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Variations in the branches of basilar artery in adult human cadavers

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ABSTRACT

Various variations of branches of the basilar artery are mentioned in the literature but the exact cause is not known. Anomalies of the vertebro-basilar vessels arise as early embryonic developmental deterioration. Many studies are available on the anterior circulation of the brain but studies on the posterior circulation are very few. Hence the present study is concentrated on morphological variations in branches of the basilar artery. The anterior inferior cerebellar arteries appear normal except one hypoplastic seen on left side. Many labyrinthine or internal auditory arteries arise from the anterior inferior cerebellar artery (60% on right and 65% on left). Numbers of the pontine branches on right side ranges from 3-7 and on left side numbers of branches are 4-7. Most of the superior cerebellar arteries arise from the basilar artery (85% on right and 80% on left). Variation in the superior cerebellar artery is unilateral duplication. Bilateral duplication of the superior cerebellar artery and the superior cerebellar artery arising from the posterior cerebral artery was also seen. The posterior cerebral artery most commonly appear as adult type (75% bilaterally), fetal type was seen more common on left side and transitional types was seen more common on right side. Neurosurgical importance of this study lies during the exposure of the region for different purposes. Knowledge of variations will increase the success of the surgical and radiological procedures.

Key words: anterior inferior cerebellar artery, basilar artery, internal auditory artery, labyrinthine artery, posterior cerebral artery, pontine artery, superior cerebellar artery

Introduction

The basilar artery is a large median vessel formed by the union of the vertebral arteries. It gives the following branches on either side 1) Pontine branches; 2) Anterior inferior cerebellar artery; 3) Internal auditory (Labyrinthine) artery; 4) Superior cerebellar artery; 5) Posterior cerebral artery. The pontine branches are numerous small branches which arise from the front and sides of the basilar artery along its course and supply the pons. The internal auditory (labyrinthine) artery the long slender branch has a variable origin. It usually arises from the anterior inferior cerebellar artery. The anterior inferior cerebellar artery is given off from the lower part of the basilar artery and runs posterolaterally, usually ventral to the abducent, facial and vestibulocochlear nerves.

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The superior cerebellar artery arises near the distal portion of the basilar artery, immediately before the formation of the posterior cerebral arteries. It passes laterally below the oculomotor nerve, which separates it from the posterior cerebral artery, and curves round the cerebral peduncle below the trochlear nerve to gain the superior cerebellar surface. The posterior cerebral artery is a terminal branch of the basilar artery. Surgical nomenclature divides the vessel into three parts or segments: P1 – from the basilar bifurcation to the junction with the posterior communicating artery; P2 – from the junction with the posterior communicating artery to the portion in the perimesencephalic cistern; and P3 – the portion that runs in the calcarine fissure. An annular network of leptomeningeal arteries arise from the vertebral and basilar arteries and embrace the cerebellum and brain stem. The meningeal arteries so formed have been classified into three groups, namely paramedian, short circumferential and long circumferential arteries. They can be distributed both supratentorially and infratentorially, and all give off fine side branches and end as penetrating arteries. Infratentorial meningeal

arteries are very variable. The paramedian arteries, after arising from the basilar or vertebral arteries, penetrate the brain stem directly. The short circumferential arteries end at the lateral surface of the brain before penetration and the long circumferential arteries later form the range of cerebellar arteries. These vessels, arranged as a series of loops over the brain, arise from the brain stem vessels on the base of the brain.[1]Various variations of branches of the basilar artery are mentioned in the literature. Many variations in position of arteries of the vertebro-basilar system and the loop formation are quoted in the literature, but the exact cause is not known. Ageing and haemodynamic factors have been postulated as a probable reasons.[2] Anomalies of the vertebrobasilar vessels arise as early embryonic developmental deteriorations. The majority of them are seen in position, origin and shape of the vertebral and or basilar arteries.[3]The microsurgical anatomy of the posterior circulation is very complex and variable. Surgical approaches to this area are considered risky due to the presence of the various important blood vessels and neural structures. Many authors have documented various anomalies as well as differences of the anatomy in this area in the Indian population as compared to the Western literature.[4] Prior knowledge of possible anatomical variations can prevent inadvertent trauma & bleeding to a very great extent.[5]

Many studies are available on vessels of the anterior circulation of the brain i.e. on vessels of the circle of Willis but studies on the posterior circulation are very few. Such studies so far had been done mostly in the American and European races and are mostly based on imaging techniques. Studies in the Indian population have been few. Hence the present study is concentrated on the morphological variations of the branches of the basilar artery of human adult cadaver brain, to show the frequency and type of anomalies in branches of the basilar artery.

Material and methods

In present study the basilar artery is studied by dissection method[6] in 40 human adult brain specimens from embalmed human cadavers collected from various medical colleges of Maharashtra. Male, female differentiation was not made while collecting the data since numbers of female cadavers was less. Branches of the basilar artery were studied. Variations in the branches of basilar artery were noted and photographed.

Results

Table 1: Incidence of variation in the anterior inferior cerebellar artery

Anterior inferior cerebellar artery		Right	Left
Normal	Specimens	40	39
	Percentage	100%	97.5%
Hypoplastic	Specimens	0	1
	Percentage	0%	2.5%

Chi-square test value for left side=36.1, DF=1, P<0.01 (highly significant)

Figure 1: Arrow showing hypoplastic left anterior inferior cerebellar artery

Table 2: Variation in the Internal auditory (Labyrinthine) artery

Origin of the Internal auditory (Labyrinthine) artery			Normal from BA	From AICA	Other variation
Total	Right	Specimens	16	24	0
		Percentage	40%	60%	0%
	Left	Specimens	14	26	0
		Percentage	35%	65%	0%

Chi-square test value for right side=1.6, DF=1, P>0.05 (not significant), Chi-square test value for left side=3.6, DF=1, P>0.05 (not significant).

Table 3: Number of pontine branches

Number of pontine branches	Right	Left
Mean ± S.D.	4.5±0.75	4.7±0.83
Maximum	7	7
Minimum	3	4

Table 4: Variation in the Superior cerebellar artery

Variation in SCA	Right		Left	
	Specimen	Percentage	Specimen	Percentage
Normal arising from BA	34	85%	32	80%
Unilateral duplication arising from BA	3	7.5%	5	12.5%
Unilateral duplication with one SCA arising from PCA	0	0%	2	5%
Unilateral duplication with both arising from PCA	1	2.5%	0	0%
Single SCA arising from PCA	0	0%	1	2.5%
Bilateral duplication	1 (2.5%)			

Chi-square test value on right side=80.69, DF=3, P<0.01 (highly significant), Chi-square test value on left side=87.65, DF=4, P<0.01 (highly significant)

Figure 2: Arrow showing duplication of the left superior cerebellar artery.

Figure 3: Arrow showing the bilateral duplication of the superior cerebellar artery.

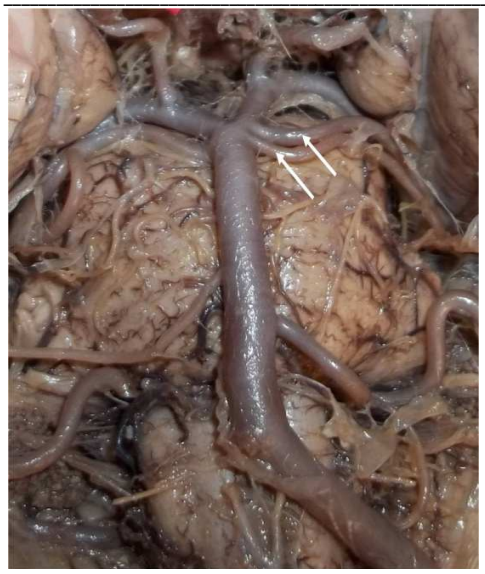

Figure 4: Arrow showing duplication of the superior cerebellar artery on the left side. Upper superior cerebellar artery is arising from the left posterior cerebral artery and lower superior cerebellar artery is arising from the basilar artery.

Figure 5: Arrow showing duplication of the superior cerebellar artery on right side. Both of the superior cerebellar arteries arising from the right posterior cerebral artery. The left superior cerebellar artery is arising from the left posterior cerebral artery and left posterior cerebral artery shows the fetal type here.

Table 5: Variation in the Posterior cerebral artery

Variation in the posterior cerebral artery	Adult type	Fetal type	Transitional type
Right	3	2	4
Percentage	7.5%	5%	10%
Left	6	4	1
Percentage	15%	10%	2.5%
Bilateral	30	2	0
Percentage	75%	5%	0%

Chi-square test value=23.78, DF=2, P<0.01 (highly significant)

Figure 6: Arrow showing bilateral fetal type of the posterior cerebral artery. The posterior communicating artery is larger in diameter than the pre-communicating part of the posterior cerebral artery on both sides

Discussion

In the present era of microscopic and neuroendoscopic procedures, the surgical anatomy of the skull base vessels has gained increased significance. Branches from the vertebro-basilar and postrerior cerebral arteries supply the different parts of the brain stem-the vertebral for the medulla, the basilar for the pons, and the posterior cerebral for the mid brain.[7] Variations of the vertebral artery, the basilar artery, or their branches are the rule rather than the exception.[8] Anomalies of the vertebrobasilar vessels arise as early embryonic developmental deteriorations.[3]The origin of the anterior inferior cerebellar artery may be single, duplicate or triplicate. Bilateral or unilateral absence had also been noted. Anomalous origin of the anterior inferior cerebellar artery from the internal carotid artery had been reported several times. In some cases, the posterior inferior cerebellar artery arose by a common trunk with the anterior inferior cerebellar artery.[9] Sunderland[10] (1948) noted bilateral duplication of the anterior inferior cerebellar artery in 1.9% cases. Unilateral duplication was noted in 5.2% cases, out of it duplication on right side in 1.9% cases and duplication on left side in 3.3% cases. Hollinshead[8] (1961) quoted duplication of the artery in 0.6%, absence bilaterally in 0.6% and on left in 1.3% cases. Harrigan, Deveikis, Ardelt[11] (2009) quoted solitary artery in 72%, duplication in 26% and triplication in 2% cases. In present study, solitary trunk is noted in 100% cases on right and 97.5% cases on left. Hypoplastic artery[4] (diameter <0.5mm) is noted in 2.5% cases on left side. No other variation like duplication, triplication, absence or origin from the other vessel than the basilar artery is noted. The internal auditory artery is most often a branch of the anterior inferior cerebellar artery but may arise directly from the basilar artery.[9] Sunderland[10] (1948) noted that in 17% cases the internal auditory (Labyrinthine) artery arises from the basilar artery and in 83% cases from the anterior inferior cerebellar artery. Harrigan, Deveikis, Ardelt[11] (2009) quoted that in 16% cases the internal auditory (Labyrinthine) artery arises from the basilar artery, in 45% cases from the anterior inferior cerebellar artery and in 25% cases from the superior cerebellar artery. In present study 40% cases on right and 35% cases on left the internal auditory (Labyrinthine) artery arises from the basilar artery and in 60% cases on right and 65% cases on left the internal auditory (Labyrinthine) artery arises from the anterior inferior cerebellar artery. Origin from the superior cerebellar and other arteries is not seen in the present study. Variations in the pontine branches are not seen but their numbers supplying the region is very variable. Luzsa[12] (1974) quoted 3-5 pontine branches arises from the basilar artery on each side. In present study we has seen that on right side 3-7 branches and on left side 4-7 branches arises from the basilar artery.

The superior cerebellar artery also may be single, duplicate or triplicate at origin. Although rare, absence of the superior cerebellar artery had been reported.[9] Hollinshead[8] (1961) quoted duplication of the superior cerebellar artery on right side in 12%, on left side in 16% and bilaterally in 3% cases. Songur et al[13] (2008) noted duplication on right in 14.5% and on left in 12.7% cases. Common trunk with the posterior cerebral artery on right side in 6.3% and on left in 10% cases. Aydin et al[14] (2011) noted the superior cerebellar artery arising from the posterior cerebellar artery bilaterally in 5% cases. Garcia-Gonzalez[15] (2012) noted the superior cerebellar artery arises as single trunk in 90% cases. In present study the superior cerebellar artery arises as single trunk from the basilar artery in 85% on right and 80% on left , as unilateral duplication from the basilar artery in 7.5% on right and 12.5% on left, as unilateral duplication with one of the superior cerebellar artery arising from the posterior cerebral artery in 5% cases on left side, as unilateral duplication from the posterior cerebral artery in 2.5% cases on right side, as bilateral duplication in 2.5% cases and arising as single trunk with the posterior cerebral artery in 2.5% cases on left side.Three types of the posterior cerebral artery are noted by the researchers. In the foetal type, the diameter of the ipsilateral pre communicating (P1) segment of posterior cerebral artery is less than the diameter of posterior communicating artery. In transitional type, the posterior communicating artery is equal in diameter to the P1 segment of the posterior cerebral artery. And in the adult type P1 segment has a diameter larger than the posterior communicating artery.[16] Common trunk of origin of the posterior cerebral artery and the superior cerebellar artery is also noted in the literature.[9] Overbeeke, Hillen and Tulleken[17] (1991) studied the posterior cerebral artery and noted adult type of posterior cerebral artery in 84%, fetal type in 14% and transitional type in 4% cases. Pai et al[4] (2007) seen adult type in 56%, transitional type in 24% and fetal type in 20% cases. DeSilva et al[16] (2009) noted adult type on right side in 4.4%, on left side in 4.4% and bilaterally in 88.8% cases. Fetal type was noted on right side in 2.6%, on left side in 3.5% and bilaterally in 1.3% cases. Transitional type was noted on right side in 1.7%, on left side in 0.8% and bilaterally in 0.9% cases. Poudel and Bhattarai[18] (2010) has found the adult type in 91.4% and fetal type bilaterally in 8.6% cases. In present study adult type was seen on right side in 7.5%, on left side in 15% and bilaterally in 75% cases. Fetal type was seen on right side in 5%, on left side in 10% and bilaterally in 5% cases. Transitional type was noted on right side in 10% and on left side in 2.5% cases. Such different variations are seen in the branches of the basilar artery.

Conclusion

Neurosurgical importance of this study lies during the exposure of the region for different purposes. Knowledge of the vascular variations will increase the success of the surgical procedures and radiological procedures used in interventional radiology. Variations in the morphology of the basilar artery are common. Knowledge of anatomy of the basilar artery and variations in them is important for dealing with cerebro-vascular diseases which is one of the leading problems of the modern lifestyle.

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List of abbreviations

AICA- Anterior inferior cerebellar artery
BA- Basilar artery
SCA- Superior cerebellar artery
IAA- Internal auditory (Labyrinthine) artery
PCA- Posterior cerebral artery
VA- Vertebral artery
PCoA- Posterior communicating artery

P1- First segment of posterior cerebral artery from the basilar bifurcation to the junction with the posterior communicating artery
P2- Second segment of posterior cerebral artery from the junction with the posterior communicating artery to the portion in the perimesencephalic cistern
P3- Third segment of posterior cerebral artery is the portion that runs in the calcarine fissure

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