Infratentorial Vascular Anatomy

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The posterior cerebral circulation is comprised of the distal vertebral arteries that join to form basilar artery at the level of the anterior aspect of the medulla oblongata. The basilar artery ends by bifurcating in two posterior cerebral arteries that functionally are a part of the supratentorial circulation (as described in Chap. 3).

The arteries of the posterior circulation are considerably more variable than the supratentorial arteries. The cerebellar arteries ideally form in a bilateral symmetric fashion, but often cerebellar arteries are very small or fail to form at all. Arteries are usually tortuous, and this makes it even more difficult to recognize them on angiography images. In this chapter, we will describe arteries of the cerebellum, brainstem, and basal ganglia [1–6].

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9.1 Major Infratentorial Arteries

9.1.1 Brainstem

The brainstem is vascularized mainly by the basilar artery. The basilar artery arises from the conjunction of the two vertebral arteries at the base of the medulla oblongata. The vertebrobasilar axis and the cerebellar arteries provide for arterial supply of the brainstem, cerebellar hemispheres, and the vermis. Its main branches include:

- Median and paramedian perforating arteries: these perforators penetrate in the brainstem close to and around the anterior sulcus of the brain stem.
- Short (anterolateral) and long (lateral) circumferential arteries: these arteries penetrate in the brainstem more laterally and are also known as collicular arteries in the mesencephalon, short and long pontine arteries, and anterolateral bulbar arteries.

9.1.2 Cerebellum

The cerebellum is vascularized by the distal portion of the cerebellar arteries that—after surrounding the brainstem—spread over to the cerebellar hemispheres and the vermis (Figs. 3.13, 9.1 and 9.2).

Superior cerebellar artery (SCA) arises from the basilar artery in front of the mesencephalon

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just before its bifurcation. It may be a single trunk or a double trunk arising symmetrically from the basilar artery. It passes laterally around the mesencephalon under the third and the fourth cranial nerves. Branches are:

- Marginal artery of the SCA: it is the first cortical branch of the SCA. It arises outside the cerebellar-mesencephalic fissure before the bifurcation of the common trunk. It usually is inconstant, and its importance depends mostly on the concomitant hypoplasia of AICA with whom is anastomosed to supply the anterior hemispheric surface (petrous surface) of the cerebellum. Direct perforators to the middle cerebellar peduncle arise from it.

The ramification of the main trunk of the SCA in its cranial and caudal branches and the emergence of precerebellar arteries take place inside the cerebellar-mesencephalic fissure.

- Precerebellar arteries: these arteries supply the deep territory of the SCA.
- Superior vermian arteries: these are typically two and arise from the cranial (or medial) branch of the SCA and anastomose posteriorly with the inferior vermian arteries of the PICA. They distribute to the superior vermis (and the cerebellar hemisphere close to the paravermian region).
- Cortical arteries: these arise from the hemispheric branch (or lateral) and reach the rest of the cerebellar hemispheric surface (tentorial surface). The most common pattern is the three hemispheric arteries: anterior, medial, and posterior that distribute evenly along the hemispheres.

Anterior inferior cerebellar artery (AICA) originates at the level of the pons, just below the sixth cranial nerve and alongside the seventh and the eighth cranial nerves, reaches the middle cerebellar peduncle, and ends at the level of the petrous surface of the cerebellum. The AICA remains very close to the pons, close to the pontine-bulbar sulcus, and reaches the lateral recess of the fourth ventricle at the level of foramen of Luschka. Branches are classified as follows:

- Perforating arteries of the brainstem.
- Choroidal arteries for the lateral segment of the choroidal plexus and arteries to the cranial nerves. After crossing the seventh and the eighth cranial nerves and after having crossed the foramen of Luschka, AICA surrounds the flocculus and reaches the cerebellopontine sulcus. It terminates at the level of the middle cerebellar peduncle into a rostral and a caudal branch and supplies the petrosal surface of the cerebellum.

The AICA originates in most cases as a single trunk; rarely however it may arise as two branches (duplication). The rostral trunk normally lies above the flocculus reaching the surface of the cerebellum-pontine fissure, whereas the caudal trunk lies inferiorly to the flocculus to supply the petrous surface of the cerebellum. If the PICA is absent, the caudal branch supplies almost the entire ipsilateral hemisphere and the inferior portion of the vermis.

Posteroinferior cerebellar artery (PICA) arises from the vertebral artery, the V4 intracranial segment. More rarely it may originate below the foramen magnum coursing in between the lower cranial nerves. It surrounds the cerebellar tonsils in the cerebello-medullary cistern. At this level, arteries that supply the choroid of the fourth ventricle and the dentate nucleus arise. From here it ascends toward the superior end of the tonsil, passes posteriorly to it to form a cranial loop. It divides into two branches; one reaches medially the inferior vermis, and the other courses laterally in the inferior aspect of the cerebellar lobes.

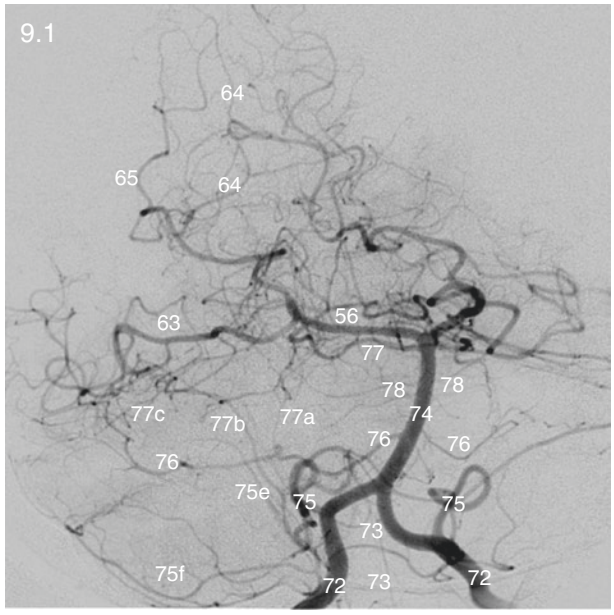

Fig. 9.1 Arteries of the posterior circulation and anterior spinal artery. Oblique projection

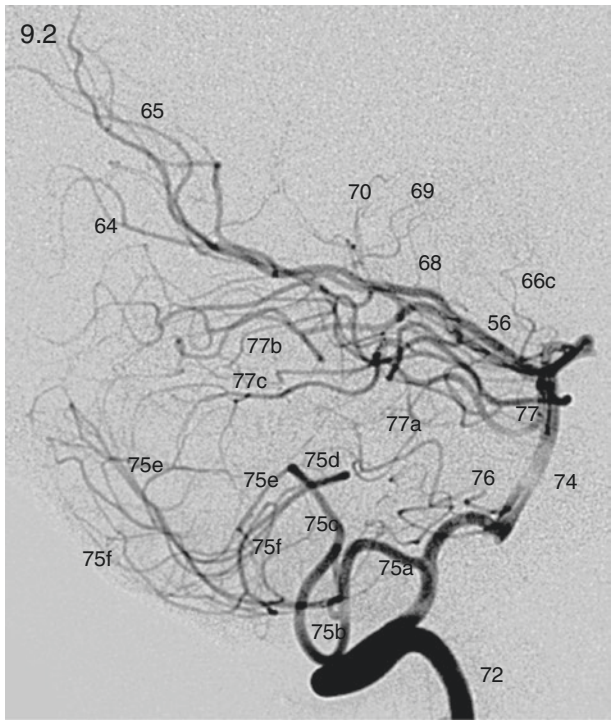

Fig. 9.2 Arteries of the posterior circulation and the posterior choroidal arteries. Lateral projection

56	Posterior cerebral artery (PCA)
63	Posterior inferior temporal artery
64	Parieto-occipital artery
65	Calcarine artery
66c	Perforating thalamic arteries, posterior thalamic or thalamoperforating arteries
68	Thalamogeniculate artery
69	Medial posterior choroidal artery
70	Lateral posterior choroidal artery
72	Vertebral artery (VA)
73	Anterior spinal artery (ASA)
74	Basilar artery (BA)
75	Posterior inferior cerebellar artery (PICA)
75a	PICA, bulbar segment
75b	PICA, tonsillar segment
75c	PICA, telo-velo-tonsillar segment
75d	PICA, cranial loop
75e	PICA, inferior vermian arteries
75f	PICA, hemispheric branches
76	Anterior inferior cerebellar artery (AICA)
77	Superior cerebellar artery (SCA)
77a	SCA, marginal artery
77b	SCA, superior vermian arteries
77c	SCA, hemispheric branches
78	Long pontine arteries

Of note, the degree of variability in the anatomy of the posterior circulation (point of origin of different arteries, the size of the PICA-AICA complex, degree of asymmetry, etc.) often leads to nonstandard vascularization of the brainstem and cerebellum.

9.1.3 Infratentorial Artery Pathology

Occlusion syndromes of the basilar artery:

- Locked-in syndrome (ventral pontine lesion): quadriplegia, aphonia without loss of conscious, and loss of all voluntary movements except for vertical eye movements and blinking
- Top of the basilar syndrome (infarct of the mesencephalon, thalamus, and bilateral parts of the occipital and temporal lobes): somnolence, hallucinations, memory loss, delirium, unilateral or bilateral loss of vertical gaze, nystagmus, oscillatory ocular movements, and visual deficits such as hemianopsia, cortical blindness, and Balint's syndrome (optic ataxia and simultanagnosia)

9.2 Major Infratentorial Veins

9.2.1 Superficial Veins of the Posterior Cranial Fossa

The superficial cortical veins are well recognized over the external surface of the cerebellum that can be further divided into three surfaces: tentorial, petrous, and the suboccipital (Figs. 9.3, 9.4, 9.5 and 9.6).

9.2.1.1 Cerebellar Tentorial Surface Territory

- Superior vermian veins
- Paramedian superior cerebellar veins (anterior group is at the level of the tentorial incisure that drain into the tentorial through the precentral vein, and the posterior group drains into the sinus torcular)
- Subtentorial veins of the lateral surface: cerebellar hemispheric veins drain into the transverse sinus or in the tentorial sinus.

9.2.1.2 Cerebellar Suboccipital Surface Territory

- Inferior hemispheric cerebellar veins and inferior vermian veins drain into the transverse sinus and into the torcular.
- Superficial anterior tonsillar veins drain in the deep venous system by connecting with the veins in the cerebello-medullary fissure and then to the superior petrous vein and then onward into the superior petrous sinus.

9.2.1.3 Cerebellar Petrous Surface Territory

- The superficial veins on the anterior surface of the cerebellum drain into superior petrosal vein, that is, a tributary of the superior petrous sinus and, through this, of the sigmoid sinus.
- The superior petrous vein is formed at the level of the cerebellopontine angle by the conjunction of the transverse pontine vein, cerebellopontine vein, and the vein of the middle cerebellar peduncle.

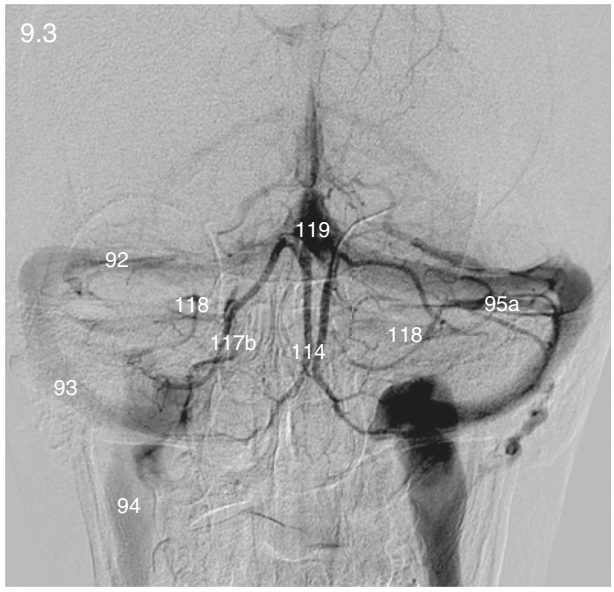

Fig. 9.3 Veins of the posterior cranial fossa. Anteroposterior projection

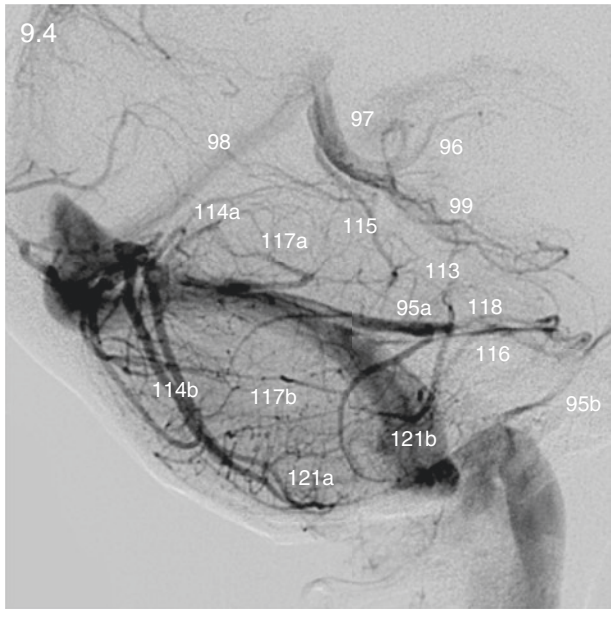

Fig. 9.4 Veins of the posterior cranial fossa, cerebellum. Lateral projection

92	Transverse sinus
93	Sigmoid sinus
94	Internal jugular vein
95a	Superior petrosal sinus
95b	Inferior petrosal sinus
96	Internal cerebral vein
97	Vein of Galen
98	Straight sinus
99	Basal vein of Rosenthal
113	Lateral mesencephalic vein
114	Vermian veins
114a	Vermian veins, superior
114b	Vermian veins, inferior
115	Precentral cerebellar vein
116	Transverse pontine vein
117a	Hemispheric cerebellar veins, superior
117b	Hemispheric cerebellar veins, inferior
118	Petrosal vein
119	Confluence of sinuses or torcular Herophili
121a	Superficial tonsillar veins, posterior
121b	Superficial tonsillar veins, anterior

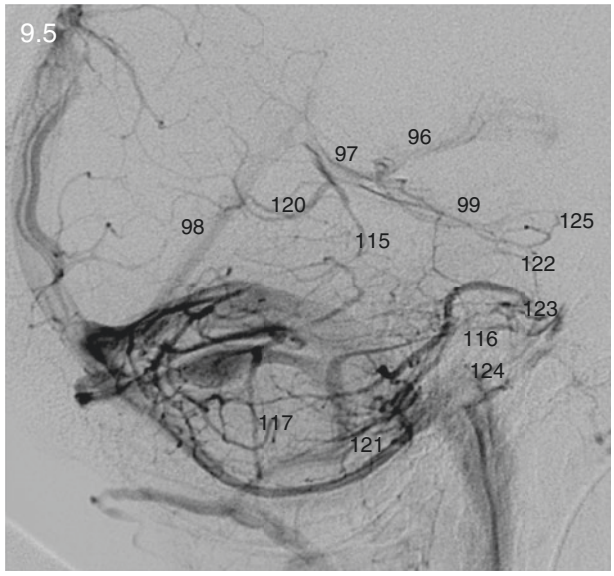

Fig. 9.5 Veins of the posterior cranial fossa, cerebellum, and the brainstem. Lateral projection

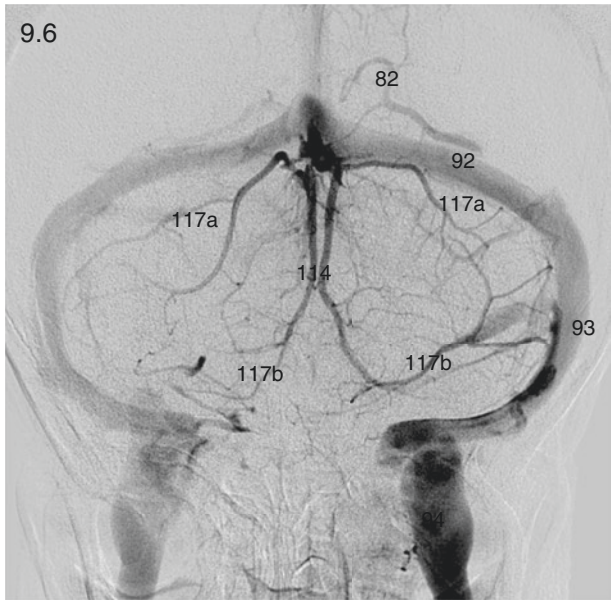

Fig. 9.6 Veins of the posterior cranial fossa. Occipitofrontal projection

82	Occipital veins
92	Transverse sinus
93	Sigmoid sinus
94	Internal jugular vein
96	Internal cerebral vein
97	Vein of Galen
98	Straight sinus
99	Basal vein of Rosenthal
114	Vermian veins
115	Precentral cerebellar vein
116	Transverse pontine vein
117	Hemispheric cerebellar veins
117a	Hemispheric cerebellar veins, superior
117b	Hemispheric cerebellar veins, inferior
120	Internal occipital vein
121	Superficial tonsillar veins
122	Anterior mesencephalic vein
123	Anterior pontine vein
124	Anterior bulbar vein
125	Interpeduncular veins

9.2.2 Deep Vein Territory of the Posterior Cerebral Fossa

The deep venous system is made up of the scissural veins interposed between the cerebellum and the brainstem in the deep cerebellar-mesencephalic, cerebellopontine and the cerebello-medullary fissures. They run parallel to the cerebellar peduncles and surround the fourth ventricle (Figs. 9.4 and 9.5).

9.2.2.1 Cerebellar Deep Drainage

- Cerebello-mesencephalic vein: anastomosis between the cerebello-mesencephalic vein and the lateral mesencephalic vein allows a direct posterior venous drainage to the vein of Galen.
- Cerebellopontine vein: It surrounds the superior cerebellar peduncle and connects the roots of the superior petrous vein, cerebello-medullar vein, and the deep inferior cerebellar hemispheric veins with the superior petrous sinus.
- Cerebello-medullary vein: It lies laterally to the fourth ventricle and connects to the middle cerebellar peduncle and then to the cerebellopontine vein to form the superior petrous vein. These interconnected veins ensure deep ascending venous circulation which together with the vein of the cerebellopontine fissure drains into the precentral cerebellar vein, and the basal vein (through the lateral mesencephalic vein, and the vein of Galen).

9.2.2.2 Brainstem Deep Drainage

- Anterior mesencephalic, pontine, bulbar veins
- Posterior mesencephalic veins: these are quadrigeminal veins that drain into the precentral cerebellar veins
- Lateral pontine territory: lateral transverse pontine vein drains directly into the superficial petrous vein.

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