ORIGINAL RESEARCH PAPER

Volume-7 | Issue-1 | January-2018 | PRINT ISSN No 2277 - 8179

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ANOMALIES OF BASILAR ARTERY AND VARIATIONS OF ITS BRANCHES WITH SURGICAL PERSPECTIVES

Anatomy

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ABSTRACT

The basilar artery is formed by the union of two vertebral arteries and it forms an important part of the posterior circulation of the brain. The present study is based on the observation of brain specimens obtained from the cadavers and specimens were preserved in 10% formalin for 1 month. The fevibond - acetone solution enabled to fix up and gave a shining smooth surface for further painting. Many vascular bypass and shunting procedures for the treatment of stenosis, occlusions, aneurysms, arterio-venous malformations of the arteries of the posterior cranial fossa. Anatomical variations, duplications, fenestration or the absence of certain vessel will significantly alter the plan of surgical approach and also determines the outcome of revascularization procedures. Hence a detailed anatomical knowledge is necessary for successful design and completion of any surgical procedures.

KEYWORDS

basilar artery, fevibond - acetone solution, stenosis, aneurysm.

INTRODUCTION: The basilar artery is formed by the union of two vertebral arteries and it forms an important part of the posterior circulation of the brain. Through its terminal branches (Posterior cerebral artery), it contributes for the formation of "CIRCLE OF WILLIS" which is an important arterial anastomosis situated at the base of the brain, connecting the carotids and vertebro-basilar systems.

It gives off many important branches which supplies the vital parts of the brain like cerebellum, pons, medulla-oblongata, choroid plexus, ventricles and internal ear. A variation of the vertebro-basilar system is more often congenital and many anatomists have suggested embryological explanation for the same.

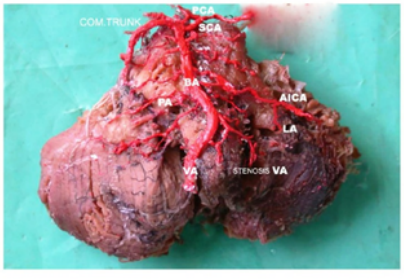
Over the past 4-5 decades, Neurosurgery has seen the development of many vascular bypass and shunting procedures for the treatment of stenosis, occlusions, aneurysms, arterio-venous malformations of the arteries of the posterior cranial fossa.

Many clinical problems like atherosclerosis, arterio-venous malformation, transient-ischaemic attacks, strokes and infarcts, clinical syndromes like Wallenberg's syndrome, Medial medullary syndrome, basilar-artery syndrome, Weber's syndrome have been attributed to the anatomical variations in the branching pattern of the basilar artery. The pulsatile nerve compression by the normal or aberrant vascular pedicle of the vertebro-basilar system have resulted in trigeminal neuralgias, hemifacial spasms, lower cranial nerve palsies.

Materials and Methods: The present study is based on the observation of 20 brain specimens obtained from the cadavers given for dissection to the 1st year undergraduate medical students of college. Removal of brain by dissection method used is as given in Cunningham's manual of practical anatomy for the removal of whole brain. The brain was washed in running water for half an hour. After labelling, specimens were preserved in 10% formalin for 1 month. The fevibond - acetone solution enabled to fix up and gave a shining smooth surface for further painting. The arteries were painted using the red oil colour (Winsor & Newton). The specimens were allowed to dry. Individual photos high lighting the variations were captured using the digital camera.

RESULTS: In the present study the level of formation and termination, course, branches of the basilar artery was studied in 20 adult cadavers (of viable age) by dissection method.

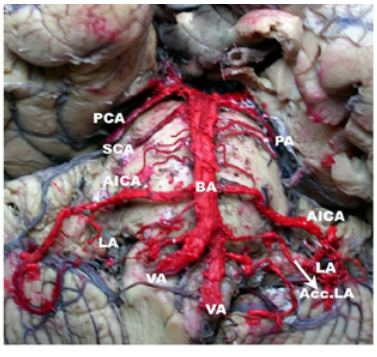
The basilar artery is formed by union of two vertebral arteries at the level of 5 mm below the Ponto Medullary junction. Stenosis of the vertebral artery on the left side, common stem of origin of posterior cerebral arteries and superior cerebellar arteries on both sides, higher level of origin of anterior inferior cerebellar arteries on the right. **(Fig:1)**



(Figure.1) Inferior view of the Brain Stem and Cerebellum.

VA- vertebral artery
BA- basilar artery
SCA-superior cerebellar artery
PCA-posterior cerebral artery
AICA-anterior inferior cerebellar artery
PA- pontine artery
LA- labyrinthine artery

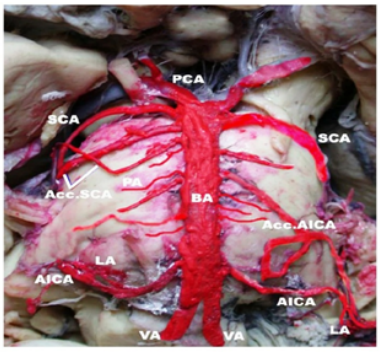
Basilar artery is formed by the union of two vertebral arteries at a level 3 mm above the Ponto-Medullary junction. Accessory labyrinthine artery is present on the left side arising from basilar artery and normal labyrinthine artery arises from anterior inferior cerebellar artery. Anterior inferior cerebellar artery and posterior inferior cerebellar artery on both sides are reciprocal in size. There is common trunk of origin of left posterior cerebral artery and superior cerebral artery. **(Fig: 2)**



(Figure.2) Inferior view of the Pons and Cerebellum.

VA- vertebral artery
BA- basilar artery
SCA-superior cerebellar artery
PCA-posterior cerebral artery
AICA-anterior inferior cerebellar artery
PA- pontine artery
LA-labyrinthine artery
Acc.LA-accessory labyrinthine artery

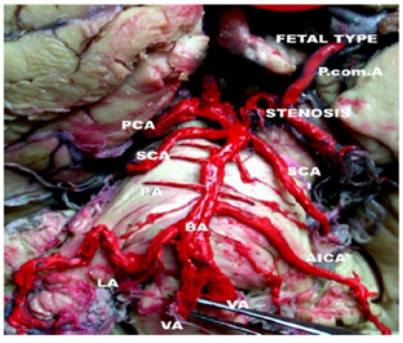
Basilar artery is formed by the union of two vertebral arteries at a level of Ponto-Medullary junction. Triplication of superior cerebral artery is present on the right side arising from basillar artery. Accessory anterior inferior cerebellar artery on the left side has a loop formation and it arises from basilar artery the at a higher level. **(Fig: 3)**



(Figure.3) Inferior view of the Pons and basilar artery.

VA-vertebral artery
BA-basilar artery
SCA-superior cerebellar artery
Acc.SCA- accessory superior cerebellar artery
PCA-posterior cerebral artery
AICA-anterior inferior cerebellar artery
PA-pontine artery
LA-labyrinthine artery
Acc.LA-accessory labyrinthine artery

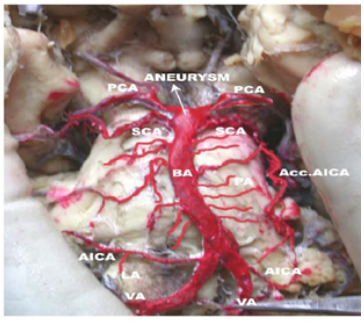
Basilar artery arises from two vertebral arteries at a level 1 mm below the Ponto-Medullary junction. Fetal type of posterior cerebral artery with stenosis is present on the left side. Basilar artery is tortuous in its course. There is common trunk of origin of posterior cerebral artery and posterior cerebral artery on the left side. The level of termination of basilar artery is 10 mm above the Ponto-Medullary junction. **(Fig: 4)**



(Figure.4.) Inferior view of the Pons and basilar artery with stenosis(fetal type)

VA-vertebral artery
BA-basilar artery
SCA-superior cerebellar artery
PCA-posterior cerebral artery
AICA-anterior inferior cerebellar artery
PA-pontine artery
LA-labyrinthine artery
P.com.A.-posterior communicating artery

Basilar artery takes origin from the 2 vertebral arteries at a level 2 mm above the Ponto-Medullary junction. Aneurysm is present at the basilar apex. Accessory superior cerebral artery is present on the left side. Left side accessory anterior inferior cerebellar artery arises at a higher level from basilar artery. **(Fig: 5)**



(Figure.5) Inferior view of the Pons and basilar artery with Aneurysm

VA-vertebral artery1
BA-basilar artery
SCA-superior cerebellar artery
PCA-posterior cerebral artery
AICA-anterior inferior cerebellar artery

DISCUSSION: In the present study the basilar artery was examined by dissection method in 20 adult human brain specimens. Importance was given to the length, diameter, angle of formation, origin, branching pattern, termination of the basilar artery and their concerned variations. Many authors have studied the variation of the vertebro-basilar system and have suggested an embryological explanation for the same.

Over the past 50 years, interventional radiology and many revascularization procedures like transluminal angioplasty, vascular shunt and bypass surgeries have greatly advanced and is being performed for various diseases of the basilar artery.

Name	year	Lt. VA > Rt. VA	Rt. VA > Lt. VA	Rt VA = Lt. VA	Rt VA absent or hypoplastic	Lt. VA hypoplastic
Grand et al.	1997	39.3%	21.7%	25%	7.3%	-
Kushner MJ	1991	50-60%	-	-	-	-
Krayenbuhl and Yasargil	1987	42%	32	26	6.2%	4.5%
Present study	2017	64.8%	11.1%	13%	5.6%	3.7%

Kushner had noted that left vertebral artery was greater than right vertebral artery in 50-60% of cases. Grand et al. has shown that left vertebral artery is greater than right vertebral artery in 39.3%, right vertebral artery is greater than left vertebral artery in 21.7%, both are of equal sizes in 25% and in 7.3% right vertebral artery is absent. Krayenbuhl and Yasargil noted that right vertebral artery and left vertebral artery are of equal size in 26% and right vertebral artery is greater than left vertebral artery in 32%, in 42% left vertebral artery is greater than right vertebral artery. In 6.2% and 4.5% hypoplasia was noted in right vertebral artery and left vertebral artery respectively. In the present study right vertebral artery was equal to left in vertebral artery 13%, left vertebral artery was greater than right in 64.8%, the right vertebral artery was greater than left in 11.1%. Hypoplasia was noted in the right vertebral artery in 5.6% and left vertebral artery in 3.7% cases. The present study is comparable to the study done by Krayenbuhl and Yasargil.

Stopford studied 160 cases and noted that in 156 cases, the bifurcation was at the upper border of pons, in 2 cases just below this level and in 2 more cases 1 cm below. In the present study out of 20 cases, in 8 cases (44.4%) termination was at the upper border of pons (Ponto-Medullary junction), 3 cases (29.6%) above the level of Ponto-Medullary junction as rostral as 10 mm above. In 9 cases the basilar artery terminated below the Ponto-Medullary junction as caudal as 4 mm.

The level of termination of basilar artery determines the type of approach to be made for the treatment of aneurysms of basilar apex and the one involving the posterior cerebral artery, so as to minimize or prevent the damages to the nearby important structures like mamillary body, optic chiasma, etc.

Name	Solitary	Duplication	Triplication	Absence / Hypoplasia
Fujii and Rhoton	58%	20%	20%	2%, 20%
Martin RG	72%	-	-	-
Present study	92%	7.4%	-	4.6%

Anterior inferior cerebellar artery and internal auditory artery are very important branches of basilar artery and are frequently involved in tumours like acoustic neuromas, meningiomas at the Cerebello-pontine angle, vascular lesions like arterial occlusions, aneurysms, A-V malformations.

internal auditory artery is an end artery supplying internal ear and nearby structures and may be damaged during operations done at the C-P angle, diseases of the internal ear and middle ear, tumours of pyramid resulting in deafness.

Name	Year	Solitary trunk	Duplication	Triplication
Von Mitter Wallner	1955	78.7%	21.3%	-
Blackburn	1907	96%	4%	-
Hardy	1980	86%	14%	-
Present study	2005	78.7%	20.4%	1.9%

The Basilar - SCA junction is the second most common site for occurrence of aneurysms and Oculomotor nerve is involved in such cases resulting in Weber's syndrome and extraocular muscle paralysis. Sub-temporal approach has been suggested for basilar artery - SCA junction aneurysms. Vascular neoplasms like haemangioblastomas, cerebellar masses, tentorial tumours, meningiomas frequently affects the SCA. Superficial temporal artery and peripheral branch of superior cerebellar artery is anastomosed for stenosis of the proximal or midsection of basilar artery.

Name	Year	Fetal type of PCA			
		Total	Bilateral	Right	Left
Windle	1888	24%	4%	11%	9%
De Vriese	1905	28%	-	20%	8%
Blackburn	1907	22%	10%	7%	5%
Von Mitter Wallner	1955	19%	3.6%	9.7%	4.7%
Present study	2017	13%	-	5.6%	7.4%

Windle has noted fetal type of posterior cerebral artery in 24% of cases, De Vriese in 28%, Blackburn in 22%. In the present study fetal type was noted in 6.5% of cases and in 86% of cases both recent and transitional type of posterior communicating artery was seen. 11% of cases exhibited a common trunk of origin of both posterior cerebral artery and superior cerebral artery posterior cerebral artery subserves the function of vision and many ocular functions like pupillary reflexes, eye movements, visual memory, binocular and visual spatial integration. It is commonly involved in malignant gliomas, astrocytomas, choroid plexus papillomas, cerebral angiomas.

Anastomoses of external carotid artery and posterior cerebral artery is been successfully performed with a Saphenous artery - vein graft for treatment of stenosis of basilar artery. Trans-sylvian pterion approach is suggested for treatment of basilar apex aneurysms. Posterior communicating artery aneurysms may cause cranial nerve palsies especially of 3 rd cranial nerve resulting in Weber's syndrome. Clipping or ligation of the neck of aneurysm has been suggested for successful treatment.

Fetal type of posterior communicating artery acts like an impediment to the blood supply of respective hemispheres and opposite hemisphere gets a better blood supply being supplied by both the basilar artery and inferior cerebellar artery.

CONCLUSION AND SUMMARY: The basilar artery was studied with regards to the variations in the branching pattern, origin and termination. The basilar artery formation was as caudal as 15 mm and as cranial as 5 mm above the ponto-medullary junction. The variations in the origin of the basilar artery was seen in 35.2% of the cases and in 64.8% the origin was normal (Left vertebral artery was greater than the right vertebral artery).

The length of the basilar artery varied from a minimum of 25 mm to a maximum of 38 mm. The basilar artery bifurcated as caudal as 4 mm and as cranial as 10 mm from the ponto-mesencephalic junction. Variations of anterior inferior cerebellar artery were more on the left side (9.3%) with regards to hypoplasia, where as more on the right side for duplication (9.3%). Overall the percentage variation of AICA noted was 13.9%. Fetal type of posterior cerebral artery was more on the left side and overall percentage variations of posterior cerebral artery noted was 17.6%.

A very sincere attempt has been made studying the 20 brain specimens in detail, hoping this work would be of some help to the neurovascular surgeons and radiologist while performing surgeries of the basilar artery and during interventional radiology for better interpretation, diagnosis and treatment.

ACKNOWLEDGEMENT: We the authors are thankful to Dr. P. Bapuji, M.S., professor and HOD, department of Anatomy, and Dr. Uma Maheswara Rao, M.D.,D.Ch., principal, Alluri Sitarama Raju Academy of Medical Sciences, Eluru for their valuable suggestions and support.

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