

A Study of Variations in the Posterior Inferior Cerebellar Artery

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Abstract

Background: Posterior inferior cerebellar artery and its branches supply extensive and vital areas of the nervous system. This vessel is reported as the most variable cerebellar artery in the literature. The knowledge of normal anatomy as well as variations in this artery is of utmost importance to help diagnosis and treatment of vascular lesions as well as space occupying lesions in the region of its distribution. *Aims and Objectives:* To study the normal gross anatomy and development of posterior inferior cerebellar artery, with incidence of variations and their embryological correlation. *Materials & Methods:* The posterior inferior cerebellar artery was studied by digital subtraction angiography. The procedure of digital subtraction angiography was performed in Department of Radiology of a tertiary care hospital of Mumbai in 102 consecutive subjects on both sides. *Results:* A significant number of variations were observed in origin, course and distribution of the posterior inferior cerebellar artery in this study. *Conclusion:* This study confirms as well as adds to the knowledge of the existing literature on posterior inferior cerebellar artery and assists interventional radiologist, neurosurgeons and neurologist in diagnosis and treatment of cerebrovascular diseases.

Keywords: Posterior Inferior Cerebellar Artery (PICA); Anterior Inferior Cerebellar Artery (AICA), Variations.

Introduction

The posterior inferior cerebellar artery (PICA) arises from the vertebral artery at the anterolateral aspect of the brainstem, near the inferior olive. Numerous authors have described variations in origin, course and vascular distribution of PICA [1-13]. Despite many variations of this artery, Hauge 1954 [11] described the standard course comprising of a caudal loop at the lower part of the tonsil and the cranial loop coinciding with its upper border. Huang and Wolf in 1969 [11] divided the main trunk of PICA into four segments. Anterior medullary, lateral medullary, posterior medullary and supratonsillar segment of the vessel have been designated the names according

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to their relation to medulla oblongata and cerebellar tonsil respectively. The PICA gives of perforating, choroidal and cortical branches and terminates by dividing into inferior medullary and cerebellar hemispheric arteries.

The long tortuous course of PICA is related to medulla, fourth ventricle, cerebellar tonsil, vermis, and cerebellar hemisphere, so that displacement or distortion may be deduced from careful study of this vessel. It is possible to localize these structures because of the characteristic configuration of this vessel in relation to them. Unfortunately this artery more than any other artery in the posterior fossa is subjected to many variations, which may cause difficulties in diagnosis. Thus this study was done to evaluate the vessel for variations using the advanced technique of digital subtraction angiography which will help the investigators to diagnose and treat cerebrovascular diseases.

Materials and Methods

The posterior inferior cerebellar artery was studied

by digital subtraction angiography. The radiological procedure was performed in the Department of Radiology of a tertiary care hospital of Mumbai. The study was done in 102 consecutive subjects who underwent the procedure on both sides. Age of the subjects ranged from 3 years to 75 years and most of the subjects were having cerebrovascular diseases. Of the 102 patients, 57 were males and 45 were females.

The origin, course, termination and branches of the artery were studied for variations. The data collected has been analysed and discussed.

Results

The posterior inferior cerebellar artery (PICA) was studied by digital subtraction angiography in 102 subjects who underwent the procedure on both sides. The origin, course, termination and branches of 204 PICAs were evaluated for variations.

In this study of 102 subjects, 27 subjects (26.47%) showed variations in right or left or both sides of PICA, while 75 subjects (73.53 %) had normal vessel on both sides (Table 1 and Chart 1).

In the 27 subjects with variations, 13 subjects (12.75%) were with variation in the right PICA, 11 subjects (10.78%) were with variation in left PICA, and 3 subjects (2.94%) showed variations in both PICAs (Table 2 and Chart 1).

The angiograms of PICA examined in this study showed variations in origin of the vessel. PICA originated as a continuation of vertebral artery in 3 subjects (2.94%), 2 subjects (1.96%) on right side and 1 subject (0.98%) on left side. Vertebral artery terminated into PICA and a small branch to fill basilar artery. This variation was seen in 4 subjects (3.92%), 2 subjects (1.96%) on right side and 2 subjects (1.96%) on left side. Vertebral artery terminating into PICA and a posterior meningeal branch was seen in 1 subject (0.98%) on right side (Table 3 and Chart 2).

Table 1: Incidence of findings observed in PICA in total examined subjects

Sr. No.	Subjects	NOS	%
1	PICA with variations	27	26.47
2	PICA without variations	75	73.53

Table 2: Incidences of findings in PICA with variations in 27 subjects examined out of 102 subjects

Sr. No.	Subjects with	NOS	%
1	Variations only in Rt PICA	13	12.75
2	Variations only in Lt PICA	11	10.78
3	Variations in both PICAs	3	2.94

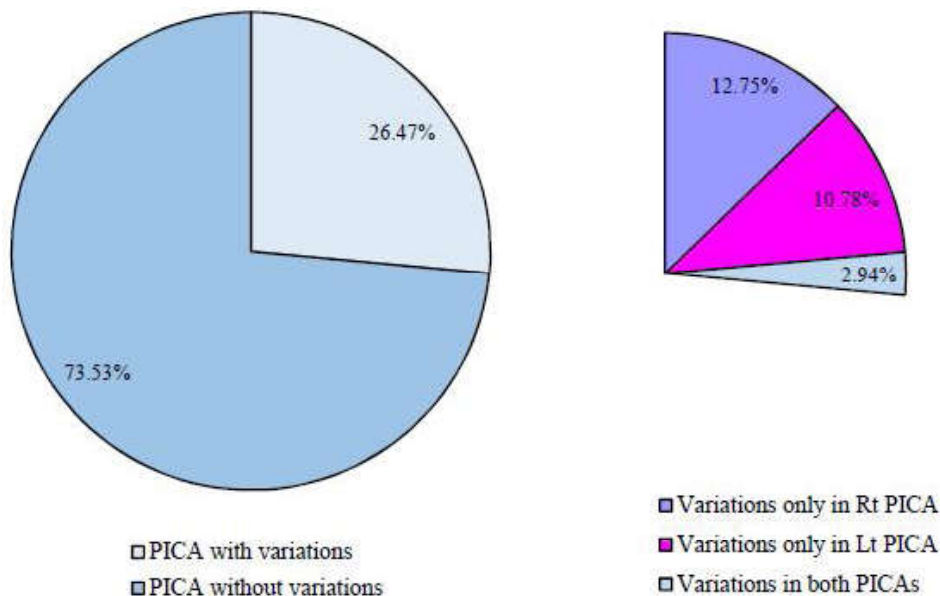


Chart 1: Incidence of variations in PICA in examined subject

There were cases in which AICA and PICA originated as a common trunk from basilar artery. This variation was seen in 14 subjects (13.72%) of the 102 subjects. The variation was seen on right side in 8 subjects (7.84%), on left side in 4 subjects (3.92%) and on both sides in 2 subjects (1.96%). In 1 subject (0.98%) on left side AICA and PICA originated as a common trunk from vertebral artery. Proximal origin

of PICA at C1C2 level of cervical vertebra was observed in 1 subject (0.98%) (Table 3 and Chart 2).

PICA was absent on left side in 2 subjects (1.96%) and in them right PICA supplied both PICAs territory. In 1 subject (0.98%) both AICAs were absent and PICAs supplied their territory.

Chart 2 shows the incidence of variations in PICA.

Table 3: Incidence of variations in origin of PICA

Sr. No.	Variation in origin of PICA	Rt.		Lt.		Both	
		NOS	%	NOS	%	NOS	%
1	PICA as continuation of vertebral artery	2	1.96	1	0.98	-	-
2	VA terminating as PICA and a small branch to BA	2	1.96	2	1.96	-	-
3	VA terminating as PICA and a small posterior meningeal artery	1	0.98	-	-	-	-
4	AICA-PICA common trunk from BA	8	7.84	4	3.92	2	1.96
5	AICA-PICA common trunk from VA	-	-	1	0.98	-	-
6	Proximal origin of PICA at C1C2 level	-	-	1	0.98	-	-

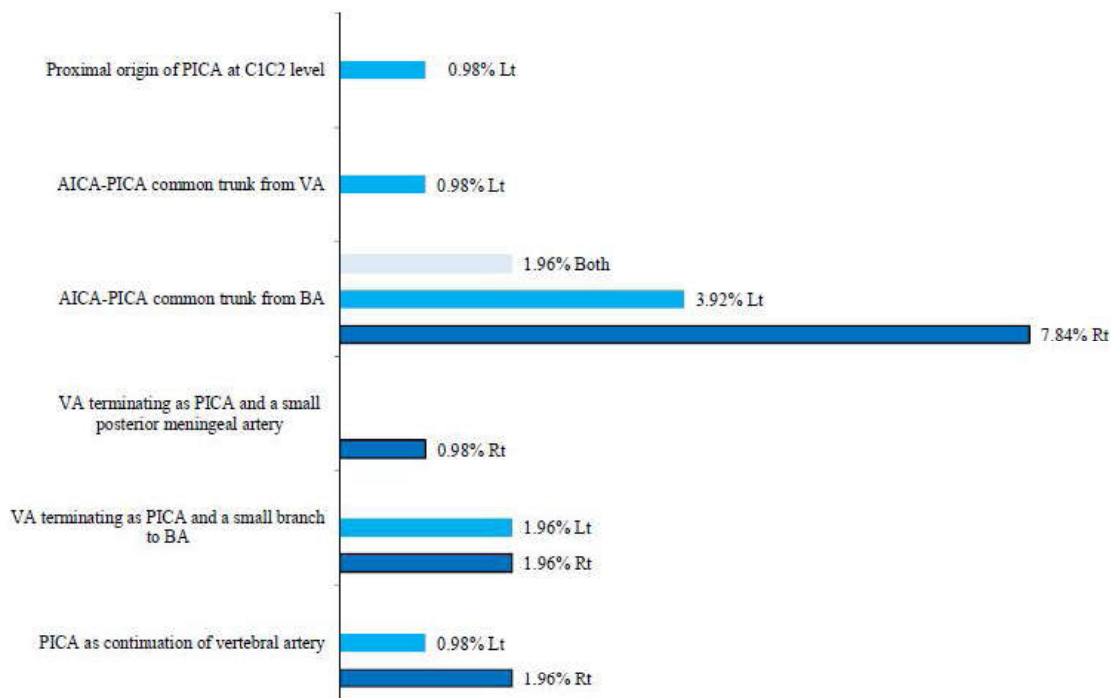


Chart 2: Incidence of variations in PICA

Discussion

The posterior inferior cerebellar artery (PICA) is normally a branch of distal part of intradural vertebral artery. Variations in the origin of PICA are reported frequently in the literature. Significant number of cases of PICA originating as a continuation of vertebral artery are reported [10, 12]. Berry and Anderson 1910 [10] described the autopsy findings in a case of non-union of the vertebral arteries. One vertebral artery was extremely large and supplied the whole of the

vertebro-basilar system apart from the PICA on opposite side. The contralateral vertebral artery was small and terminated in the PICA. They found only one similar case reported in literature, which for many years, subsequently showed scant reference to this variation. With the advent of the vertebral arteriography, this variation has been more frequently recognized. Morris 1962 [10] also reported 2 such cases of non-union of vertebral arteries. Krayenbuhl and Yasargil 1965 [10] and Osborn 1999 [12] stated that in 0.2% the vertebral artery fails to join the basilar artery on one side and thus terminates in the PICA

and the opposite vertebral artery provides most of the posterior fossa blood supply.

In present study the incidence of PICA originating as a continuation of vertebral artery is similar to earlier reports. But in literature there are no reports of cases as vertebral artery terminating into PICA and a small branch to fill basilar artery Figure 1 and vertebral artery terminating into PICA and a small posterior meningeal artery, however in this study such cases were observed.



Fig. 1: Showing Lt vertebral artery terminating into PICA and a small branch to basilar artery

Level of origin of PICA from vertebral artery varies from vertebrobasilar junction to below the foramen magnum as low as C1, C2 or C3 [4, 5, 6, 9, 11, 12]. Newton, Potts 1974 [11] described PICA on a study based on an analysis of forty cerebellar hemispheres and compared the data with a hundred normal vertebral arteriograms. In their study they reported that in the necropsy material PICA originated from the vertebral artery at an average distance of 16mm, below origin of basilar artery and in 2 cases origin was at vertebrobasilar junction. In their study of arteriograms, PICA originated at an average of 13mm below the origin of basilar artery. In relation to the foramen magnum, in 18% of arteriograms PICA originated below the foramen magnum, in 4% at the level of the foramen magnum, in 57% it arose above the foramen magnum. Hollinshead 1982 [4] stated that PICA usually arises from the vertebral artery but varies in the level of its origin, and may even arise from the basilar artery. Lasjaunias et al 1987 [5], 1990 [6] reviewed the earlier gross anatomy descriptions of PICA and stated that PICA is the most variable cerebellar artery. They also reported the possible variations C1, C2, C3 origins of PICA. Osborn 1999 [12] stated that an extradural origin of the PICA occurs in 5% to 18% of cases in which PICA originates from the extracranial vertebral artery and then courses

superiorly through the foramen magnum. He added that a third of all cases PICA originate from intradural vertebral artery and in unusual cases the PICA may originate as low as C1, C2 level.

In this study a proximal origin of PICA at C1C2 level of cervical vertebra was observed in a subject.

Atkinson 1949 [1] described the AICA variations, along with the corresponding PICA variations. He studied the variations and findings in a series of consecutive necropsies and stated that, not only each case is different but there is usually a difference between either side in an individual case. He also found that the variation in the size of AICA was in inverse proportion to the size of PICA and sometimes to that of vertebral artery. He quoted about common AICA-PICA trunk arising from either basilar artery or vertebral artery. Osborn 1999 [12] stated that a shared AICA-PICA trunk is a common normal variant and occasionally a single trunk supplies both PICAs.

A significant number of cases were observed in this study having AICA-PICA originating as a common trunk from basilar artery Figure 2 and AICA-PICA originating as a common trunk from vertebral artery.

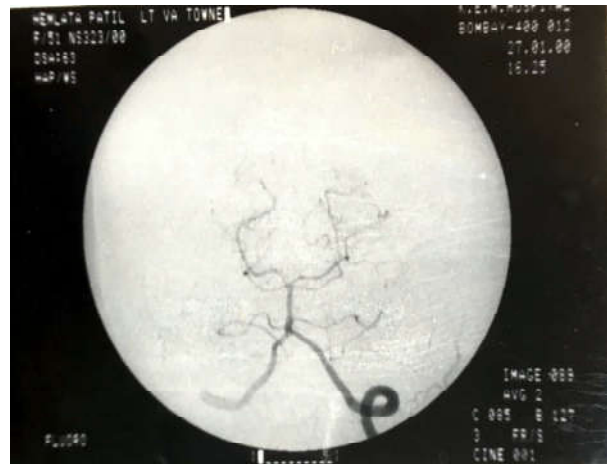


Fig. 2: Showing AICA - PICA common trunk from basilar artery

Stopford 1916 [4] observed absence of PICA bilaterally in 3%, absence on right in 15%, absence on left in 6% and also emphasized the variation in distribution of PICA. Krayenbuhl and Yasargil in 1957 [11] and Takahashi et al 1968 [11] stated the occasional absence of PICA. Crosby et al 1962 [13] stated that in these instances of absence of the PICA, the AICA supplies the territory. The entire inferior cerebellar hemisphere may be supplied by the contralateral PICA. Sometimes a single stem takes the place of both AICA and PICA. In Newton, Potts 1974 [11] anatomic studies PICA was absent in 6 hemispheres (15%), hypoplastic in 2 hemispheres

(5%). In their study of arteriograms, PICA was absent in (20%), of the cases. AICA supplied PICA territory in majority of cases, 1 hemisphere was supplied by both AICA and superior cerebellar artery, 2 hemispheres were supplied by the superior cerebellar artery alone. In 5% hypoplasia of the PICA, accessory blood supply from the AICA was noted. Lasjaunias et al 1987 [5], 1990 [6] reviewed the earlier gross anatomy descriptions of PICA. They stated that PICA is the most variable cerebellar artery and the vessel is reported to be absent in high percentage of cases and PICA hemispheric supply is from AICA.

In present study absence of PICA was observed on one side in two subjects and in them contralateral PICA supplied both PICAs territory (Figure 3a, 3b). Also angiogram showing both AICAs absence and PICAs supplying their territory was seen. Hypoplastic PICA was not observed in this study.

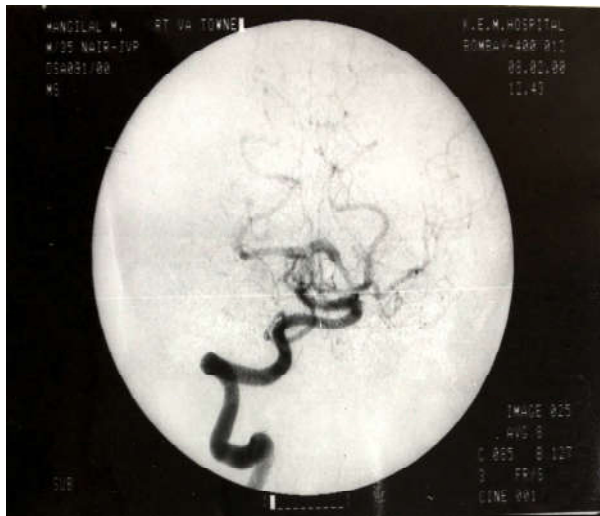


Fig. 3a: Showing normal origin of Rt PICA from Rt vertebral artery, supplying both hemispheres



Fig. 3b: Showing Absence of Lt PICA

Anatomic or angiographic reports of cerebellar arteries arising from the internal carotid artery are present but rare. Newton, Potts 1974 [11] and Haughton 1978 [3] reported origin of PICA from the internal carotid artery. Lasjaunias et al 1981 [7] reported a case of PICA originating from the ascending pharyngeal artery and gave its embryological mechanism. Osborn 1999 [12] stated that PICA origin from posterior meningeal artery or the internal carotid artery as uncommon. He also quoted about duplicated PICA that arises as two or more vessels instead of a single dominant trunk, has been identified in 2% of anatomic dissections.

In this study these rare origins of PICA or a duplicated origin of PICA were not observed.

Lasjaunias et al 1987 [5], 1990 [6] has given the embryological explanation for the occurrence of variations in the posterior inferior cerebellar artery. In embryos between 20 and 44mm, both anterior and posterior inferior cerebellar arteries are represented by vessels that terminate in the large choroid plexus of the fourth ventricle. Before 40mm stage the arteries are usually identified tentatively only as larger and longer than numerous other branches of the basilar and vertebral arteries that supply the hindbrain region. These transverse branches are often connected by longitudinal remnants of prominent lateral channel (the primitive lateral vertebrabasilar anastomosis). This channel parallels the intracranial part of the primitive vertebral artery and the basilar artery. The arteries of the embryonic medulla therefore present somewhat plexiform appearance. This development process explains the varied origin of the anterior and posterior inferior cerebellar arteries in the adult.

The course of PICA has been described by numerous authors Stopford 1916, Sjogren 1953, Hauge 1954, Krayenbuhl and Yasargil 1957, Crosby et al 1962, Gray 1962, Wolf et al 1962, Greitz and Sjogren 1963, Huang and Wolf 1969, Stephens and Stilwell 1969 [11].

Mones 1961 [9] performed a study to evaluate vertebral angiography as a diagnostic tool. Mones reported these PICA findings by studying lateral views of 79 vertebral angiograms. PICA was above the foramen magnum throughout in 56 subjects, started below the foramen magnum in 8 subjects, gradually looped below the foramen magnum from above in 10 subjects and had a sharp loop below the foramen magnum from above in 5 subjects. Wolf et al 1962 [13] described the course of PICA angiographically. He stated that despite numerous variations it is possible to select a configuration of the PICA in both lateral and anteroposterior projections, which can be considered as typical or

standard and helps in localization of expanding lesions. Greitz and Sjogren 1963 [2] studied anatomy of PICA at autopsy by dissection and postmortem angiography and at vertebral angiography in living subjects in normal and pathological conditions. They stated that PICA and its branches although subject to numerous variations have a constant relationship to certain brain structures, which enables diagnosis of posterior fossa lesions. Margolis and Newton 1972 [8] studied PICA by correlating the gross and angiographic anatomy, and stated that the origin, course and distribution of the PICA vary considerably.

This study confirms the findings of earlier studies which state that PICA and its branches are a subject to numerous variations and despite the variations the vessel shows a standard course.

Conclusion

The literature states that the occurrence of variations in the posterior inferior cerebellar artery are very common and this study further confirms and adds to the documentation in the literature. To evaluate this vessel a interventional radiologist should have knowledge of normal anatomy and variations in the vessel with their embryological correlation. This knowledge will also help the neurosurgeons and neurologists to investigate and treat the cases of cerebrovascular diseases and space occupying lesions.

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