

## Vascular Anatomy:

- **The common carotid artery** arises from the aortic arch on the left side and from the brachiocephalic trunk on the right side at its bifurcation behind the sternoclavicular joint. The common carotid artery lies in the medial part of the carotid sheath lateral to the larynx and trachea and medial to the internal jugular vein with the vagus nerve in between. The sympathetic trunk is behind the artery and outside the carotid sheath. The artery bifurcates at the level of the **greater horn** of the hyoid bone (C3 level?).
- **The external carotid artery** at bifurcation lies medial to the internal carotid artery and then runs up anterior to it behind the posterior belly of digastric muscle and behind the stylohyoid muscle. It pierces the deep parotid fascia and within the gland it divides into its terminal branches the **superficial temporal artery and the maxillary artery**. As the artery lies in the parotid gland it is separated from the ICA by the deep part of the parotid gland and stypharyngeal muscle, glossopharyngeal nerve and the pharyngeal branch of the vagus. The IJV is lateral to the artery at the origin and becomes posterior near at the base of the skull.
- Branches of the ECA: A. From the medial side one branch (**ascending pharyngeal artery**: gives supply to glomus tumour and petroclival meningiomas)

B. From the front three branches (**superior**

**thyroid, lingual and facial**)

C. From the posterior wall (**occipital and**

**posterior auricular**). Last Page 437 and picture page 463.

- **The ICA** is lateral to ECA at the bifurcation. At its commencement it shows a slight bulge (carotid sinus) which contains baroreceptors supplied by the carotid sinus branch of the IX cranial nerve. The carotid body is found near the bifurcation and contains chemoreceptors. Behind the carotid artery in the neck are the sympathetic trunk, pharyngeal veins, and superior laryngeal branch of the vagus. The internal jugular vein lies lateral to the artery and then posterior to it as it approaches the base of the skull. At its origin it's crossed by the facial and lingual veins, occipital artery and hypoglossal nerve. At higher level it is overlapped by the posterior belly of digastric muscle stylopharyngeal muscle and the posterior auricular artery. In carotid endarterectomy one has to divide the facial vein to get exposure. Be careful not to injure the hypoglossal nerve. Last -438
- Segments of the internal carotid artery: **Van Loveren**
  1. Cervical : described above –no branches
  2. Petrous: The artery enters the petrous bone through the carotid canal. This segment has 2 parts vertical and horizontal. The horizontal part runs forwards at 45 degrees slope parallel to the GSPN. The overlying bone can be deficient. This part is used for high flow saphenous graft if the ICA is needed to be sacrificed. Persistent otic artery(foetal circulation) connects this segment with the posterior circulation
  3. Lacerum segment: lying over the lacerum foramen which is covered by fibrous tissue in life.
  4. Cavernous segment: it has 5 parts a. posterior vertical segment b. posterior genu ( bend) c. horizontal part d. anterior genu (bend) e.

anterior vertical part. This segment gives the following branches **A. Meningo- hypophyseal trunk**: the most proximal from posterior genu t between the petrous and cavernous segments It passes posteriorly and gives three branches ( **tentorial** or Bernasconi-Cassinari branch that supplies the tent, **inferior hypophyseal artery** that runs medially to supply the posterior part of the pituitary gland and the **dorsal meningeal branch** which perforates the posterior wall of the sinus and supplies the dura of the clivus and the VI nerve) **B. The artery of the inferior cavernous sinus**: from the lateral wall of the horizontal segment of the ICA , runs above the abducens nerve to supply the lateral wall of the sinus and the nerves in the lateral wall **C.**

**McConnell's capsular arteries**: frequently absent, arise from the medial wall of the horizontal segment and supply the pituitary capsule

5. Clinoidal segment: between the proximal ring (carotico-oculomotor membrane)( aperture in the dura running from the inferior surface of the ACP and distal dural rings (aperture in the dura running fro the superior surface of ACP to diaphragma sellae through which the ascending ICA enters he arachnoid space. This segment is outside the venous channels of cavernous sinus and outside the arachnoid (intradural). It has no branches but occassionally gives origin to the superior hypophyseal arteries (from **the medial wall**) and sometimes the ophthalmic artery.
  6. Ophthalmic segment: from the ophthalmic artery to the PcomA. Branches are OA and superior hypophyseal artery or arteries
  7. Posterior communicating segment: from PcomA to the bifurcation and has 2 main branches (posterior communicating and anterior choroidal. In the old classification, anterior choroidal segment was included as separate segment (from anterior choroidal to the bifurcation of ICA).
- Rhoton described 4 segments C1-cervical, C2-petrous, C3-cavernous and C4 supraclinoidal which is divided into ophthalmic, posterior communicating and choroidal segments. From its position under the ACP it goes posterolaterally and ends with bifurcating under the anterior perforating substance lateral to the chiasm and in the medial part of sylvian fissure. **C3 and C4 on the lateral view have S shape and these 2 segments are called carotid siphon.** Each of the 3 parts of C4 gives perforating branches. On average 4 from ophthalmic segment, 0-3 from P-com and 4 from AchA.
  - The anterior clinoid process (**ACP**) is the medial continuation of the lesser wing. It forms the bony roof of superior orbital fissure and the anterior part of the CS. **Optic strut** is a bony process extending from the inferomedial surface of the ACP to the body of the sphenoid bone and separates the optic canal from SOF. Drilling of the ACP and OS is important in exposing aneurysms of the Clinoidal, cavernous and ophthalmic segment which can be done extradurally for elective OS aneurysms and **intradurally** for ruptured, complex and anteriolateral Clinoidal segment aneurysms. **Falciform ligament** if fibrous ligament running from the tip of ACP to middle Clinoidal process (medial to the optic nerve.

- The carotid artery enters the proximal sylvian fissure posterior and lateral to the optic nerve and medial to the oculomotor nerve
- Definition of the siphon of ICA=C3+C4
- **Ophthalmic artery**: originates from the **superior wall** of the supraclinoid segment of the ICA below the optic nerve (majority of cases), occasionally it can arise from the cavernous segment (8%) or even from anterior cerebral artery, MMA. It rarely gives origin to perforators. Mostly anterior and medial to the tip of the clinoid. The preforaminal OA can range from 0-7 mm in length. The artery runs in the optic canal **below and medial** to the optic nerve. In the orbit it gives a branch that supplies the posterior 2/3 of the nerve. It spirals around the lateral part of the nerve to pass forward above the nerve. It gives branches that accompany all branches of the nasociliary, frontal and lacrimal nerves (**anterior and posterior ethmoidal, infratrochlear, dorsal nasal, posterior ciliary, frontal “supraorbital and supratrochlear”, lacrimal and central retinal**). It supplies the intraorbital muscles, lacrimal gland, optic nerve and retina. The superior ophthalmic vein accompanies the artery (above it in the optic canal) and drain directly into the cavernous sinus. It communicates with the angular vein which drains into the facial vein. The inferior ophthalmic vein passes through the inferior orbital fissure into the pterygopalatine plexus. Exposure of the OA is facilitated by removal of ACP, roof of the orbit and incision of falciform ligament.
- **Posterior communicating artery** originates from the **posteriomedial wall** of ICA, 7-10 mm distal to the dural penetration of ICA (midway between OA and bifurcation), it is **2mm** in diameter and runs backwards and **medial to the III nerve** penetrating the **lilquest** membrane to enter the interpeduncular fossa where it joins P1 segment of PCA. It gives perforators to optic chiasm, tract, pituitary stalk, interpeduncular fossa and the floor of the third ventricle. In 20% there is persistent foetal circulation (posterior cerebral artery filling from ICA) on one side and in 10% bilaterally. This is very important to appreciate preoperatively in case one will need to sacrifice P-com. It gives between **4-14 perforators (preammillary or anterior thalamoperforator which supplies the anterior thalamus, posterior hypothalamus and posterior limb of internal capsule and thalamoperforators are the most constant)**. Dilatation of the proximal origin (infundibulum) is found in 6% of people. This functional dilatation is neither aneurysmal nor preaneurysmal.
- **Anterior choroidal artery** originates from ICA few mm distal to P-com and more laterally. In <1% originates from MCA, p-com.. It runs initially laterally and then posteriorly inferior to the optic tract; it can be **double in 30%** of cases and sends perforators to the internal capsule, lentiform nucleus and optic tract, uncus and hippocampus. It runs in the choroidal fissure and ends in the choroid plexus of the temporal horn (expand-Yasargil). Above and medial to it runs the optic tract, basal vein of Rosenthal. It is divided into 2 segments **1. Cisternal**: from the origin to the choroidal fissure :runs in the crural cistern between the uncus and cerebral peduncle and it has proximal and distal part in relation to the lateral geniculate body **2. Choroidal** runs in the choroidal fissure and supplies the choroid plexus of the temporal horn . It gives 4-18 perforating branches (cisternal segment perforators supply optic tract, uncus,

hippocampus, dentate gyrus, fornix, cerebral peduncles, , posterior 2/3 of IC, LGB and the origin of optic radiation and globus pallidus. The choroidal perforators supply choroid plexus of temporal horn and anastomose with lateral posterior choroidal artery (PCA). Occlusion of this artery results in contralateral hemiplegia (IC and middle 1/3 of cerebral peduncle), hemianesthesia (internal capsule), homonymous hemianopia (optic tract, radiation and LGB) and infarction of globus pallidus (silent). Sometimes occlusion of the artery can be silent (overlap in the area supplied by the perforators with ICA, P-com, MCA and PCA perforators).

- **Anterior cerebral artery:** terminal branch of ICA arises at the bifurcation of ICA in the stem of sylvian fissure. It then runs forwards and medially above the optic chiasm or nerve beneath the anterior perforating substance to enter the interhemispheric cistern in the midline from there it ascends anterior to the lamina terminalis. After that it curves around the genu of corpus callosum and continues posteriorly as the pericallosal artery which runs in the pericallosal cistern. It has three segments A1 from the origin to the A-com artery, A2 from the A-com artery to the division into callosomarginal and pericallosal arteries usually at the genu of corpus callosum. **Rhoton described 5 segments of ACA**(A1-as above, A2- from a-com to the junction of rostrum and genu, A3- anterior to the genu, A4- from the posterior turn into callosal cistern to the level of coronal suture, A5- distal to the level of coronal suture (the reason for this modification is the fact that callosomarginal artery is absent in 18%). See below.
- Aneurysms of the AcoA are associated with **anatomic variation** from the circle of Willis in at least 60%.

-One A1 is hypoplastic in 10% of individuals and 26-85% of patients with A com aneurysms

- Double A1, accessory A1 from proximal ICA runs under the optic nerve to end as Frontopolar and Orbitofrontal branches

-2 AcoA in 30%, 3 arteries in 10%

-Three A2 or single azygos A2 (arteria termatica of Wilder reported in 1.5-10%)

- Branches of ACA:
  1. A1-perforators to the internal capsule, basal ganglia and hypothalamus and chiasm variable in number. In 14% gives origin to recurrent artery of Heubner. The perforators arise from the posteromedial surface of the artery and hence dissection along the anterolateral surface of the artery is safe
  2. A2-
    - Heubner artery in 86% of cases( average 1mm in size runs on the rectus gyrus and can be confused fro cortical branch, supplies the anterior limb of the internal capsule, caudate head, part of putamen and globus pallidus)
    - Frontopolar: supply frontal lobe
    - Orbitofrontal : supply frontal lobe

3. A3- Cortical branches to the medial surface of the hemisphere and the motor area of the leg
  4. A-com:
    - subcallosal: supplies the CC, cingulate gyrus and fornix (Injury to these perforators may result in severe memory deficits)
    - Hypothalamic
    - Chiasmatic perforators
- **Middle cerebral artery:** Terminal branch of the ICA in the stem of the sylvian fissure lateral to the chiasm, posterior to the medial and lateral olfactory striae and below the anterior perforating substance. Average diameter 3.9 mm.
    1. **M1 (sphenoidal)** segment runs about 1cm posterior and parallel to the sphenoid ridge covered by thick arachnoid with frontoorbital bridging veins and ends by bifurcation just proximal to the limen insulae (the lateral boundary of the anterior perforating substance. It is 14-16 mm long
      - Inferolateral branches: **anterior temporal** and **temporal polar arteries**, middle temporal
      - Superomedial branches: **medial , intermediate and lateral lenticulostriate arteries** and occasionally **lateral fronto-orbital branch** (lenticulostriate perforators supply the internal capsule and basal ganglia. Injury to these perforators results in severe hemiplegia and aphasia if on the dominant side)
    2. **M2 segment (insular):** from the bifurcation of M1 near the anterior edge of limen insulae (island of Reil) to the angular branch. 2-2.5 cm deep to the sulcus between superior and middle temporal gyri. In 60-80% bifurcation while in 20% trifurcation or two bifurcations. The M2 emerge at 90 degrees angle to the long axis of M1 but then converge.
      - Superior frontal trunk (more superficial)
      - Inferior temporal trunk
 In **20%** of cases the important lenticulostriate arteries can arise from M2. The earlier the bifurcation the greater the number of perforators from M2
    3. **M3 (opercular)-** from the angular branch to the cortical branches M4
 

**80%** of aneurysms occur at the **bifurcation**, 12% at M1, and 10-15% at M2 or more distally.
    4. M4 segment (cortical branches, variable including precentral, central, and postcentral, posterior temporal, angular).
  - Rhoton described 4 segments differently **1. M1 (sphenoidal)** as above but ends at the genu when the artery turns 90 degrees posteriorly and is divided into prebifurcation and postbifurcation parts **2.M2 (insular):** from the origin at the genu near limen insulae to the circular sulcus (around the insula).**3. M3 (opercular):** from the circular sulcus to the surface of the fissure **4. M4 (cortical):** cortical branches. 78% bifurcation, 12% trifurcation and 10% multiple trunks. Trunks divide into **stem arteries** (average 6) and these and the main trunks give 12 cortical groups of cortical arteries (front orbital,

prefrontal, precentral, central, anterior and posterior parietal, angular, polar temporal, anterior, middle, posterior temporal and occipitotemporal). Early branches come from the trunks as above. Rhoton described the anatomy of lenticulostriate arteries in detail (medial 1-5 found in 50% from the medial, intermediate variable number and lateral about 5 found in 100%). These important perforators arise from M1 in 80% and M2 in 20% of cases within 5 mm from the bifurcation. **The lateral and intermediate group** pass through the putamen and supply the entire length of the upper part of IC, head of caudate. The medial group supplies the lateral part of globus pallidus and the upper part of the anterior limb of IC and anterosuperior part of the head of caudate.

- For bypass grafts the largest cortical branch is **temporooccipital**, the largest frontal is **central**, the largest parietal is angular branch and the largest temporal is **posterior temporal** and **temporooccipital**.

5. **Vertebral artery: It has 4 segments** **A. V1:** from subclavian artery runs up in the pyramidal space (between scalenus anterior, vertebral column 'longus coli' and the subclavian artery). At the apex of this space it enters C6 transverse foramen .**B. V2-** runs vertically up to C2 transverse foramen **C.V3-**which has vertical part V3v-runs from C2 to C1 transverse foramina in the inferior suboccipital triangle between inferior capitis oblique, semispinalis capitis and longissimus capitis crossed by C2 root and surrounded by venous plexus and horizontal segment from C1 foramen to the dura which runs in the superior suboccipital triangle(rectus capitis posterior major and superior and inferior oblique muscles) behind atlantooccipital joint on the arterial sulcus on the posterior arch of C1 and gives muscular and posterior meningeal branches. **D. V4-**intracranial. 80% of left vertebral arteries are dominant. Intradurally it ascends in **front of the denticulate ligament** (spinal accessory nerve is behind the ligament) between the lower rootlets of XII and the upper rootlets of C1. It spirals up and medially to meet its counterpart anterior to the Pontomedullary sulcus between the two abducens nerves in the prepontine cistern. In the transverse foramina it has sympathetic nerve behind it and occasionally one or two vertebral veins. It gives the following branches.

1. Spinal intervertebral branches that enter intervertebral foramina.V2
2. Muscular branch given in the suboccipital triangle-V3
3. Posterior meningeal branch. Extradural-V3
4. Posterior spinal artery is the first intradural branch (often 2). They run through foramen magnum-V4

5. Anterior spinal branch which joins its counterpart to form anterior spinal artery.-V4
6. **PICA**: The largest and most tortuous branch arises from the vertebral artery near the inferior olive. In 8% can originate extracranially It arises about 10 mm above the dural entry and 15 mm from the VB junction. It emerges through the fibres of IX, X, XI, and XII nerves. It arises from the posterior or lateral part of the vertebral artery and measures about 2 mm. Its size is inversely related to the size of the ipsilateral AICA and the contralateral PICA. Rarely does it have origin from the ICA or posterior meningeal artery. It supplies the suboccipital surface of the cerebellar hemisphere, inferior vermis, tonsils and medulla. **It has five segments (anterior medullary, lateral medullary** “this segment passes through the fibres of the lower cranial nerves, **tonsillomedullary or posterior medullary** which forms a caudal loop, **telovelotonsillar segment** which forms the rostral loop, the apex of which is the choroidal point, and lastly the artery becomes buried between the vermis, tonsil and cerebellar hemisphere and gives its cortical branches “**cortical segment**”. The anterior medullary gives 2 perforators “short circumflex” to the medulla, the lateral medullary gives about 5 perforators to the medulla, the tonsillomedullary gives 11 perforators. The last 2 segments do not give any medullary perforators. In general significant perforating vessels do not arise distal to the choroidal point. This artery gives the following groups of branches 1. Perforators as above (first 3 segments) 2. Choroidal arteries (tonsillomedullary and telovelotonsillar segments):3. cortical branches (tonsillar, vermian and hemispheric)

Because of the tortuous nature of this artery the loops can reach up and cause compression of VII and VIII nerves

**Injury to this artery results in lateral medullary syndrome (dysphagia and dysphonia from injury to the ambiguous n, loss of pain and touch sensation on the contralateral part of the body and ipsilateral face “crossed spinal lemniscus and uncrossed trigeminal lemniscus and vertigo, vomiting and nystagmus “injury to vestibular nuclei”.**

Medial medullary syndrome results from injury to the **anterior spinal perforators** (contralateral hemiplegia “pyramids”, contralateral loss of touch and kinaesthetic sensation “medial lemniscus” and ipsilateral XII “nucleus”

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The vertebral artery in the neck has 3 segments:

1. from the origin to entry into the transverse foramen of C6
2. from C6-C1
3. from C1- dura (suboccipital triangle segment): this is the most common site of dissection

- **Basilar artery:** forms at the junction of the vertebral arteries in the prepontine cistern at the level of pontomedullary junction ascends superiorly anterior to the pons and behind the clivus and dorsum sellae. It is about 3 cm long and 4mm wide. It ends by dividing into 2 cerebellar arteries. It gives the following branches. The bifurcation can be as low as 1 mm below the pontomesencephalic fissure and as high as the mamillary bodies.
1. **Pont medullary (PM)** artery is the first branch that originates between V-B junction and AICA and runs in the pontomedullary sulcus and ends in the postolivary sulcus. (intermediate branch)
  2. **AICA:** usually arises from the proximal basilar artery, but can rise from the upper trunk in 4%, vertebral artery in 2%. Its size is inversely related to the ipsilateral PICA. It encircles the pons and runs posteriorly and laterally in the CP angle below or between VII and VIII nerves. It bifurcates into rostral(rostral to flocculus and supplies the upper lip of pontomesencephalic fissure) and caudal trunks (caudal to flocculus and supplies the flocculus and lip of ponto- mesencephalic fissure. It is divided into 4 segments **A.** anterior pontine-in contact with the 6<sup>th</sup> nerve and ends at the antero-lateral part of the pons **B.** lateral pontine segment which runs posteriorly below or between VII and VIII nerves and gives origin to the arteries supplying these nerves (labyrinthine-VII, VIII and labyrinth, and subarcuate artery-petrous bones in semicircular canals) and recurrent perforators to brain stem **C.** flocculopeduncular- is the segment passing rostral or caudal to the flocculus going to middle peduncle **D.** Cortical segment –supplies the petrosal surface of the cerebellum . It divides into two terminal branches, lateral that runs between the flocculus and the horizontal fissure and medial branch. The branches of AICA are divided into 3 groups 1. arteries to the nerves (labyrinthine, subarcuate, recurrent perforators and cerebellosubarcuate usually from the second segment) 2. Cortical : to petrosal surface 3. Choroidal to choroid plexus of 4<sup>th</sup> ventricle
  3. **Long lateral pontine arteries (LLP)** (superolateral and inferolateral ) supply the lateral and paramedian pons
  4. **Posterolateral pontine (PLP)** artery arises is the most distal intermediate perforator arises just proximal to SCA.
  5. **Superior cerebellar artery:** runs in the superior cerebellar cistern and supplies the upper vermis and the tentorial surface of the cerebellum. It has 4 segments (anterior pontomesencephalic, lateral pontomesencephalic (makes caudal loop and comes in contact with trigeminal nerve root entry zone), cerebellomesencephalic and cortical ). Branches are **perforators** to midbrain, colliculi, pons and superior peduncle, **precerebellar** to cerebellar nuclei (dentate, globose, emboliform and fastigial) and **cortical** (vermian, hemispheric to tentorial surface and marginal to the junction of petrosal surface). Read the first page of Rhoton cerebellar arteries .
  6. Posterior cerebral artery.
  7. **Perforators** **A. caudal group**-1-4 between the VB junction and AICA arise from the dorsal surface and occasionally from AICA or pontomedullary arteries. **B. Middle group:** from BA between AICA and posterolateral artery



.some arise from AICA, PM, LLP arteries C. **Rostral group** from the segment between PLP and SCA .1-5 arise from dorsal BA or near by branches.

The **basilar bifurcation** is **15-17 mm** deep to the intracranial ICA and can be accessed through Transylvian approach by dividing the Lilliequist's membrane. The interpeduncular fossa can be reached through A. Carotico-oculomotor space (ICA, OMN) B. Carotico-optic space (ICA, ON and ACA) C. Above the carotid bifurcation (A1, M1 and optic tract).

### **Anatomy of Lilliequist's membrane: Greenberg -794**

**6. Posterior cerebral artery:** The posterior cerebral artery runs along the inferior aspect of the cerebral hemisphere and occipital lobe. It supplies the posterior parietal cortex, the occipital lobe and inferior parts of the temporal lobe, thalamus and choroid plexus of the 3d ventricle. It has 4 segments

**1. P1 (precommunicating segment)** from the origin to p-com artery and runs in the interpeduncular cistern. Gives posterior thalamoperforators (the anterior thalamoperforators are from P-com segment. These perforators come from the posterior and superior surface. Dissection of P1 should be on the inferior surface (Drake).

**2. P2 (ambient segment):** Runs in the ambient cistern lateral to cerebral peduncle. Rhoton described P2A(proximal) and P2B(distal) segments. It gives the following branches:

A. Thalamogeniculate perforators (1-7): supply thalamus, posterior limb of IC, geniculate bodies and optic tract.

B. Medial and lateral posterior choroidal arteries or gives temporooccipital trunk which gives the above branches.

C. Inferior temporal group (anterior inferior temporal artery, medial inferior TA and posterior inferior TA).

**3. P3 (quadrigeminal segment):** Runs in the g quadrigeminal cistern and ends by dividing into calcarine and occipito-parietal arteries.

- Interpeduncular cistern is limited anteriorly by the clivus and posterior clinoid processes, posteriorly by cerebral peduncles, laterally by mesial temporal lobes and tentorium and superiorly by mamillary bodies and posterior perforated substance and inferiorly by the continuation of Lilliequist membrane. Anteriorly the Lilliequist membrane (thickened arachnoid forming the anterior wall of the interpeduncular cistern and the roof of prepontine cistern. It contains basilar apex, P1, P-com artery and initial P2, SCA, 3-d and 4<sup>th</sup> cranial nerves.
- Access to the basilar apex and P1 through transylvian approach is through carotid retrocarotid and supracarotid spaces and division of Lilliequist membrane.

### **Cerebral venous anatomy:**

1. Superior sagittal sinus: starts at the level of foramen caecum anterior to crista galii. Runs posteriorly and drains into the torcula of herophilii (venous confluence). It enlarges as it goes posteriorly. The superior and medial cerebral veins enter the sinus obliquely against the direction of blood flow. If these veins encounter venous lake (between the layers of the dura), they run on the cerebral surface of that lake under the arachnoid.
2. Inferior sagittal sinus: runs in the inferior margin of falx cerebri. It drains the lower part of the medial surface of the hemispheres. It ends into the straight sinus
3. Transverse sinus: carries blood from the venous confluence into the sigmoid sinus and then into the internal jugular veins. The sinuses can be asymmetrical with the right sinus being dominant in many cases.(left vertebral artery is usually dominant)
4. Straight sinus: is formed by the confluence of inferior sagittal sinus, vein of Galen and two basal veins of Rosenthal. It runs in the tentorium (tip of the tent and drain into the venous confluence.
5. Internal cerebral vein is formed at foramen of Munro by the confluence of the choroidal vein, thalamostriate vein, anterior caudate vein and septal vein. It runs in the roof of the third ventricle in vellum interpositum cistern with the medial posterior choroidal arteries. Both internal cerebral veins join under the splenium of corpus callosum to form the great vein of Galen. **It drains the upper part of the thalamus and basal ganglia.**
6. Basal vein of Rosenthal is formed by the confluence of A. deep middle cerebral vein (draining the insular cortex and the cortex of the deep sylvian fissure) B. Anterior cerebral vein (draining the anterior medial frontal lobes and runs with the anterior cerebral artery it curves around the genu of corpus callosum and join the basal vein) C. Striate veins from the anterior and posterior perforating substances (**draining the lower half of the basal ganglia and thalamus**). It runs around the cerebral peduncle in the crural and ambient cisterns below the optic tract and then in the quadrigeminal cistern to drain into the great vein of Galen.
7. Cavernous sinus: lies alongside the body of the sphenoid bone, runs from the medial part of the superior orbital fissure where it receives the superior ophthalmic vein to the petrous apex where it drains into the superior and inferior petrosal sinuses. It has 3 main tributaries A. Superior ophthalmic vein enters the sinus through the superior orbital fissure B. Superficial middle cerebral vein enters the roof of the sinus near the exit of ICA. C. Sphenoparietal sinus which drains the bones of the skull vault and runs between the two layers of the dura under the lesser wing of the sphenoid and drain through the roof of the cavernous sinus. The cavernous sinus drain through the A. Superior petrosal sinus into the transverse/sigmoid junction B. Inferior petrosal sinus which runs under the posterior petroclinoid ligament between the two dural layers in the groove between the clivus and the petrous apex to enter the petrosal part of the jugular foramen medial to IX nerve and drains into the IJV. It receives the medullary veins. Retrograde thrombosis of these veins can be fatal. C. Emissary vein that drain into the pterygoid plexus and passes through foramen ovale or Vesalius. Both cavernous sinuses communicate through anterior, inferior and posterior intercavernous sinuses. For detailed

anatomy of the sinuses look Last's page 568 and look up the cavernous triangles (Rhoton).

8. Vein of Labbe: inferior anastomosing vein drains into the junction of transverse, sigmoid and superior petrosal veins. Injury to that vein can result in venous infarction of the temporal lobe. It connects the posterior part of the superficial middle cerebral vein to the site of drainage.
9. Venous drainage of brain stem: **midbrain drains into basal veins** as they pass **around the cerebral peduncles** and from colliculi into great vein of Galen, **Pons drains into basilar plexus** behind the clivus and into the **inferior petrosal sinus**. Medulla drains into the **inferior petrosal sinus**.
10. Venous drainage of the cerebellum: the vermis drains through the median vermian vein into the vein of Galen. Tentorial surface drains into the straight and transverse sinuses. Petrosal surface drains into transverse and sigmoid sinus (superior petrosal vein can be sacrificed during posterior fossa surgery). Occipital surface drains into inferior petrosal, occipital and sigmoid sinuses.

### **Anatomy of cavernous sinus:**

- It runs from the medial part of SOF to the petrous apex. **Medially** is bound by sphenoid body and fibrous lateral wall of pituitary fossa, **anteriorly** by medial part of superior orbital fissure where the superior OV enter the sinus, the **roof** is formed by dura that runs from diaphragma sellae (posterior and middle clinoid processes) medially and the free edge of the tent laterally. The roof is pierced anteriorly by ICA and posteriolaterally at the level of dorsum sellae and medial to the free edge of the tent by 3-d nerve and more posteriolaterally by the 4<sup>th</sup> nerve. Also superficial MCV and SP sinus drain into the roof. **Inferiorly** is the greater wing of the sphenoid bone. **Laterally** is the dura running from the roof to the floor of the sinus? The lateral wall contains from above to below (3-d, 4<sup>th</sup> nerves, V1 and V2). This dural wall is attached to the lateral margin of foramen rotundum and medial margin of foramen ovale so V3 is outside the sinus. Within the sinus runs ICA, IC nerve (sympathetic nerve fibres to dilator pupillae and levator palpebrae superiores. These are picked up by the ophthalmic division and end in the nasociliary branch) and lateral to the artery at the level of V1 is the abducens nerve which enters the sinus through the posterior wall under posterior petroclinoid lig. (Dorello canal).
- Medially to the cavernous sinus is the body of the sphenoid bone and sinus, laterally is the medial temporal lobe and postero-inferiorly is the trigeminal cave).
- It receives blood through SOV; superficial MCV and sphenoparietal sinus (drains the bone of the temporal region runs in the dura under lesser sphenoid wing and drains through the roof of the sinus). Blood is drained from the sinus through 1. Superior petrosal sinus which leaves the posterior wall runs on the upper edge of the petrous bone and drains into transverse-sigmoid junction 2. Inferior petrosal sinus which leaves the posterior wall under petroclinoid lig, enters the antero-medial compartment of the jugular foramen medial to IX and drains into IJV. 3. Emissary vein that goes through foramen ovale or venous foramen of Vesalius into pterygoid venous plexus. Both sinuses communicate through **anterior, inferior and posterior intercavernous plexus**. Each sinus contains 1.5 ml and is divided into caves by fibrous septae.

- Triangles of the cavernous sinus and middle cranial fossa:
  1. Clinoidal: between optic and III nerve exposed by drilling the ACP the clinoidal part of ICA is in the middle of this triangle
  2. Oculomotor: bound by anterior and posterior petroclinoid dural folds and interclinoid dural fold. it contains the III nerve
  3. Supratrochlear between 3-d and 4<sup>th</sup> nerves and the line connecting their entry points
  4. Infratrochlear (Parkinson's): between 4<sup>th</sup> and V1. It gives access to cavernous ICA
  5. Anteromedial: between V1 and V2 (drilling leads to sphenoid sinus)
  6. Anterolateral between V2 and V3 and the line connecting foramen rotundum with ovale (drilling leads to lateral pouch of sphenoid sinus)
  7. Posterolateral (Glascocock's): behind foramen ovale anterior to GSPN Gives access to petrous ICA. Bone over this triangle can be deficient
  8. Posteromedial (Kawase's): bound superiorly by GSPN, inferiorly by trigeminal ganglion, medially by petrous apex, posteriorly by IAM. Drilling of this rectangle gives access to clival region of posterior fossa and to basilar tip.

#### **Anatomy of SOF**

#### **Anatomy of jugular foramen**