CADAVERIC STUDY ON BASILAR ARTERY AND ITS VARIATIONS IN OUR REGION

AIM OF STUDY

Basilar artery is the main artery of posterior circulation with complex position for surgical approach and with considerable variations. The surgical approach is complicated due to the compact bony structures and the vital neural structures attached to the artery like brain stem and the complex cisterns and complex vascular structure like perforating branches and the twisting of the vessels around the cranial nerves.

Aim of the study is to document the microsurgical anatomy of the basilar artery and its variations which may coincide with the western literature studies compare to our region.

INTRODUCTION

The senior authors studied and concentrated the anterior circulation since 1953 -64. Recent work on Vertebra basilar system was done by Zeal and Rhoton(1978) and Fuji et al.Huber and Lasjaunias made significant contribution to the understanding of vertebral artery anatomy. The aneurysms and other vascular malformation like AVM and cerebro vascular accidents are common in Vertebro basilar junction, upper basilar trunk and posterior cerebral arteries. So the anatomical variations in the basilar artery may useful in its surgical approaches. For example, the perfect straight course of the basilar artery is usually present in 25% of the cadavers in western studies. Most of the findings coincide with the literature but some findings like the straight course of the artery in our study was 60%.

REVIEW OF LITRATURE:

The intracranial portions of the vertebral arteries join to form the basilar artery usually at the level pontomedullary junction.

Both vertebral arteies are around 3.57mm in diameter (0.92-4.09mm) . The arteries penetrate the atlanto occipital membrane after they leave the foramen transversarium of the atlas and through the foramen magnum arteries enter the posterior cranial fossa. From the lateral cerebello medullary cistern, it courses anteromedially along the medulla below the hypoglossal rootlets to reach the pontomedullary sulcus and joins the opposite counterpart and forms the basilar artery. Reinforcing fibers of arachnoid at ponto medullary sulcus demarcate the beginning of the prepontine cistern and basilar artery. The bony landmark at the vertebrobasilar junction is usually at the lower border of the clivus but this position is variable due to tortuosity of the arteries, but the straight course is maintained in 25% cases. Fenestrations and duplication of the vertebral arteries are reported but these anomalies were usually associated with other vascular malformations like AVM and aneurysms.

BASILAR ARTERY

Basilar artery usually starts at the pontomedullary sulcus by joining of the two vertebral arteries, usually starts at the lower margin of the pontomedulary sulcus and courses upwards in the prepontine cistern in shallow depression made for the artery on the surface of the pons. Distal segment reaches interpeduncular cistern at or below the level of dorsum sellae and divides into posterior cerebral arteries. The basilar artery becomes more tortuous and lie somewhat superior in position in the increasing age may encroaches posterior third ventricle. The perfectly straight course of the artery is present in 25% of the cases and the midline situation of the artery deviated mainly in old age often towards left. The proximal basilar artery is usually concave toward the larger vertebral artery. The vertebral arteries are run as paired channels to posterior cerebral arteries and other ends as posterior inferior cerebellar artery. Fenestrations of the basilar artery are not uncommon documented as one percent in vertebral angiograms which has more possibility of aneurysms. Duplications, fenestration and persistence of fetal circulation of the embryo have been described. Persistent carotid

and basilar anastomosis such as primitive trigeminal, optic, hypoglossal or proatlantic arteries may fill the basilar artery from the carotid circulation. The diameter ranges from 2.7-4.3 mm roughly same size as the internal carotid artery. Basilar artery supplies pons by paramedial and circumferential perforating arteries. It supplies most of the pons and mesenchephalon. Its named branches are the anterior inferior cerebellar artery and the labyrinthine artery. Penetrating branches may arise from the most proximal portions of the basilar artery which supply the pyramidal decussation frequently seen which needs further descriptions.

Around 15% of aneurysms mostly saccular in type occur in the Posterior circulation. 63% of which occur at the basilar bifurcation. Congenital duplications, fenestrations and hypoplasia presence are prone for aneurysmal occurence. Apex aneurysm at the bifurcation arises usually at the posterior cerebral arteries and from the basilar artery. The junction points upward in the direction of the long axis of

the basilar artery. Hypoplastic variations of posterior cerebral artery are more prone for aneurysms. Aneurysms are visualized by carotid and vertebral angiography especially in P1 segment. Aneurysm from the basilar and its branches initially seems to confirm poorly to the first three facets of anatomy.

The basilar and vertebral arteries are coursed straight arteries, with the cerebellar arteries usually originating at right angles from them. The tortuosity of the aneurysm harbouring artery causes change in direction of blood flow. The curves near the origin of cerebellar arteries create hemodynamic stress on the wall of the basilar artery.

Basilar Apex Aneurysms

15% of aneurysms mostly saccular types occur in the posterior circulation. Usual location is posterior part of the circle of Willis most common at the point of basilar artery bifurcation. Also apex aneurysms arise at the branches of the posterior cerebral artery. Change in course of basilar artery from vertical to lateral course of posterior cerebral artery is basilar bifurcation. The curve at this junction is common site

for aneurysms. The aneurysm projects upward along the long axis of the basilar artery. The common land mark for basilar bifurcation is opposite the interpeduncular fossa. Rarely may it be present as far as around 1.3 mm below the pontomesencephalic junction. It may extend rostrally upto mamillary bodies. In rare occasions the basilar bifurcations push the mamillary bodies upward. The Bifurcation aneurysms are best approached through the sub temporal craniotomy. The neck of the basilar bifurcation aneurysm is best found by the inferior side of the posterior cerebral artery and medial to the cerebral peduncle where the artery curves and wind around. The safe approach to the P1 and basilar bifurcation is sub temporal since the perforating branches may arise inferiorly which is rare. Anomalies are common at the basilar bifurcation. The arterial segment from the bifurcation to the junction of posterior communicating artery is named as P1 segment. The segment distal to the Pcom is called as P2. P1, P2 segments have normal diameter when the Pcom is hypoplastic. In hypoplastic P1 segment, posterior communicating artery serve as a main source of

blood supply to the areas of P1, P2 segments. The hypoplastic posterior communicating artery and fetal circulation of posterior cerebral artery are predominantly gets blood supply from carotid artery, either unilateral or bilateral. Deficient posterior communicating artery and hypoplastic P1 segment are usually compromised for basilar bifurcation access. The number of perforating branches and its diameter is relatively constant. The hypoplastic segment has the same perforating area of blood supply as larger vessel, irrespective of the size of the vessel.

Posterior end of the circle of Willis gives perforating branches to the diencephalan and midbrain. These arteries may stretched in basilar apex aneurysms. Largest branch of P1 segment's perforating artery is thalamoperforating artery which is in the region of the basilar apex aneurysm. They usually enter the brain behind the mamillary bodies. Also via the posterior perforated substance in the interpeduncular fossa and medial cerebral peduncles. They branches nearest to the basilar bifurcation in most of cases. In some cases single thalamoperforating

artery on either side take the blood supply of the diencephalon and medial cerebral peduncle. Occlusion of these vessels cause loss of vision, pyramidal weakness, sensory deficit, memory impairment, autonomic disturbances, extrapyramidal signs and symptoms, double vision and altered conscious level. Lot of perforating arteries arises from the posterior and lateral surfaces of upper basilar trunk. An average of 8and ranges of 3–18 branches arise from the upper basilar trunk. Half arise from the posterior surface and one-fourth arises from each side. Anterior surface doesn't have perforating branches. The basilar bifurcation aneurysms dissection and clipping causes perforator artery compromise, so the aneurysm management and complications are managed seriously.

Posterior basilar bifurcation aneurysms have poor prognosis, as the perforators usually arise in posterior surface. Surgical results of anterior projecting aneurysms are better since it does not have any perforator branches. The most dangerous site is where rich plexus of perforating vessels on the posterior basilar surface. This area is situated 2 to 3 mm

below the bifurcation. These perforators enter the interpeduncular fossa and terminate in the medial midbrain. The thalamoperforating artery is easy to identify during apex aneurysm clipping which carries intermediate risk. Distal posterior cerebral artery aneurysms are uncommon. Posterior cerebral artery aneurysms are common in its first branch where they curve the midbrain either on the P1 or P2. They present in the crural or in ambient cisterns. Aneurysms in distal segments beyond P1, P2 segments are usually uncommon; they are larger and mimics space occupying lesion. The most common symptom of posterior cerebral aneurysms is partial or complete oculomotor nerve deficit.

Anterior inferior cerebellar artery is the main branch of the basilar artery which is constant about 58% of cases, may be duplicated and triplicated in 20%. Absent in 2% of cases. AICA origin is calculated from the vertebrobasilar junction. Most commonly it arises from lower third of basilar artery (75% of cases). In 16% cases it arises from the middle third. The origin of AICA in close proximity to vertebrobasilar junction

cannot be ruled out. It courses backwards and wind around the pons where it crosses the trochlear nerve either dorsally or ventrally. Then the artery leaves the prepontine cistern and enters the pontocerebellar cistern. In some cases, artery may perforate abducent nerve. Hypoplasia of the artery is not uncommon. The fenestration of artery may be pierced by the abducent nerve in rare instance. In cerebellopontine angle runs downwards in close relation to pons and supplies lateral pons from its medullary junction to upper one third. At the level of origin of the facial and vesteblocochlear nerve the anterior inferior cerebellar artery usually bifurcates and then turns laterally to course with these nerves, generally on their ventral medial surface. Lateral medullary branches may arise at this junction and course to the area of olive and lateral medullary fossa.

Basilar Trunk Aneurysms

The superior cerebellar artery level basilar aneurysms are arising at curvature and medial or lateral tilt of the upper basilar trunk. The

hemodynamic flow is low along the basilar artery and just above the origin of the superior cerebellar artery rather than at the basilar apex. The aneurysms at the origin of the anterior inferior cerebellar artery are rare. But if it arises, it usually present in the convexity of basilar artery. It is along the direction of the long axis of the basilar segment proximal to the aneurysm. Vertebral artery aneurysms usually arise at the level of origin of the posteroinferior cerebellar artery. The vertebral artery has straight course. In case of an aneurysm, this usually found to have a convex upward curve. The aneurysm arise in curve at the origin of the posteroinferior cerebellar artery is points upward.

Aneurysms are rare at vertebral artery, but vertebro basilar aneurysms are frequent and challenging. The position and directions are confirmed by cerebral angiographic studies mostly in saccular type to know the direction of the projections which has to be confirmed for surgical management. The origin of saccular aneurysm is on the convex side of a tortuousity of the vertebrobasilar junction. In tortuous course of the vertebrobasilar junction, one vertebral artery is dominant and

the opponent hypoplastic vertebral artery acts as branch. In straight configuration,the aneurysm is associated with congenital anomaly in the lower part of the basilar artery.

The surgical tips followed commonly in intra cranial aneurysms:

1. Basilar apex aneurysms, the basilar artery proximal to the aneurysm can be controlled by follow the inferior surface of the posterior cerebral artery. The superior surface of the superior cerebellar artery to the basilar artery can also be followed. Approach from above to the side of the basilar artery and to the neck of the aneurysm. Proximal balloon may also be considered for control. Operative approaches for best exposure of basilar artery to be explained below.

2. The parent aneurismal vessel and the opposite component vessel both are exposed, and the opponent vessel exposed first and then the

parent vessel were exposed. Dissection has to be carried out to expose the parent vessels and all around the neck of aneurysm.

3. The dissection should be started from the neck to the fundus of the aneurysm. Since the neck can tolerate the greatest manipulation and have least tendency to rupture. The neck of aneurysm is mostly incorporating the origin and tolerates the handling. It can be easily clipped.

4. All perforating arterial branches supplies vital structures like diencephalan and cerebral peduncles. All the branches should dissect from the neck of aneurysm and then the clips to be passed. Dissection of perforating vessels from neck of aneurysms should do under operating microscope magnification. The use of magnification increase accuracy of dissection and to prevent damage to the perforating arteries. The risk of damage to the perforating vessel in naecked eye procedure has to be avoided. Dissection should always do under magnification. Appropriately sized microdissectors are used to separate

the perforating vessels from the neck of aneurisms. Small spatulated dissectors of 1 or 2 mm wide (Rhoton No. 6 or 7) or 40 degree angled teardrop dissectors available for microdissection. Hypotensive anaesthesia required for dissecting the perforators which are packed tightly against and or adherent to aneurysm. Alternatively temporary clipping may be used. In some cases, the middle portions of the body aneurysm have to be dissected from the perforating arteries. The middle portion of the aneurysm to be clipped to reduce the width of the aneurysm. Then the perforators can be easily dissected from the neck. In some difficult cases where the perforators cannot be dissected from the neck, clip may be put in the open area. Then the same clip may used to clip the neck of the aneurysm. In endoscopic approaches, the neck is viewed by angled endoscopes. This helps to know the position of perforating branches clearly.

5. The rupture of the aneurysms is rare in microdissection. If it happens bleeding vessels should not be cauterized. The bleeding should controlled by cottonoids and wait for bleeding to stop spontaneously

with minimal pressure. Alternatively the mean arterial pressured can be reduced for appropriate level not to compromise the cerebral perfusion. If bleeding does not stop temporary occlusion with a clip may be used. Temporary ballooning proximal to the bleeding point may used but not to cause cerebral damage.

6. Large bone flap should be planned which avoid the brain retraction to reach the target area. Most of the aneurysms are located in and around the circle of willis which occupies the centre of the brain. Cranial-base approached through the orbitozygomatic, anterior petrosectomy, presigmoid craniotomies. But commonly far lateral approach is used to minimize brain retraction and toimprove vascular exposure. The area of operative field and broad operative angle are advantage for attacking the aneurysm in far lateral approach.

7. A clip with spring should be used always. It has advantage of reposition, reclipping and removal if warranted.

8. After the clipping, the area should always inspected for inclusion of the perforating vessels or injury to the adjacent vital brain structure due to retraction or during the procedure of clipping. Sometimes intraoperative angiography may be done to confirm the clipping at appropriate site or neck of the aneurysm. Also the angiogram ruled out the clipping of the major vessel and the inclusion of perforator branches.

9. Broad-based neck of aneurysms are managed in different techniques. Here the bipoar can be used (1mm) used to reduce the diameter of the neck of the aneurysms. Coagulation of the perforator should be avoided. Minimum amount of current should be used so as to avoid the injury to the brain structures. After considerable reduction of the diameter of the neck of aneurysm the clip can be applied without difficult. Perforating arteries should protect with cottonoids to prevent thermal injury. Small size bipolar tip should used. The forceps should

catch the walls of the neck, for that the forcep should in between the adjacent vessels and protected with cottonoids. During coagulation the forceps to be squeezed so as the blood should not be there at coagulation site. During coagulation it has to be irrigated with saline to avoid thermal injury. Short burst low current are used. During the application of cautery, the tips to be opened and closed intermittent and relaxed. This will avoid the adherence of the tip with the wall of the vessel and aneurysm wall. The shrinkage of the neck of the aneurysm to be assessed intermittent during the coagulation so as to enable appropriate size for the clipping.

There are multiple number of approaches for the basilar apex aneurysms. The common approaches are through a pterional, pretemporal, craniotomies. In some difficult aneurysms, anterior subtemporal and subtemporal approaches are used. There are four routes to approach the apex of the artery. The common craniotomy is pterional approach where the frontal and the temporal lobes are exposed. Four triangle are there to gain access to the basilar apex. But

commonly optico carotid triangle is used. Opticocarotid triangle is formed by the optic nerve superiorly, internal carotid artery, and anterior cerebral artery inferiorly. Another triangle is between the internal carotid artery bifurcations inferiorly and the optic tract superiorly. Other triangles are between the carotid arteries, the oculomotor nerve superiorly posterior communicating artery. Fourth route is in between internal carotid artery and oculomotor nerve and posterior communicating artery inferiorly.

Some basilar apex aneurysms are exposed between opticocarotid corridors. Since the area of triangle between the optic nerve, A1segmentof ACA and internal carotid artery is wide. Usually aneurysm projects superiorly or anteriorly, so can be approached without difficulty and without injuring the vital structure. The triangle may wide in the supraclinoid carotid and in elongated first segment of ACA. The triangle area is small if the carotid is infraclenoid in position and in short A1 segment. The vital perforating arteries arise from the internal carotid artery and supply the optic nerve and tract usually cross this

triangle. This perforating branch also supplies the diencephalon. So while using this triangle we must preserve these perforating branches.

Aneurysms of upper basilar bifurcation may also be managed through the bifurcation of the internal carotid artery inferiorly and the optic tract superiorly. The bifurcation of carotid artery has to be depressed commonly easy access. Here also the same perforating arteries will come in the field and to be protected. This approach may also be used when the supraclinoid carotid short segment. This results in wide space between carotid bifurcations. Aneurysms are usually approached through the frontotemoral craniotomy. The triangle of entry for the aneurysm is mostly through the corrdor between the carotid artery and the oculomotor nerve. This exposure can be widened by pushing the carotid artery upwards and proximal M1 segment downwords. After the exposer of oculocarotid triangle aneurysm may be approached through superior or inferior corridor of the posterior communicating artery. The posterior upper basilar aneurysms are

best approached by minimal retraction of the temporal lobe upwards and through floor of middle cranial fossa.

Basilar artery aneurysms also can be managed through an Anterior subtemporal approach. Usual oblique curvelinear scalp flap was raised as in for pterional approach or the question mark incision also some time used. The floor of the middle cranial fossa is exposed by the wide based bone flap for which the straight line of the question mark has to go below the zygomatic arch near the tragus and to be stopped at this point so as to avoid injury to zygomatic branch of fascial nerve. The temporalis fascial flap to be raised separately for duroplasty if needed. The temporal muscle flap raised separately and folded to gain access to the middle cranial fossa floor. Anterior part of temporal lobe elevated carefully with minimum pressure so that the retraction injury to be avoided. The oculomotor nerve exposed sub temporally in anterior direction where the nerve emerging from surface of cerebral peduncle, medial side between posterior cerebral and superior

cerebellar arteries. At this point is confirmed by the entry of nerve in to the roof of cavernous sinus. Posterior communicating artery and temporal lobe elevated. Basilar apex, both oculomotor nerve and junction of PCA and posterior communicating artery on right side is exposed.

Sub temporal approach is used for the low basilar bifurcation and for aneurysms at origin of superior cerebellar artery. Tentorium cerebellai to be sectioned posterior to junction of trochlear nerve and tentorial edge. Low basilar bifurcation, origin of superior cerebellar artery and origin of anterior inferior cerbellar artery are best approached through the subtemporal route. Combined with sectioning of tentorium cerebelli posterior to junction of trochlear nerve with tentorial edge, accesses the aneurysms arising on a low basilar bifurcation or at origin of the superior cerebellar artery. High origin of AICA also approached through this corridor.

In sub temporal approach, the inferior side of posterior cerebral artery is followed to reach basilar bifurcation and PCA, where PCA

curves and wind around cerebral peduncle. The inferior surface of P1 segment of PCA is unusual site of origin of perforating branches. So it is safest approach for the aneurismal clipping in proximal part of posterior cerebral artery and basilar bifurcation.

The anterior temporal lobe in front of vein of Labbé has better exposure of perforating arteries. These arteries arise from posterior aspect of basilar artery. Pterional approach has some difficulty in aneurismal exposure. These perforating branches supply the diencephalon so that gain its importance. The diencephalon has control in maintaining the level of consciousness. Usually the hypoplastic posterior communicating artery and P1 segment sacrificed to approach basilar bifurcation either for tumor or aneurysms. Since the perforating branches of the hypoplastic arteries are less signficant. But number and diameter of perforating branches are usually constant, irrespective to hypoplastic artery. Small perforating branches should be preserved. Sub temporal route may not useful in medial

surface of posterior cerebral artery anerusms. Small perforating branches are not visible in subtemporal approach and to be avoided.

Cranial-base approach are used now a days to approach the basilar apex aneurysms. The most common craniobasal approach is OrbitoZygomatic craniotomy. Here the roof of orbit and zygomatic arch sacrificed. This is useful for angled approach. After adequate bony exposure and durotomy, the approaches are transsylvian, pretemporal, anterior subtemporal. Rarely mid subtemporal approach is used. The modifications in reaching low basilar bifurcation are orbitozygomatic craniotomy and transcavernous approach.The anterior and posterior clinoid processes and roof of cavernous sinus are removed. Another approach is the anterior petrosectomy approach. Here the petrous apex behind petrous carotid artery. Petrous bone under trigeminal nerve is removed extradurally. In frontotemporal or

orbitozygomatic craniotomy, the drilling is completed and the dura is opened and tentorium divided. Trigeminal nerve depressed for exposure. This significantly increasing length of basilar artery, by sectioning tentorium then petrosectomy.

Aneurysms at vertebrobasilar junction are approached by subtemporal and transtentorial exposure if aneurysm and junction are high in posterior fossa. The combined supra and infratentorial presigmoid exposure needed when VB junction is deep in the middle of posterior fossa. In case of the Vertebro basilar junction is low lateral suboccipital and the far lateral approach is used.

ANTERIOR INFERIOR CEREBRAL ARTERY

In common either of anterior inferior cerebellar artery trunks reaches inferomedial surface near brain stem to reach the inferior cerbellar surface medially. In some of cases before looping the artery courses with cranial nerves VII and VIII toward the internal auditory

meatus for a variable distance. This segment of artery as reaching or actually protruding into the internal auditory canal in 64% and 67% of cases respectively. In 54% of cases this segment of artery is located anteroinferior or between nerves, and supplies recurrent perforating branches and these nerves. The entry zone of the pons also supplied by these branches. After looping out of internal acoustic meatus, nerve related arterial branch gives branches to middle cerebral peduncle and to the inferior cerebellar surface adjoining the horizontal fissure. The other nerve unrelated branch of the AICA supplies the focculus, choroid plexus and inferomedial surface of cerebellum.

Anastomoses between anterior and posterior inferior cerebellar arteries are rich which exist in the cerebellopontine cistern. This anastomosis exist between peripheral branches of anterior inferior cerebellar artery and PICA but limited with superior cerebellar artery. The relationship between anterior and posterior cerebellar artery is inverse in that terms if one cerebellar artery is small, either of

ipsilateral or contralateral arteries become larger. The anterior inferior cerebellar artery is hypoplastic in 20% of cases with corresponding enlargement of the ipsilateral or rarely contralateral PICA. In some occasions superior cerebellar artery enlarged for compensation. PICA is hypoplastic in 32%. In that cases ipsilateral anterior inferior cerebellar artery or the contralateral posterior inferior cerebellar artery being larger. Labrynthine artery mostly has origin from anterior inferior cerebellar artery in 85% of cases. 15% of cases, it originate from main basilar arterial trunk.

The anatomies of the arteries are variable but the anatomies of the perforating are constant. The numbers of the perforators are constant. Majority of case, point of entry was lateral medullary area just caudal to posterior olivary sulcus and foramen caecum. Area of penetration usually in relation with origin of vertebrobasilar aneurysms. Basilar artery perforators distinguished in to three groups. Caudal perforators are varied in numbers of 2-5 and the diameter of 80-

600micrometer enters the foramen caecum. The pontomedullary artery occasionally gives perforator branches, also gives pyramidal vessels and hypoglossal branches. Middle perforators also arise separately from basilar artery collateral branches. They are varied between 5-9 and the diameter of 210-940 micrometer. It gives off pontomedullary artery in 8.5% and long pontine artery in 24%.antero lateral vessels arises in 100%of cases. Rostral perforators originate in the terminal part of basilar artery in 91% of cases, from superior cerebellar artery in 91%. posterolateral artery in 16%. They are 1-5 in numbers with diameter between 190-840 micrometer. Anastomosis noted in perforator arteries in 41.6-66.6%.

The anterior inferior cerebellar artery occlusion causes the syndrome related to lateral portions of brain stem and thecerebellar peduncles. The symptoms are fascial and vestibulocochlear involvement of the nerve at the nuclear level. The connections of vestibular nuclei involvement casues nystagmus , vertigo and vomiting.

Ipsilateral pain and temperature sensation on face are lost. There is corneal hypesthesia also present. These are all caused by involvement of the spinal tract of trigeminal nerve. Horner,s syndrome caused by involvement of descending sympathetic fibers which involved in the pupilary reflexes. Lateral spinothalamic tract involvement results in contralateral hypo or asthesia for pain and temperature. Symptoms are sudden onset of symptums due to vascular compromise without loss of consciousness. Symptoms are vertigo associated with vomiting and fascial paralysis, deafness, sensory loss and occasionally with cerebellar disorders. Pyramidal weakness and differentiation of sensations are absent since the structure are nourished from midline tributaries of basilar arteries. Recovery and survival of many patients after intentional occlusion of anterior inferior cerebellar artery at operation is attributed to adequacy of collateral circulation from other cerebellar arteries. The contralateral disproportionate size may have poor outcome.

Operative exposure involved in anterior inferior cerebellar artery in cases of cerebellopontine angle tumors. Aneurysm of AICA is rare, if presents occur in origin or branch near the acoustic meatus. AVM uncommon compare to the supratentorial lesion. Compression of the VII and VIII nerve by the Tortuous AICA is common. AICA may be approached retrosigmoidal, middle fossa craniotomy and translabrinthine approach. Suboccipital approach is excellent for lesions involving meatal post meatal segments of AICA, lateral part of middle and lower brainstem below trigeminal nerve and near acoustic meatus. Lesions in high origion AICA and also involves SCA and BA and in medial to trigeminal nerve, middle cranial fossa approach is used. Tentorium may divided sometime, occasionally combined with medial petrosectomy. In middle cranial fossa approach to internal meatus only short segment near meatus is exposed. Translabrynthine approach exposes AICA short distance proximal and distal to meatus with anterior surface of petrous bone. AICA origin may expose through anterior approach. Midline lesion entered through clivus directly.

Lesion from tortuous basilar artery loops laterally in cerebellopontine angle. So this can be approached by retro mastoid craniotomy.

Superior cerebellar artery is most consistent in origin and location in posterior fossa, by hardy rhoton in 1978. Superior cerebellar artery arises from the basilar apex below in most cases. Site of oirgin is directly adjacent to origin of PCA. In deep bifurcation cleft, superior cerebellar arteries may appear originate from base of the posterior cerebellar arteries. In few cases the artery may arise several millimeters from bifurcation or rarely from posterior cerebral arteries. Origin of SCA is considered to lie within the interpeduncular cistern, but as artery courses laterally separated from posterior cerebral artery from oculomotor nerve, it aquires its own arachnoid sleeve. Small branches are given within the interpeduncular cistern. It encircles brainstem within groove between pons and mescencephalan. Within ambient cistern, lateral side of the brain stem, artery makes shallow caudal loop. Then divides into lateral and medial branch. At this point either the

trunk itself or one of the branches often comes into direct contact or distorts the emerging trigeminal nerve.

The superior cerebellar artery trunks then course posterioly in the infratentorial portion of the ambient cistern in close relation to the brainstem but near the free edge of the tentorium, trochlear nerve, basal vein of Rosanthil and posterior cerebral arteries. The lateral branch courses antero laterally to follow the quadrangular lobule of the cerebellum above the trigeminal nerve and then extends posterolaterally in the region of horizontal fissure to supply the superolateral cerebellar hemispheres and deep nuclei. Medial branch encircles the pontomescecephalic junction as the trunk of the superior cerebellar artery gives origion to the several hemispheric branches and then reaches the caudal tectum in the area of inferior colliculus where it enters the quadrigeminal cistern. This branch supplies the fine perforating vessels to the brachium conjuntivum and inferior colliculus. It approximates the contralateral vessel then turn inferiorly over the

superior vermis as the superior vermian artery. The hemispheric branches reach the superior cerebellar surface and fan out in radial pattern towards the horizontal fissure supplying the superomedial cerebellar hemisphere and dentate nucleus. All of the superior vermian and hemispheric branches may form anastomoses with anterior inferior or the posterior inferior cerebellar arteries. Numerous fine anastomosis occur between medial branch of SCA and posterior cerebral artery in quadrigeminal cistern. Critchely and Schuster called this anastomosis a plexus pedunculi, but Duvernoy pointed out that most of these anastomoses are ipsilateral.

The size of superior cerebellar artery varies from 0.72-1.50mm. The superior cerebellar arteries are of equal size in 33% of cases, the right is larger in 31% of cases. Duplication of this vessel is seen on the right in 8% and on the left is 13.3%. Mani et al found duplication in 28% of cases while Blackburn found it on the right in 2%, on the left one percent and bilateral in one percent of cases. It is generally considered

that the double origin is equivalent to the lateral branch of the artery having its own origin from the basilar artery.

Effect of occlusion of cerebellar artery may be asymptomatic. But infarction of portions of brainstem and cerebellum with swelling and haemarrage may cause death. Superior cerebellar artery occlusion cause infarction of cerebellum, dendate nucleus and brachium conjuntivum. Long sensory pathways in tegmentum of rostral pons also involved.

Clinical picture comprises of sudden vomiting, dizziness and instability in standing and walking. Cerebellar infarction, involvement of peduncles and dendate nuclei causes cerebellar dysfunction in the form of ipsilateral intention tremor. Dysfunction of descending ocular sympathetic fiber causes Ipsilateral Horner's syndrome. Involvement of lateral spinothalamic and quintothalamic tract results in contralateral loss of pain and temperature, MLF and cerebellar path ways dysfunction causes nystagmus. Crossed fibers of lateral lemniscus get

affected which causes contralateral hearing impairment. Upper brain stem involuntary mimetic path way affected and results inimpairment of emotional expression. Recovery from superior cerebellar artery occlusion mainly depends on presence of collateral formation.

Superior cerebellar artery exposed usually in cases of neoplasm of cerebellum, posterior cavernous sinus, tentorial incisura and cerebellopontine angle. In caes of aneurysms at the basilar apex origin, SCA and PCA exposed. Unsualally when dealing with AVM and in case of micro vascular decompression in symptomatic trigeminal neuralgia and during revascularization surgery the exposure of SCA was important.

The operative approach is depends on the cerebral angiogram and position of the superior cerebellar artery radiologically. Lesions located in front and back of brainstem needs different approaches. Only supratentorial approach to access the artery is temporal approach with elevation of temporal and occipital lobes. The tent to be divided.

Extending this approach backward to quadrgeminal cistern necessitates obliteration of veins draining lower surfaces of temporal and occipital lobe. This results in venous infarct and edema. Superior cerebellar artery is exposed widely in infratentorial presigmoid approach and tentorial split. Pterional approach also used for the upper basilar trunk exposure. Infratentorial and supracerebellar approach also useful to lateral pontomescenchephalic segment.

Posterior cerebral artery, the terminal bifurcation of the basilar artery within the interpeduncular cistern bifurcates 1-3 mm distal to origin of superior cerebellar artery inferior to much larger paired posterior cerebral arteries. From its origin posterior cerebral artery curves superior to oculomotor nerve. It wind rounds anteromedial portion of peduncle, joins posterior communicating artery. This segment of posterior cerebral artery from its origin to the posterior communicating artery is termed P1 segment. Synonyms include the

mescencephalic, procommunicating, circular,peduncular and basilar segment.

Most commonly the P1 segment of posterior cerebral artery is larger than posterior communicating artery. But P1 segment may be smaller than posterior communicating artery in up to 20 -40% cases. Embryologically posterior cerebral arteries arise from internal carotid artery. With development the P1 segment of posterior cerebral artery usually enlarge to from major connection between basilar and posterior cerebral arteries with subsequent diminution in size of posterior communicating arteries. In 22% of cases, P1 segment is smaller with larger posterior communicating arteries. Persistence of the fetal type of posterior cerebral circulation usually accompanies this anomaly. Fetalcirulation arise from internal carotid artery.

Present series posterior cerebral artery primarily perfused by basilar artery in 67.5% of cases, from internal carotid artery in 24.5% cases and equally from both in around 8 % of cases.

Angiographic demonstration of the posterior cerebral artery occurs in 14-41% as per literature. It should be noted that in both angiographic and cadaveric studies, the fetal type of circulation with larger posterior communicating artery seems to occur with greater frequency on the right.

After connecting with posterior communicating artery, at anterior margin of peduncle, posterior cerebral artery arches posterolaterally around cerebral peduncle and enters the ambient cistern.

The artery parallels the course of the basal vein of Rosanthal which lies superior and the trochlear nerve, tentorial edge,and superior cerebellar artery, which are lie inferior. As the vessel approaches the mescencepahlic cistern inferior temporal branches arise. This portion of the posterior cerebral artery from the posterior communicating artery to origin of inferior temporal arteries is called the P2 segment. Synonyms include the ambient, posterior communicating and perimescencephalic segments .Zeal and Rhoton divides this segment in

to two halves P2 anterior and P2 posterior. The branches of this segment include peduncular perforating arteries (1-6 in numbers) that penetrate cerebral peduncle and supply corticospinal and corticobulbar pathways, substantia nigra, red nucleus and other mescencephalic segmental structures, medial and lateral posterior choroideal arteries and thalamogeniculate arteries.

After the origin of inferior temporal arteries, posterior cerebral artery continues to curve around mescenchepalic system until it pierces quadrigeminal cistern and reaches lateral geniculate body under pulivinar thalami. Here the vessel divides in to its terminal divisions the parietal occipital and calcarine branches. The segment of posterior cerebral artery from origin of inferior temporal branches to origin of parieto occipital and calcerine arteries is termed as P3 or quadrigeminal segment. Segment after origin of parieto occipital and calcerine artery is P4 segment.

Branches of the P3 segment with inferior temporal artery is termed as posterior pericallosal arteries.

From inferior and posterior surface of P1 segment multiple (1-13) perforating branches arise and supply the interpeduncular fossa, the mamillary bodies, the cerebral peduncle,and the posterior mescencephalan. From this same area of P1 short circumflex branches arise and pass a short distance around brain stem medial to posterior cerebral artery supplying branches to cerebral peduncle, tegmentum and medial geniculate. Other branches from this segment include the thalamoperforate and quadrigeminal arteries.

<u>Branches of posterior cerebral artery</u>

I. Central or brainstem branches

A) Direct perforation branches

1. From P1 segment

a. Thalamoperforating arteries

2. From P2 segment

a. Thalamogeniculate arteries

b. Peduncular perforating arteries

B) Circumflex branches

a. Short

b. Long

II.Ventricular ,choroid plexus branches,dorsal thalamic branches

A)Medial posterior choroidal artery

B) lateral posteriorchoroidal artery

III. Cerebral cortical branches

MATERIALS

100 Cadavers from the Forensic medicine Department, Thanjavur Medical College were included in the study. The inclusion criteria are all

nontruama cadavers. The exclusion criteria were death due to head injuries, murder. Unclaimed bodies excluded due to medicolegal reasons. The institutional ethical committee approval obtained in advance. Permission obtained from the professor incharge of the Forensic Medicine department. Cadavers were examined after explaining the study purpose and after obtaining the informed consent in their regional language from the relatives.

METHODS

When cadaver comes for postmorterm examination, we used to conduct the study. Prior informed consent obtained in written from relatives. The vertebral artery was dissected at the level of thyroid from cartilage by anterior approach. As routine method of forensic cadaveric examination, the bicoronal scalp incision made. The skull skeletanised and drilled and the base of the brain dissected. The circle of willis visualized and dissected. The anterior cerebral arterial system ligated to

prevent leakage of the dye. Beveled cut tygon tube inserted into the vertebral artery on both sides. Around 50 ml of india ink dye injected. Then the brain dissected from the cranial cavity without disturbing the posterior system at the level of cervical cord level including around 1-1.5 cm of the vertebral artery. Then the specimens examined for variations and given back to keep in to the body. The caliber and diameter of the vertebral artery, vertebra basilar junction in relation to ponto medullary sulcus read and recorded. Diameter of basilar artery and length measured and included in the study. The course of the basilar artery in the prepontine groove was studied and recorded. The origin of anterior inferior cerebellar artery in relation to vertebrobasilar junction and its diameter was recorded. Diameter of the superior cerebellar artery and its origin in relation to basilar artery bifurcation recorded. The bifurcation of basilar artery in relation to mamillary body, the distance was noted. The length of P1 segment and its diameter were recorded. And the measurements analyzed statically.

OBSERVATION

We observed that there are some difficulty in dissecting the brain specimen in toto with the vertebral artery since while dissecting the brain from the cranial cavity at the level of foramen magnum is difficult in cases of narrow foramen and the vertebral artery is adherent to the clivus and teared while delivering the specimen. Some cadavers brains were in semi solid state and the vessel are fragile and became unfit for study and omitted.

The following observation were made

The vertebral arteries were teared in seven cases and could not measure. It was observed that in one case the left vertebral artery absent and right vertebral artery continuous as basilar artery. The average diameter of vertebral artery on the right side2.28mm and in the left is 2.12 and the range from 1-5mm.

The length of basilar artery range from 20-50mm and the average is 38.5mm. The diameter of the basilar artery range from 2-6 mm and

the average is 3.7 mm. The average origin of basilar artery is ponto medullary sulcus is 4-8 mm below the junction the Ponto Medullary junction. The basilar bifurcation is 0-5 below the mamillary body. The tortuasity of artery is correpondigly increased with age. The straight course in prepontine sulcus maintained in 60% of specimens.

The origin of Anterior Inferior Cerebellar Artery from the basilar artery is between 0-3mm on both sides. The average origin of right AICA is2.5mm and left AICA is2.3mm. In one specimen it was observed that the left AICA was absent. The diameter of the anterior inferior cerebellar artery range from 1-3mm, mean is 2.1mm.

The numbers of paramedian pontine branches were range from 1-5 in numbers. The circumflex pontine branches were range 1-4 in numbers.

The origin of superior cerebellar artery was just below basilar bifurcation the distance range from 1-2mm. The average diameter of

the SCA was range from1-4mm. the mean diameter were 2.1 mm on both sides

The common Bifurcation of basilar artery in to posterior cerebral artery was below the mamillary body .The distance range from1-3mm. In three specimens it reaches the diaphrama sellae. The P1 segment length was 2-6 mm with the mean on the right side was4.1mm and left side was3.8mm. The diameter of the PCA range from 1-5mm.The mean diameter of the PCA was3.1mm on both sides.

RESULT OF THE STUDY

The origin of basilar artery was at pontomedullary junction commomly coinside with the lower border of clivus, in pontomedullary citern.

The Straight course of the basilar artery maintained in 60% of specimen. If tortuous the bifurcation moves little above and to the diapharma sellae.

All the Branches of the basilar artery well studied and all the branches were present except the left AICA absent in one specimen.

The posterior cerebral artery was larger in diameter compare to previous studies by one mm.

DISSCUSSION:

VERTEBRO BASILAR JUNCTION:

The origin of BA was at pontomedullary sulcus up to 10 mm below it (means 5.55 mm). In our study it was between 0-8mm and the average is 5.84mm. The Straight course was maintained in 21% of specimens, and with the increasing age the straight course was become tortuous. The will very important in the case of anerysmal surgeries

which course to be confirmed by angiogram prior to intervention. (1,13,17). In our study the straight course was maintained in 60% of cases.

Distance from ponto medullary junction(in mm)	Number of specimen
0-5	6
5.1-6.0	40
6.1-7.0	3
7.1-8	1

MEAN: 5.84 Median:6mm MODE:6mm

DIAMETER OF VERTEBRAL ARTERY:

DIAMETER (in mm)	No. of specimens right	left
0-1.5	9	13

1.6-2.5	16	15
2.6-3.5	22	21
3.6-4.5	3	1

MEAN: 2.3mm Median:3.0mm MODE:3mm

BASILAR ARTERY:

The diameter of basilar artery ranges from 3-4.5mm and length varied from 34-40 mm (mean of 34.5 mm).in our study it was 20-50mm(mean35mm)(22). No fenestration duplication triplication and hypoplasia were noted in the basilar artery. BA gave off paramedian and circumferential perforating was restricted to cisternal anatomy.

Paramedian branches are the small branches that leave the BA .These were one to five in numbers. The circumferential arteries go laterally and course around pons and supply lateral portion of pons were 1-5 in numbers.

LENGTH OF BASILAR ARTERY:

Basilar artery length(mm)	No. of specimen
0-25	2
26-35	17
36-45	29
46-55	2

MEAN: 38.5mm Median 44mm MODE:45mm

DIAMETER OF BASILAR ARTERY

Diameter in mm	No. of specimen
0-3	21
3.1-4.0	20
4.1-5.0	4
5.1-6.0	5

Mean: 3.7mm Median 3.5mm mode:4

PONTINE BRANCHES

Paramedian branches

No. of branches	No. of specimen
0-2	9
2.1-3.0	27
3.1-4.0	9
4.1-5.0	5

Mean:3.2 median:3.0 mode:3.0

Circumferential branches

No. of branches	No . of specimen
0-2	10
2.1-3	28
3.1-4	12

Mean:3.2 median:3.0 mode:3.0

ANTERIOR INFERIOR CEREBELLAR ARTERYORIGIN

Origin from vertebrobasilar junction distance (in mm)	No. of specimen Right	left
0-1	5	9
1.1-2.0	17	18
2.1-3.0	23	19
3.1-4.0	5	4

MEAN2.6mm Median 3.0mm MODE:3

The origin of AICA from the VBjunction were range from 0-3mm. on both sides which coincides with the literature and in one specimen the left AICA was absent which was not significant. The origin of AICA from BA is variable. Yasargil et al have found solitary AICA in 58%, duplicated in twenty percent, triplicated in twenty percent and rarely absent in two percent.[1] In our series solitary origin were found in

almost all cases . The AICA arose from lower third of BA in 7.14%, from middle third in 60.7%. In our study, lower third of origin was around 14% and middle third origin was in 75%. The upper third origin was around 5%

DIAMETER OF AICA

Diameter in mm	No of specimens Right	left
0-1	4	4
1.1-2.0	26	30
2.1-3.0	20	16

Median 2 mm Mean2.1mm MODE:2

SUPERIOR CEREBELLAR ARTERY

Diameter in mm	No. specimen Right	left
0-1.5	7	3
1.6-2.5	35	39
2.6-3.5	8	8

Mean 2.1mm Median 2.0mm MODE:2

The superior cerebellar artery has close origin with basilar bifurcation was around 1-3.5mm from the bifurcation. There was no hypoplasia, duplication or triplication noted. The Diameter of the SCA range from 1-4mm with mean 2.1mm on both sides.SCA is most consistent branch of posterior circulation. The SCA frequently have contact with oculomotor, trochlear and trigeminal nerve. In our study bifurcation were normal in 55% cases compare to rhoton study it was 65%.

LENGTH OF P1 SEGMENT OF POSTERIOR CEREBRAL ARTERY

Length in mm	No .of specimen Right	left
0-2.5	1	1
2.6-4.5	39	39
4.5-6.5	10	10

Mean: 4.1 median: 4.0 mode: 4

DIAMETER OF POSTERIOR CEREBRAL ARTERY

DIAMETER in mm	NO. OF SPECIMEN RIGHT	LEFT
0-2.0	4	5
2.1-3.0	35	35
3.1-4.0	11	10

MEAN:3.8 MEDIAN:3.5 MODE:3

The PCA arises at basilar bifurcation and is joined the posterior communicating artery (PComA) at Lateral margin of interpeduncular cistern. It encircles Brain Stem passing through crural and ambient cistern to reach quadrigeminal cistern. The lengths of the P1 segment of PCA were 2-6mm with mean 3.5mm on both sides. The diameter PCA on the right side 1-5mm (mean3.5) and on left side 1-5mm (mean3.4). Fetal type of circulation found in 25% cases in rhoton series. In our study no fetal type of circulation were made out.

CONCLUSION

Cadaveric study of the posterior circulation is useful, since microsurgical anatomy is extremely complex and variable.

There are difficulty were encountered while studying the specimen like traumatic loss of vertebral arteries and part of basilar arteries.

The anatomical landmarks of vertebra basilar junction, anatomy of basilar artery were coincide with literature studies.

The variations noted were

The straight course of basilar artery maintained in 60%.

Apalsia of left AICA noted in single specimen.

Superior cerebellar artery present in the entire specimen as constant branch.

There is no fetal type of circulation made out .

It is important for micro neurosurgeon to have a working knowledge of microsurgical anatomy of vascular structures as well as the neural structures in this area.

Familiarity of the anatomical structure and variation in vascular structure will useful to tackle pathological conditions and give confidence in surgical exposure.

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CADAVERIC STUDY ON BASILAR ARTERY AND ITS VARIATIONS IN OUR REGION

AIM OF STUDY

Basilar artery is the main artery of posterior circulation with complex position for surgical approach and with considerable variations. The surgical approach is complicated due to the compact bony structures and the vital neural structures attached to the artery like brain stem and the complex cisterns and complex vascular structure like perforating branches and the twisting of the vessels around the cranial nerves.

Aim of the study is to document the microsurgical anatomy of the basilar artery and its variations which may coincide with the western literature studies compare to our region.

INTRODUCTION