Anterior circulation aneurysms and surgical Considerations

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Basic principles of aneurysm surgery

- **Hemostasis** of the extradural portion should be **meticulous.**
- Hand rests, **instrument** holders and self retaining retractors **must be checked** before bringing in the microscope.
- **Least amount of brain retraction**. Brain spatula should be kept parallel to the brain to avoid injury from the edges.

Basic principles of aneurysm surgery

- The arachnoid membrane must be completely and extensively dissected. Helps drain CSF.
- Proximal & distal control should be obtained first.
- The side of the parent vessel opposite the aneurysm should be dissected first → neck dissected → fundus.
- All perforating arterial branches should be separated.
- Clip should not be applied blindly.
- After clipping area should be inspected to ensure that only the aneurysm neck is obliterated.

Intracavernous and Paraclinoid ICA aneurysms.

- Anatomy-

Formed by lesser wing of sphenoid, provides bony roof to SOF

The OS extends from the inferomedial surface of the ACP

The ACP and OS define and obstruct access to the anterior and lateral borders of Ascending ICA as it exits the cavernous sinus often obligating ACP removal

Dural relationships

The outer dural layer forms the distal dural ring It is firmly adherent.
blunt dissection
Should not be done

The inner membranous layer forms the the proximal dural ring & then further wraps the ICA the clinoidal segment of the ICA in a dural sleeve. Posteriorly the inner dural layer forms the dural sheath of III nerve.

This is an important landmark when approaching the Cavernous sinus

Intracavernous and Paraclinoid aneurysm

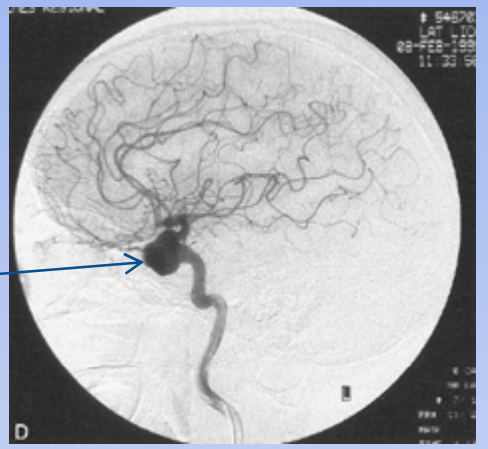
- Three types-

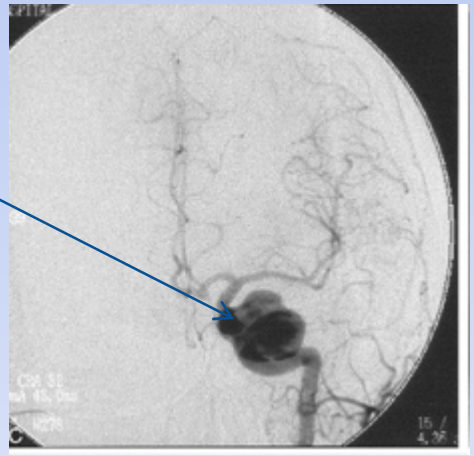
1. Cavernous segment
2. Clinoidal segment
3. Opthalmic segment.

- Female : male = 9:1
- 5^{th} and 6^{th} decade
- Usually discovered as incidental lesions or because of mass effect.
- Propensity for multiplicity.

Cavernous segment -Clinical and radiographic features

- Most clinically significant aneurysms arise from the horizontal segment and project forward and laterally toward the SOF Below the ACP.
- cavernous sinus syndrome.
- Any life threatening risks are rare.





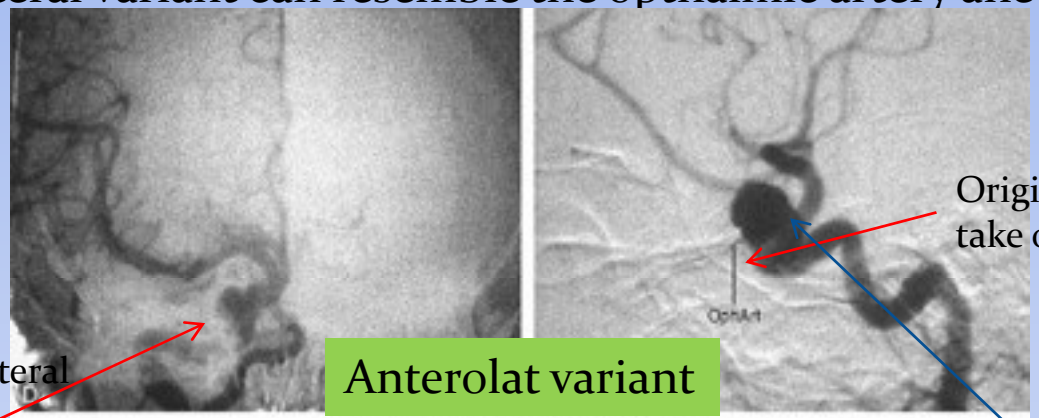
Clinoidal segment aneurysms

Anterolateral variant-erode ACP.
Monocular visual loss
Large ones can compress optic chiasma

Medial variant-
Enlargement into the pit fossa.
Hypopituitarism, may simulate
Pit apoplexy,epistaxis.

Clinoidal seg-Differential diagnosis

The anterolateral variant can resemble the opthalmic artery aneurysm

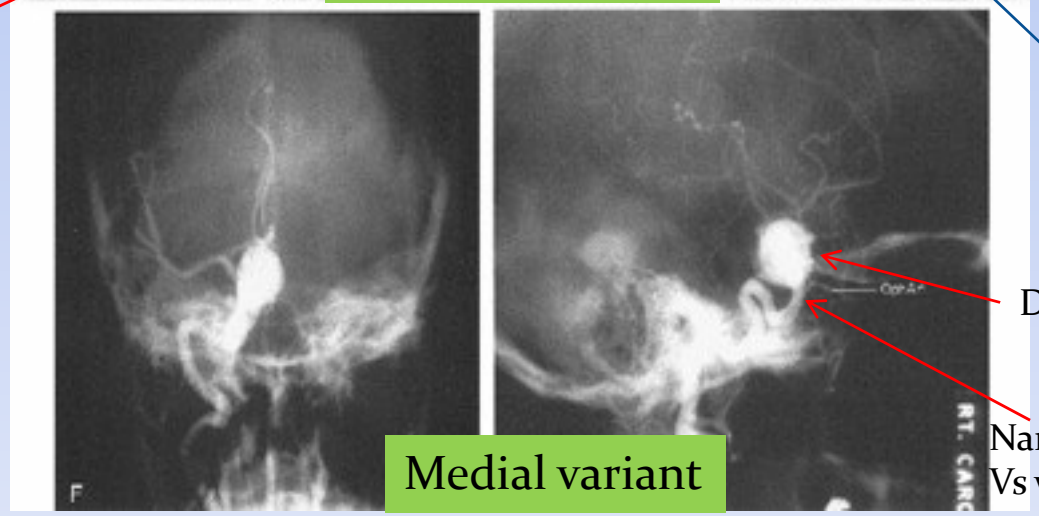


Anterolat variant

Origination proximal to the take off of the opthalmic artery

Projects dorsal and lateral vs. dorsomedial Projection of the opthal aneurysm

Angiographic waist marking the penetration dura



Medial variant

Double density

Narrow neck because of COM Vs wide neck.

Medial variant can resemble sup Hyp art aneurysm

Indications and methods of treatment

- Small asymptomatic aneurysms <1cm are interdural and treated conservatively.
- Small aneurysms are ideal for endovascular therapy.
- Large lesions best treated with surgical obliteration.

Opthalmic segment aneurysms

Opthal artery aneurysm project dorsally compressing the Optic nerve.

Monocular nasal field defect is produced due to superolateral compression of ON against falciform ligament

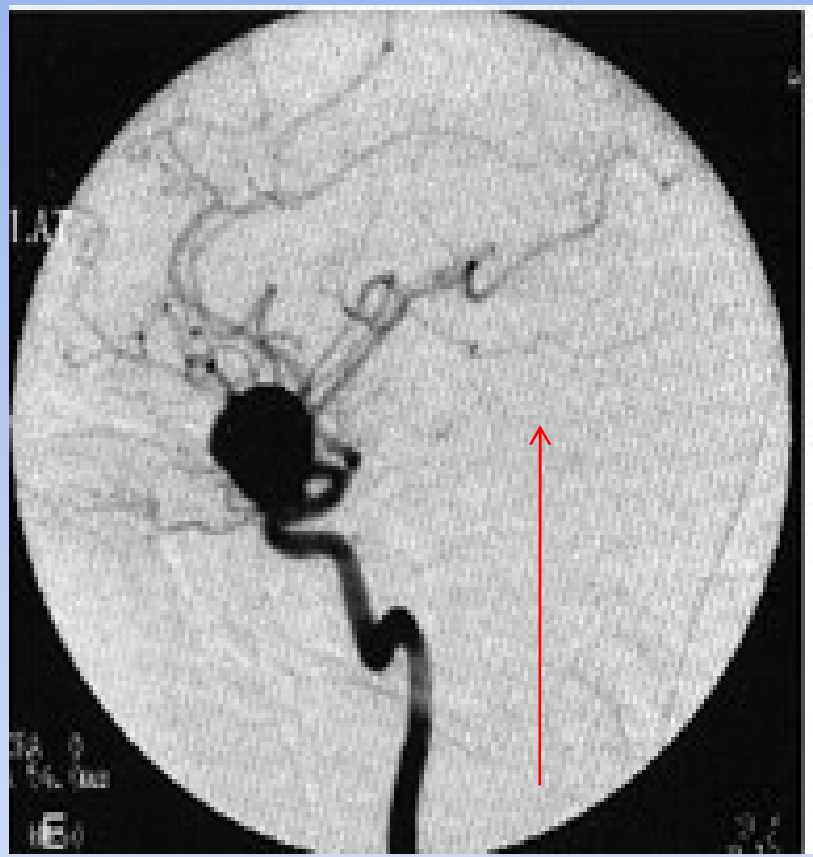
Superior Hypophyseal artery aneurysm.

Arise from the inferomedial surface.
burrow inferiorly below the diaphragm sella,
expanding the carotid cave
k/A Parasellar variant.
Suprasellar variant has
secondary suprasellar extension.

Dorsal variant

ophthalmic segment aneurysm

Opthalmic artery aneurysms

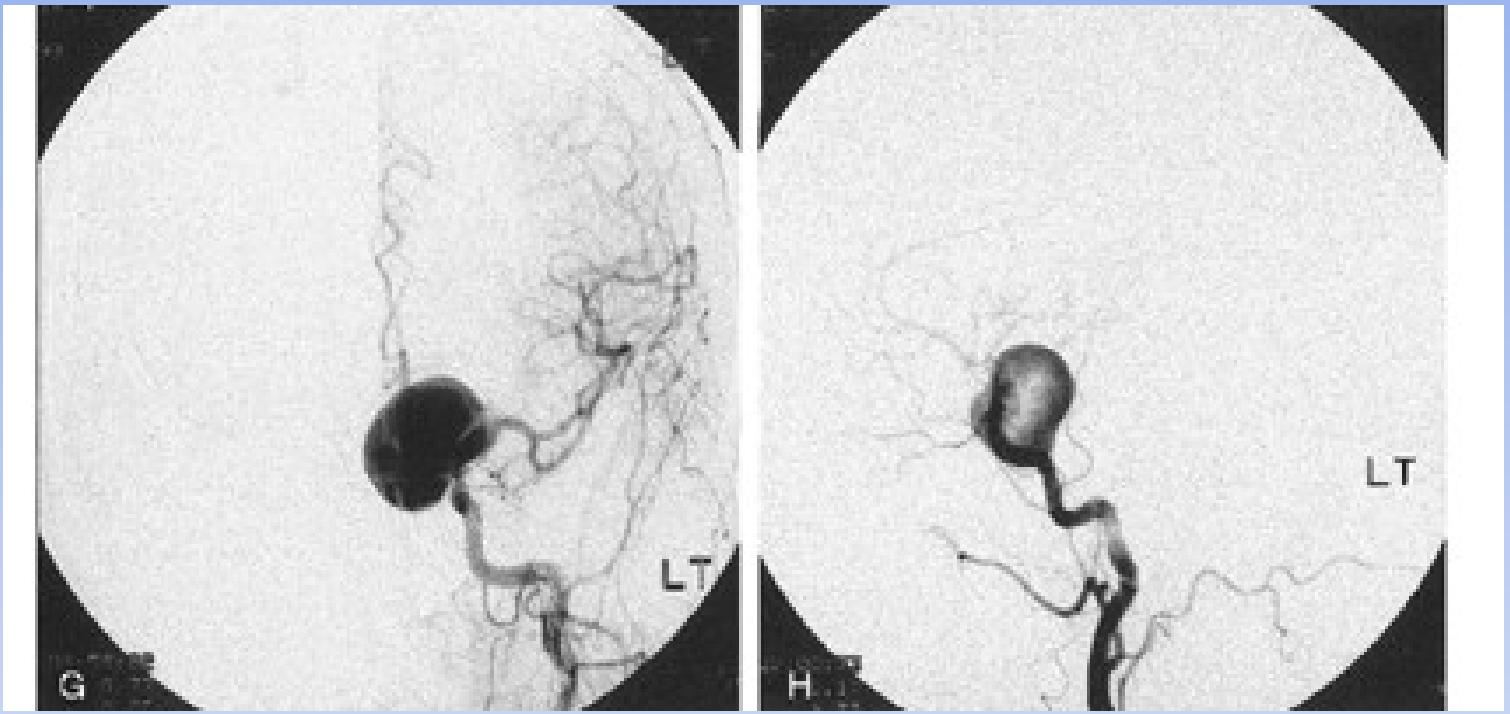


Arise dorsal to the ICA distal to Opthal art. No bony erosion.
As arise distal to ACP.

Produce hemorrhage in the chiasmatic c

Parasellar cistern.
Occasionally hematoma
In the orbitofrontal
Gyrus.

Superior hypophyseal artery aneurysm



They arise below the plane of the ACP.
As the lesion expands and fills the suprasellar space, it may venture across the midline.

Indications and methods of TT

- Those presenting with visual loss or SAH should be treated urgently. Either by surgical or endovascular means.
- Those with unruptured small lesions may be treated conservatively.

Direct operative techniques

- Proximal control is obtained at the cervical ICA before craniotomy for the giant or complicated aneurysms or for ruptured clinoid segment lesions.

Direct operative techniques

- Pterional craniotomy is done with extensive removal of the lesser wing of sphenoid, posterior orbital roof, orbital lateral wall and greater wing of sphenoid.

- The intradural bone removal includes resection of the remaining medial sphenoid wing and anterior clinoid process and optic strut.

Anterior clinoid removal

- The orbital roof and sphenoid ridge are resected extradurally.
- After splitting the sylvian fissure widely.
- 3-4 cm dural incision is made **from the ACP tip** to well beyond the resected edge of medial sphenoid wing.
- Relaxing incision is given on the Falciform ligament.

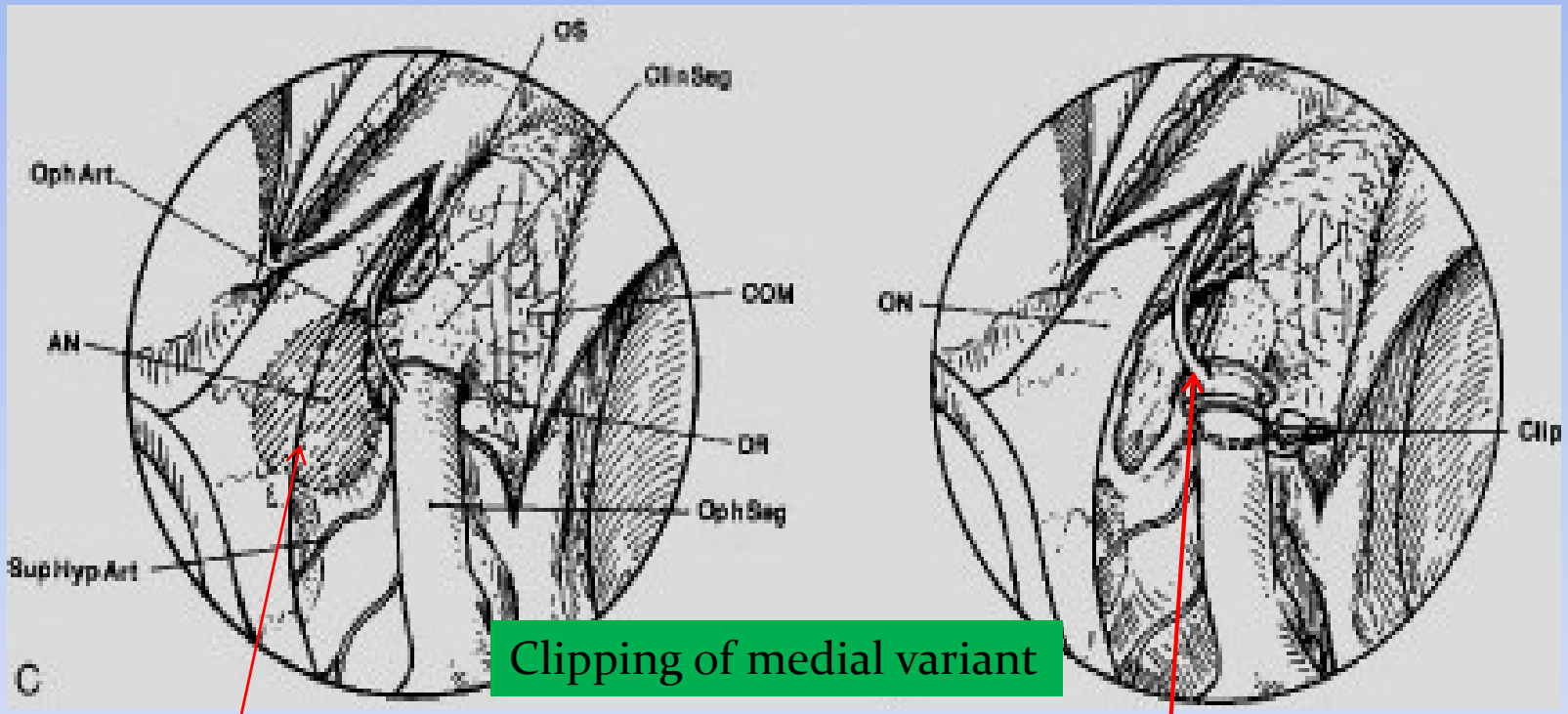
Clinoid segment aneurysm

Clipping of anterolaterl variant

Extensively remove the ACP and
Optic strut, followed by
Circumferential sectioning of the
Dural ring to completely mobilize the ICA

Gentle opening of COM & packing
of cavernous sinus lumen with surgicel
and gelfoam done.
Curved or Single angled Clip is placed
along the ICA.

Clinoid segment aneurysm



Clipping of medial variant

The medial variant projects medially into the pituitary fossa.

It requires placement of the fenestrated clip placed parallel to the ICA.

Opthalmic segment aneurysms

Ophthalmic artery aneurysm clipping

•ACP is extensively removed.
• The falciform ligament is cut to allow exposure of the proximal neck and Opth art.

The deep blade of a side angled clip is placed in a plane closely parallel to the long axis of the ICA.

Opthalmic segment aneurysms

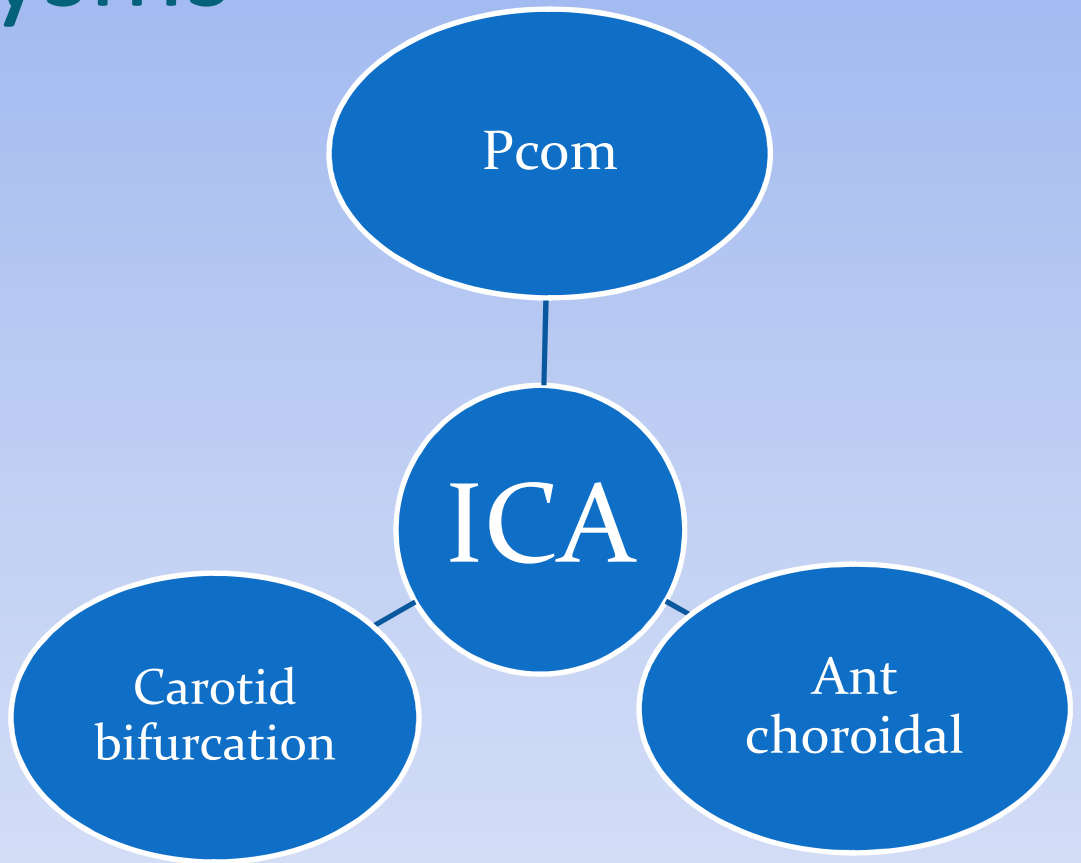
Clipping of superior hypophyseal artery aneurysm

A fenestrated clip is placed parallel to the ICA to reconstruct the carotid lumen.
Dural ring is completely sectioned allowing access of the clip blades to the Clin seg.
Care must be taken to prevent butt of clip compressing the Pcom.

Complications of Paraclinoid aneurysm surgery

- Delayed **ICA stenosis** or thrombosis- e/o hemibody deficit ⟶ CT + Angio ⟶ re-exploration and clip adjustment.
- **Visual deterioration** due to optic nerve manipulation.
- **III,IV, VI and miosis** from Sympathetic fibre disruption.
- **CSF rhinorrohea** d/t ACP communication with ethmoid or sphenoid sinus.

Intracranial internal carotid artery aneurysms



Posterior communicating artery

Communicating seg has two bends-
upward bend above the ophthalmic a.
Medial to lateral curve that begins
at the clinoidal segment and
ends at the bifurcation.

The Pcom arises from the posteromedial
Surface of the ICA. Courses
medially and inferiorly through the membrane
of Liliquest above and medial to the III n.

Posterior communicating artery

- Aneurysm arises from the distal edge of Pcom.
- Pcom is on the inferomedial edge margin of the neck.
- Anterior choroidal artery is on the superolateral margin.

Posterior communicating artery

- **Ant thalamic Perforating arteries,** that may be as large as the either the Pcom or anterior choroidal arteries arise around the neck of the aneurysm.

- May pinch the III N.

Presentation

- Constitute about 50% of the ICA aneurysm .
- **Females.**
- **Become symptomatic at a size smaller than 10mm** by SAH with a lateral suprasellar and ambient cistern pattern.
- Intraparenchymal **hemorrhage into the uncus** of the temporal lobe, intraventricular hemorrhage into the **temporal horn** or hemorrhage into the subdural space can also occur.
- Third nerve compression can cause **non pupil sparing oculomotor palsy.**

Operative technique

- The sylvian fissure is divided from lateral to medial.
- The optic and carotid cisterns are opened.
- Optic nerve is separated from the under surface of the frontal lobe to allow it to fall away.
- ICA dissection is done on the anterosuperior surface.
- Opticocarotid triangle is opened and dissection is continued on the medial aspect of ICA.
- The Pcom, Ant thalamic perforators, and the ant.choroidal arteries are identified.

Operative technique

- A small residual neck can be left to ensure patency of the parent vessel.
- Sometimes the proximal posterior communicating artery is blown into the aneurysm, in such cases **if fetal circulation is absent and filling from the opposite side is adequate then parent artery can be included in the clip.**

Anterior Choroidal artery

- It **arises distal and lateral to the Pcom artery.**
- Swings initially laterally and then posteriorly **following the optic tract** and supplying a branch to the mesial temporal structures.
- The main trunk continues posteriorly, inferior to the optic tract to enter the choroid fissure.
- Size = variable, Duplication = 30%

Anterior choroidal artery aneurysms

- Aneurysm is usually located just distal superior or superolateral to the origin of the anterior choroidal artery.

Perforators from Ant. Choroidal

- Choroidal segment has greater number of perforating branches arising from it and the **majority arise from the posterior wall** where the neck of aneurysm is situated.

- 4-9 branches enter the anterior perforated substance and ascend to the internal capsule.

Presentation

- On CT **SAH is in the lateral suprasellar region and ambient cistern**. Rarely causing intraparenchymal or subdural hematomas.

- **Cranial nerve deficits are less common** because of high location of aneurysm above the tentorium.

Operative technique for A Ch A

- **Excessive temporal lobe retraction must be avoided** to prevent ripping of the dome which is frequently adherent to the mesial temporal lobe.
- Dissection on the carotid artery is done on the lateral aspect, moving towards the proximal aspect of the neck.
- A bit of temporal lobe may be resected to reveal the dome.
- Recurrent art of heubner is on the medial aspect, it must be protected.

Internal carotid artery bifurcation

- Anatomy- Bifurcation of ICA takes place below the basal forebrain.
- The anterior cerebral artery passes forward and medially over the optic nerve.
- The middle cerebral artery passes laterally and posteriorly dividing under the cover of the frontal and parietal opercula.

Internal carotid artery aneurysm

- They point upward in the direction of the long axis of the pre bifurcation segment of the artery.

Perforating branches

- The **perforating branches** arising from the choroidal segment, ACA and MCA are **stretched around the back** side of aneurysm and must be dissected free. These **lenticulostriate perforators** supply BG,optic apparatus, hypothal, mesial temp L.

Presentation

- 5 to 15% of all intracranial aneurysms.
- They most commonly present with SAH but **may present with intraparenchymal hemorrhage into the basal ganglia simulating the hypertensive bleed.**
- They may enlarge to giant size and compress the optic apparatus.

Operative considerations

- Inferior aspect of the both the anterior and middle cerebral arteries are exposed , arachnoid membrane around the bifurcation is then rolled up to expose the aneurysm.
- The dome which is usually buried in the basal forebrain should not be disturbed. A small frontal corticectomy may be performed.

Operative considerations

- The aneurysm neck is then dissected free from the superior aspect of the ACA and from MCA posteriorly.
- Clip should not exceed the size of aneurysm to **prevent clipping of the lenticulostriate perforators, recurrent artery of heubner, basal vein of rosenthal, or deep sylvian vein.**

Middle Cerebral artery

- Anatomy- The M1 segment arises at the carotid bifurcation and follows a horizontal course from its origin at the most medial aspect of sylvian fissure to its bifurcation laterally near the limen insulae.

- The M1 segment travels below the anterior perforated substance and gives of lenticulostriate branches.(medial, intermediate and lateral). May also give cortical branches to ant temporal and operculofrontal regions.

•The post bifurcation branches arise in the sylvian fissure and are k/a M2(insular segment).

• M3 = opercular.

•M4 = cortical –begins at the sylvian fissure surface

• Only 5% of aneurysms are from M2,M3,M4.

•They are usually mycotic.

Lenticulostriate arteries

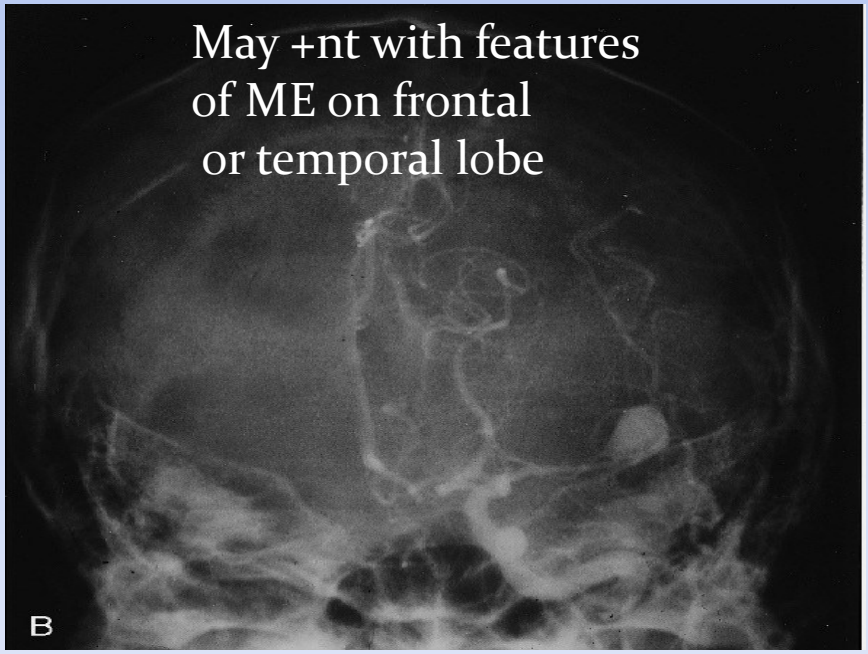
Lateral- proceed in the anterior perforated substance to supply corpus striatum, ext & int capsule, thalamus, & portions of corona radiata

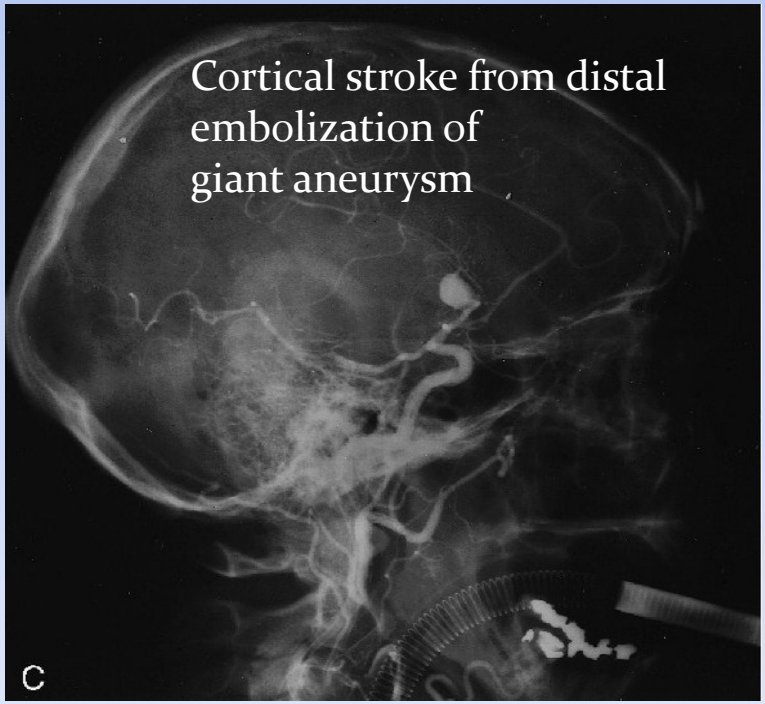
Middle cerebral artery aneurysms

- It is on the junction of the M1 and M2 segments that saccular aneurysms arise usually **project laterally & inferiorly.**
- **Superior wall** aneurysms can produce **frontal hematomas**.
- **Inferior wall** ones arise in conjunction with early temporal branch= **temporal hematomas**.

Clinical presentation

- More than 90% of the MCA aneurysms present with rupture and SAH.(Typical = LOC)
- Intracerbral hematomas occur in 40%.
- Seizures also seen in unruptured aneurysm.





Surgical considerations - preop

Cerebral angiography.

CT angiography.

3 –D reconstruction.

Operative considerations

The standard pterional craniotomy is carried out. The craniotomy must extend 2cm into the supraorbital area to provide adequate exposure of the proximal sylvian fissure. The pterion and lateral sphenoid wing are drilled away down to the superior orbital fissure.

Approaches to the middle cerebral artery aneurysms

Lateral trans-sylvian approach

For the unruptured and uncomplicated MCA bifurcation aneurysm.
Exposes the dome first.

The sylvian fissure is dissected & retracted exposing the proximal M1 segment, MCA bifurcation, & lobes of aneurysm

Medial transylvian approach

- The approach of choice for patients with short M1 segment, aneurysm arises from the proximal M1 trunk or have a **complicated configuration** with increased risk of rupture.
- The **sylvian fissure is opened medially to laterally** by sharply dissecting the arachnoid bands between the mesial anterior temporal and frontal lobes.
- **CSF is drained** through the carotid and basal cisterns.
- **Dissection is carried laterally along the anterior and inferior surface of the M1 trunk** to avoid injuring lenticulostriate arteries.

Superior temporal Gyrus approach

Advocated by Heros;
For aneurysms A/W ICH

The aneurysm is exposed through the hematoma cavity in the sup temp gyrus.

Anterior communicating and anterior cerebral artery aneurysms

- The segment of anterior cerebral artery between the ICA and A com is referred to as A1.

- The paired A1 segment is of equal diameter in only 50% of patients.

Anterior Communicating artery

The ACoA usually is oriented in an oblique or sagittal plane .

A2 Segment

The A2 segment starts from the ACoA junction follows the course of the rostrum of the corpus callosum and terminates at the rostrum and genu of the corpus callosum.Refd to as pericallosal artery.

ACA anatomy contd.

- A3 segment follows the curve of the genu of the corpus callosum and terminates where the ACA turns posteriorly above the genu.

- The A4 and A5 segments run over the body of corpus callosum and the transition from A4 to A5 is arbitrarily at the level of the plane defined by the coronal suture.

Perforators of the A1, ACoA & A2

- A1 segment gives rise to an average 8 perforators 41%of which end in the anterior perforated substance. K/A medial lenticulostriate arteries.
- Perforators arise from the superior and posterior surface
- ACo A may have 0-4 perforators.(superior and posterior surface)

Medial striate artery (rec art of heubner)

- The most important perforator from A2.It is the **first branch of A2.**
- It **courses anterior to the A1 segment in 60% and superior to A1 in 40%**.It takes the course of the A1 segment.
- Orbitofrontal and frontopolar arteries are the other branches of A2 segment.
- Supplies the striatum, globus pallidus and int capsule.

Arachnoid cisterns

Chiasmatic cistern contains the optic N & chiasma

A1 originates in the confines of the **carotid cistern**. It also has ICA & Br

Lamina terminalis cistern contains the A1-A Co A- A2 complex.

A com presentation

SAH accompanied by blood in the gyrus rectus is a characteristic

May present with DI or other hypothalamic dysfuntion

Angiographic considerations

- Do cross compression test and look for the collateral flow.
- If each ACA fills from I/L Carotid then may permit trapping.

Operative considerations

- Anterior Communicating artery aneurysms remain surgically challenging lesions because of three anatomic features-

1. Their B/L anterograde arterial supply.
2. Their Deep midline location
3. Their intimate relationship to 11 crucial arteries.

(paired A1 & A2,2 medial striate A, 2 orbitofrontal A, 2 frontopolar, & Acom.

Surgical Approaches

- Pterional craniotomy- The usual approach.
- Subfrontal approach- useful for superiorly pointing aneurysm when there is a large amount of frontal blood clot.
- Anterior interhemispheric approach- contraindicated for anteriorly pointing aneurysms as the dome is approached first.
- Trancallosal approach.

Choice of side of the craniotomy

- A right Pterional craniotomy is used with the following exceptions-

1. Large ACom aneurysm pointing to the right.
2. Dominant left A1 feeder to aneurysm (with no filling from the right A1).
3. Additional left sided aneurysm.

Head position and incision

- The head is rotated 30 to 45 degrees away from the operative site. This renders the malar eminence as the highest point.
- The incision is started a few mm anterior to tragus at the upper border of root of zygoma and extended upwards to the linea temporalis from where it is curved anteriorly to the midline, ending at the edge of the hairline.

Raising the scalp flap

- The scalp flap has been reflected downward using the subgaleal dissection. The fat pad, in which the facial nerve branches course, is exposed at the lower margin of the exposure.

Dissection of the temporalis muscle

- The superficial fascia is incised vertically about 1 cm anterior to the ascending limb of the skin incision and horizontally about 1 cm below the linea temporalis.

- To reflect the temporalis muscle it is divided superiorly with monopolar cautery, leaving a 1.5 cm cuff attached to skull.

Pterional craniotomy

- The keyhole, the site of burr hole which is located near behind the anterior part of the superior temporal line is outlined.

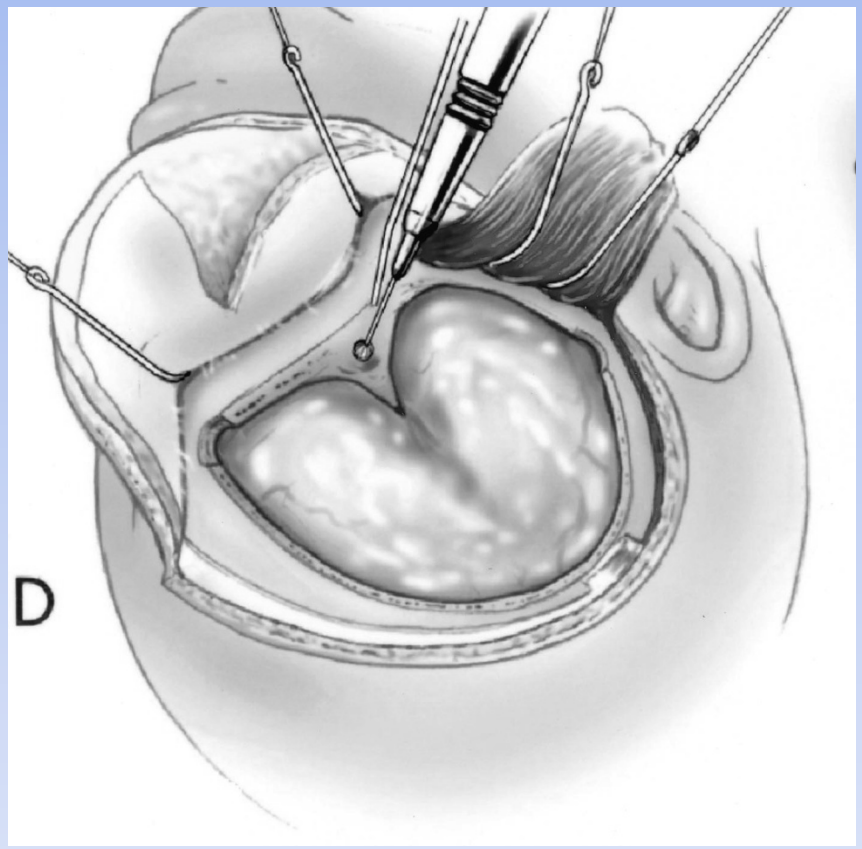
- The keyhole in its upper margin has the anterior fossa dura and the periorbita in the lower margin.

Drilling the greater and the lesser wings of sphenoid

- The temporal squamosal bone is removed, starting above the root of zygoma and proceeding anteriorly until the greater wing of sphenoid is encountered. The frontal and temporal dura is peeled off the surface of the sphenoid wing and is drilled medially.

Dural opening

- The dura is opened in a curvilinear fashion from the medial edge of the craniotomy in the frontal region to the lateral edge of the craniotomy in the temporal region and reflected anteriorly and stay sutures taken.



Sylvian fissure dissection

- It is **best to enter the fissure in its middle third**, through the same incision the surgeon identifies an artery emerging from the fissure and follows it down.

- The sylvian cistern consists of the shallow superficial and capacious deep space. When the pia of the frontal and temporal opercula are separated the larger M2 branches are seen coursing along the axis of the fissure.

Exposure of the optic nerve and ICA

- The chiasmatic cistern envelops the optic nerve and is opened along the junction B/W optic nerve and frontal lobe.

- The carotid cistern envelopes the ICA and is opened along the long axis of the ICA. ICA is followed distally to its bifurcation to expose the origin of A1 segment.

Exposure of the I/L & C/L A1 segment

- A1 segment is dissected distally off the inferior surface of the frontal lobe. The medial striate art is identified. Midportion is prepared for temporary clipping.
- The opening of the I/L chiasmatic cistern is extended over the distal C/L optic nerve.
- Lamina terminalis is fenestrated.
- C/l optic nerve is dissected and C/L A1 is identified. In its midportion temporary clip is applied. A1 segments are followed into the interhemispheric fissure to determine the location of the A Co aneurysm.

Resection of the Gyrus Rectus

- Resection of the Gyrus rectus is essential for adequate exposure of most A Co Aneuyrsms.

- To resect the Gyrus rectus an incision is made longitudinally along the lateral aspect of the gyrus rectus. Using suction and bipolar resection is achieved until the medial pia – arachnoid of the gyrus is recognized draped over the aneurysm.

Identification of the A1-ACo A – A2 complex vessels

Clipping of the ACo Aneurysm is done after identifying the entering A1 segments, the exiting A2 segments, the ACo A, the medial striate arteries of Heubner, the orbitofrontal arteries, and the frontopolar artery, critical perforators must be cleared of the path.

Dissection of neck

- The anterior pointing and inferior pointing aneurysms are easier to clip than superior pointing and posterior pointing aneurysms because of their more favorable relationship to the infundibular and hypothalamic perforators.
- The superior pointing aneurysms the most common type of A Co has their posterior wall related with perforators which must be cleared.
- Posterior pointing aneurysms are the most difficult to clip because perforators surround it.

Clip selection

- The length of the selected clip should be atleast 1.5 times the diameter of the aneurysm neck.

Complications of the A Com aneurysms

- Electrolyte abnormalities- Hyponatremia is more common than hypernatremia. Hyponatremia is more commonly due to cerberal salt wasting.
- Cognitive Dysfunction
- ACo A syndrome- impaired memory,personality changes and confabulation. These deficits are believed to be due to focal lesions in the basal forebrain.

Distal anterior cerebral artery aneurysms

Presentation

Interhemispheric fissure bleed

Operative approach

Rt anterior frontal Parasaggital craniotomy For the interhemispheric approach

They often incorporate the artery of origin. Sharp dissection with temporary clipping with deflation of the aneurysm may be necessary to clear the neck for clipping