lesions
- proximal internal carotid artery (ICA) aneurysm: superior hypophyseal or carotid cave aneurysms
- cavernous aneurysm: most often nonoperative management is indicated; giant symptomatic aneurysms better treated with bypass and endovascular ICA occlusion

PREOPERATIVE

Operative Planning

- review imaging
  - CT scan:
    1. noncontrast (with and without bone windows) shows relationship of the clinoids (if fused, favors intradural clinoid removal); also shows lateral extent of ethmoid sinuses
Ophthalmic Artery Aneurysm

2. spiral CT angiogram shows three-dimensional relationship of the aneurysm to the bony anatomy (if aneurysm has caused bony erosion, may dictate against extradural clinoid removal)

MRI scan: T1/FLAIR/MRA source images provide excellent rendering of the aneurysm in relation to cavernous sinus

angiogram:
1. takeoff of aneurysm in relationship to ophthalmic artery, posterior communicating artery, and clinoid
2. medial-lateral projection: supero-medial view for superior hypophyseal; infero-lateral view for carotid cave; superior view for ophthalmic artery
3. view ICA bifurcation in neck to confirm absence of atheroma

Routine Equipment
► as for ACOM aneurysm (see Chap. 65)

Special Equipment
► as for ACOM; also need 1-mm or 2-mm diamond burr (cutting or noncutting) for removal of the clinoid should this be necessary
► cervical carotid cutdown tray
► radiolucent Mayfield head holder if intraoperative angiography is required

Operating Room Setup
► as for ACOM aneurysm (see Chap. 65), but with prep groins to facilitate angiography and neck to facilitate cervical ICA exposure as necessary

Anesthetic Issues
► as for ACOM aneurysm (see Chap. 65)

INTRAOPERATIVE

Spinal Drain (see Chap. 195)
► for subarachnoid hemorrhage cases only (regardless of the presence of ventricular drain)

Positioning
► patient supine with head fixed in Mayfield head holder
neck is slightly extended (10°) and elevated to increase venous drainage
the head is then rotated 45° away from the approach

Pterional Craniotomy (see Chap. 49)

Control of the Cervical ICA (see Chap. 77)

goals:
- suture ligature, Romel on ICA
- ability to place aneurysm clip across proximal ICA

steps:
1. same as for carotid endarterectomy but smaller incision for a more directed goal
2. to save time, can be done simultaneously with pterional craniotomy by assistant
3. once the vessel is controlled, release retractor to diminish local tissue pressure

Extradural Removal of the Clinoid (see Chap. 59)

goal:
- exposure of the aneurysm and the proximal ICA with the dura as a protector

steps:
1. remove posterior orbital roof with small rongeur
2. unroof superior-medial superior orbital fissure, also with rongeur
3. irrigation-cooled thinning of the clinoid and optic canal with diamond burr (2 mm)
4. gently fracture these elements away from optic nerve with microdissector or Rhoton spatula
5. carefully drill the optic strut below the optic nerve to expose the clinoid for free fracture after dissection of dura off it; removal of clinoid now accomplished with pituitary rongeur; packing the cavity with Surgicel and Avitene usually necessary

Intradural Removal of the Clinoid

goal:
- exposure of the aneurysm and proximal ICA under direct visualization

steps for small aneurysms (tailored removal) (Fig. 67.1):
1. the dura over the clinoid is cauterized and incised in an inverted U
2. the dura is reflected inferiorly with a Rhoton dissector so as to protect the nerve and the aneurysm
3. 1-mm diamond burr under continuous irrigation is used to remove the clinoid to the level of the strut; the bone is waxed
4. the drill is then used to thin the roof of the optic canal (take care not to drill too medially, because the ethmoid air cells begin to intrude here)
5. the falciform ligament is now released with a Beaver blade
6. just enough of the clinoid is removed to facilitate medial displacement of cranial nerve II, exposing the neck of the aneurysm and the proximal ICA

► steps for larger aneurysms (complete removal):
1. same as above, but also:
2. complete medial dissection of the strut to release the entire clinoid
3. opening of the distal dural ring to expose the clinoidal segment of the ICA

Control of the Clinoidal Segment (Optional)

► although temporary clip placement here has been advocated by others, confines are narrow and we generally prepare a spot but do not use it; this allows the surgeon more room for placement of the final clip
Full Identification of the Neck (see Fig. 66.1)

► goals:
  ▶ perfect initial clip placement
  ▶ to avoid sacrifice of ophthalmic or superior hypophyseal artery
  ▶ to avoid compromising lumen of ICA

► steps:
  1. occlude ICA in the neck
  2. trap ICA distal to choroidal
  3. work both sides of the neck, moving the artery but not the nerve

Clipping the Aneurysm

► goals:
  ▶ exclude diseased portion of the vessel
  ▶ maintain patency of all vessels

► straight clip (Fig. 67.2):
  1. place perpendicular to long axis of ICA for small ophthalmic aneurysm
  2. take care to ensure blades are long enough

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**Figure 67.2.** Clipped ophthalmic aneurysm (resected)
► **curved clip:**
1. generally the clip of choice (with the tips down) for the superior hypophyseal, because this is essentially a medial-wall aneurysm

► **straight fenestrated (Fig. 67.3):**
1. ideal first clip for large/giant ophthalmic aneurysms; distal-blade strength and rear fenestration make this a favorite; directed medially and slightly inferiorly; not to occlude ICA but at the same time exclude the medial proximal neck (most common site of residual)
2. back up with a second clip if the neck is calcified or the aneurysm is still filling
3. the fenestration is always completed with a short straight clip to reconstruct the superior wall and curve of the ICA

► **angled fenestrated:**
1. generally reserved for giant proximal ICA aneurysms involving the entire circumference of the vessel; occasionally for superior hypophyseal unmanageable by curved clip (this carries greater risk to CN II secondary to manipulation and occlusion of perforator blood supply)
2. giant aneurysms usually require more than one; easier to place first clip with blades directed proximally into cavernous sinus; backup clip can then be placed pointing distally toward bifurcation (take care to ensure patency of choroidal)

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**Figure 67.3.** Ophthalmic aneurysm exposure
Reexamination of the Complex

**goals:**
- verify that aneurysm is excluded
- verify patency of ophthalmic artery and ICA
- verify CN II decompression

**steps:**
1. if vision is limited, now is the time to retract ICA fully
2. full medial and lateral mobilization of the ICA to view clip blades in their entirety
3. replace clip as necessary under temporary control; often it is preferable to place a backup clip and remove the first clip, which is causing the vessel to be compromised
4. needle aneurysm to confirm clipping as case and prudence dictate

Closure

- as for pterional craniotomy (see Chap. 49)

POSTOPERATIVE

- as for ACOM (see Chap. 65)

COMPLICATIONS

**INTRAOPERATIVE**

Premature Rupture of the Aneurysm Prior to Control of the ICA

- **avoidance:** intradural drilling of clinoid; control ICA in neck first
- **intervention:** immediate pressure on neck to reduce ICA flow, or clamp cervical ICA as possible; immediately place sucker over hole in aneurysm and attempt to trap segment and then carefully clip aneurysm

Injury to Ophthalmic Artery

- **avoidance:** see vessel well prior to placing clip
- **intervention:** reposition clip
Injury to the Superior Hypophyseal
- avoidance: mobilize ICA inferolaterally with clip blades as they are being deployed; use angled rather than fenestrated clip
- intervention: reposition clip, though often not worthwhile; usually asymptomatic

Injury to ICA
- avoidance: avoid temporary clip use on atherosclerotic plaque either in neck or at dural ring
- intervention: intraoperative angiography useful; replace clip as necessary

Injury to the Optic Nerve
- avoidance: minimize use of cautery in all dissection and take care not to overly manipulate (generous dural and bony decompression); keep drills well irrigated and avoid the temptation to speed up bony decompression with micro-Kerrisons
- intervention: steroids (but injury is usually permanent)

Injury to the Third Cranial Nerve
- avoidance: minimize use of cautery in all dissection and reinspect clipping to ensure clip is not pressing on nerve
- intervention: reposition clip; steroids (injury is usually transient)

Suboptimal Clip Placement, Yielding Residual
- avoidance: full visualization of the entire complex from all angles; intraoperative angiography
- intervention: reposition clip if possible; may require converting from straight-clip approach to slightly curved clip or a fenestrated construct

Entry into the Ethmoid Sinus
- avoidance: in drilling the optic canal, stay just to the medial border of CN II
for small aneurysms and for ruptured aneurysms, I have begun drilling the clinoid intradurally in all cases, finding that the exposure gained by a formal Dolenc approach is not necessary. I feel the protection and security afforded by a cervical ICA cutdown are worth it in almost every case. A three-dimensional understanding of the ICA as it exits the cavernous sinus is critical; those with less experience may want to consider intraoperative angiography to avoid ICA occlusion with the clip; however, in my experience, angiographic control of the ICA with interventional techniques (i.e., balloons) has been underwhelming.

**INTERVENTION:** extensive waxing, spinal drain

**POSTOPERATIVE**

Vasospasm/Hydrocephalus as with ACOM (see Chap. 65)

- **treatment:** triple-H therapy, angioplasty, nimodipine, extramedial ventricular drain, ventriculo-peritoneal shunt, serial LPs

CSF Leak

- **treatment:** spinal drain; occasionally reexploration and waxing are helpful

**MANAGEMENT PEARLS**

**DR. SOLOMON**

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- A three-dimensional understanding of the ICA as it exits the cavernous sinus is critical; those with less experience may want to consider intraoperative angiography to avoid ICA occlusion with the clip; however, in my experience, angiographic control of the ICA with interventional techniques (i.e., balloons) has been underwhelming.