

## Blood Supply, Neuroscience

### A. Arteries and veins

The brain is one of the most metabolically active organs of the body consuming large amounts of both oxygen and glucose. It is dependent on its arterial supply for delivery of both of these materials. The brain accounts for about 20% of the body's total oxygen utilization, even though it is only about 3% of total body weight. Interruption of an adequate flow of blood to nervous tissue results in tissue damage and related functional deficits. Even brief interruptions of blood flow can cause transient or permanent neurological deficits. Complete blockage of blood flow for 10 seconds will result in loss of consciousness.

#### Arteries

The arterial supply to the CNS consists of two main interconnected systems: the *vertebral-basilar system* and the bilateral *internal carotid* system (Figure 4-1).

The branches of the vertebral-basilar system provide the entire blood supply to most of the spinal cord and the brainstem, including most of the midbrain, the cerebellum, the pons and medulla. The paired *vertebral arteries* begin as branches of the *subclavian artery* and enter the cranium through the *foramen magnum*. Two descending arterial branches arise from the vertebral arteries as they ascend on the ventrolateral surface of the brainstem: 1) the *anterior spinal arteries* join to form a single, midline artery that supplies medial regions of the lower medulla and the spinal cord, along which it participates in an anastomotic system with the *anterior radicular arteries*; 2) the *posterior spinal arteries* descend along the posterolateral surface of the cord and anastomose with the *posterior radicular arteries*. The *posterior inferior cerebellar arteries* (PICA), which supply the lateral regions of the pons and medulla dorsal to the inferior olive and medial portions of the cerebellum, arise from the vertebral arteries. At the border between the medulla and the pons the vertebral arteries join to form a single midline *basilar artery*. Several major branches arise from the basilar artery. From caudal to rostral these branches are 1) the *anterior inferior cerebellar artery*, which supplies the lateral region of caudal portions of the pons and portions of the inferior surface of the cerebellum; 2) *paramedian arteries*, which supply the medial pons; 3) the *short circumferential arteries*, which supply an area along the ventrolateral surface of the pons; 4) the *long circumferential arteries*, which anastomose with the anterior inferior cerebellar arteries and the superior cerebellar arteries to supply most of the pontine tegmentum; and 5) the *superior cerebellar arteries* which supply the rostral portions of pons and superior surface of cerebellum. At its rostral extent the basilar artery branches to form the *posterior cerebral arteries*, which supply the lateral aspect of the midbrain and the medial and inferior portions of the temporal and occipital lobes. The *posterior choroidal arteries*, which arise from the posterior cerebral artery, supply portions of the midbrain, thalamus, and the choroid plexus of the third ventricle.

The *internal carotid artery* has two terminal branches: the *anterior cerebral artery*, which supplies the medial cortical surface of the cerebral hemisphere, and the *middle cerebral artery*, which supplies large regions on the lateral surface of the cerebral hemisphere. A short *anterior communicating artery* joins the two anterior cerebral arteries in front of the optic chiasm. The *medial striate artery*, which branches from the anterior cerebral artery, supplies deep structures including the head of the caudate nucleus and the adjacent internal capsule. The remainder of these deep structures is supplied by branches of the middle cerebral artery, including the *anterior choroidal* and *lenticulostriate arteries*. The *posterior communicating artery* arises directly from the carotid and joins the posterior cerebral artery; the *ophthalmic artery* branches directly from the internal carotid and gives rise to the *central retinal artery*.

#### The Circle of Willis

At the base of the diencephalon, surrounding the optic chiasm, lies the *cerebral arterial circle* (Circle of Willis, indicated by asterisks in Figure 4-1), which includes portions of the *internal carotid*, *anterior cerebral*, *anterior communicating*, *middle cerebral*, *posterior communicating*, and *posterior cerebral arteries*. The Circle of Willis is an anastomotic link between the basilar and carotid circulations and between the two carotid supplies. However, its components are variably present, and the communicating arteries are usually of insufficient diameter to replace the blood supply lost by disruption of the basilar artery or one of the two carotid arteries. Therefore, obstruction of one internal carotid frequently results in serious disruption of blood supply to the brain, and normally there is little exchange of blood between the two sides of the circle (unless pathology develops over a period of years).

TABLE 4-1: Vertebral Artery System

Major Artery	Branch	Perfusion Field
Vertebral Artery	Posterior Spinal Artery	Dorsal portion of caudal medulla (cuneate and gracile fasciculi and nuclei), dorsal and caudal part of inferior cerebellar peduncle, spinal dorsal horn and dorsal columns
	Anterior Spinal Artery	Medial and ventral portions of medulla (pyramids, medial lemniscus, medial longitudinal fasciculus, hypoglossal nucleus, caudal portion of nucleus of the solitary tract and of the dorsal motor nucleus of the vagus, and medial accessory olive), spinal anterior and lateral horns, base of dorsal horn, central gray
	Posterior Inferior Cerebellar Artery	Inferior surface of the cerebellum, inferior cerebellar peduncle, some of the choroid plexus of IVth ventricle, and much of lateral portion of the upper medulla, including region of the spinothalamic and spino trigeminal tracts, the spinal trigeminal nucleus, and the nucleus ambiguus, descending autonomic tracts
	Bulbar Branches of Vertebral Artery	Pons and medulla (pontine portions of the pyramids, rostral portion of the hypoglossal nucleus, most of the inferior olive, cuneate and spinal trigeminal nuclei, much of rest of lateral portions of rostral medulla)
Basilar Artery	Anterior Inferior Cerebellar Artery	Caudal portion of pontine tegmentum, inferior surface of cerebellar hemispheres, portions of the dentate nucleus of the cerebellum, and some of the choroid plexus of the IVth ventricle.
	Labyrinthine Artery	Inner Ear
	Paramedian Artery	Corticospinal, corticobulbar and corticopontine tracts, pontine nuclei, medial lemniscus
	Circumferential Pontine Rami	Medial lemniscus, spinothalamic, spinocerebellar, and corticospinal tracts, medial longitudinal fasciculus, cerebellar peduncles, reticular formation, nuclei of cranial nerves III - VIII
	Superior Cerebellar Artery	Superior surface of the cerebellum, deep cerebellar nuclei, and some of the choroid plexus of the IVth ventricle.
	Posterior Cerebral Artery	Midbrain, thalamus, parts of temporal and occipital lobes

TABLE 4-2: Carotid Artery System

Major Artery	Branch	Major Branch	Perfusion Field
Carotid Artery	Anterior Cerebral Artery	Medial Striate Artery	Head of the caudate nucleus, internal capsule (anterior limb)
		Orbital Branches	Orbital and medial surface of the frontal lobe
		Frontopolar Artery	Frontal pole of the frontal lobe and part of the medial surface of the frontal lobe
		Callosomarginal Artery	Paracentral lobule (i.e., medial parts of pre- and postcentral gyri), parts of cingulate gyrus
		Pericallosal Artery	Medial surface of parietal lobe, parts of the cingulate gyrus
	Middle Cerebral Artery	Anterior Choroidal Artery	Globus pallidus, retrolenticular portion of the internal capsule, part of posterior limb of the internal capsule, hippocampal formation
		Lenticulostriate Arteries	Body of caudate nucleus, putamen and part of the posterior limb of the internal capsule
		Anterior Temporal Artery	Anterior portions of the temporal lobe
		Orbitofrontal Artery	Part of orbital surface of the frontal lobe
		pre-Rolandic branch	Lateral convexity of the frontal lobe
		Rolandic branch	Pre- and postcentral gyri
		Anterior parietal branch	Anterior portion of the parietal lobe
		Posterior parietal branch	Posterior portion of the parietal lobe
		Posterior temporal branch	Posterior portions of the temporal lobe

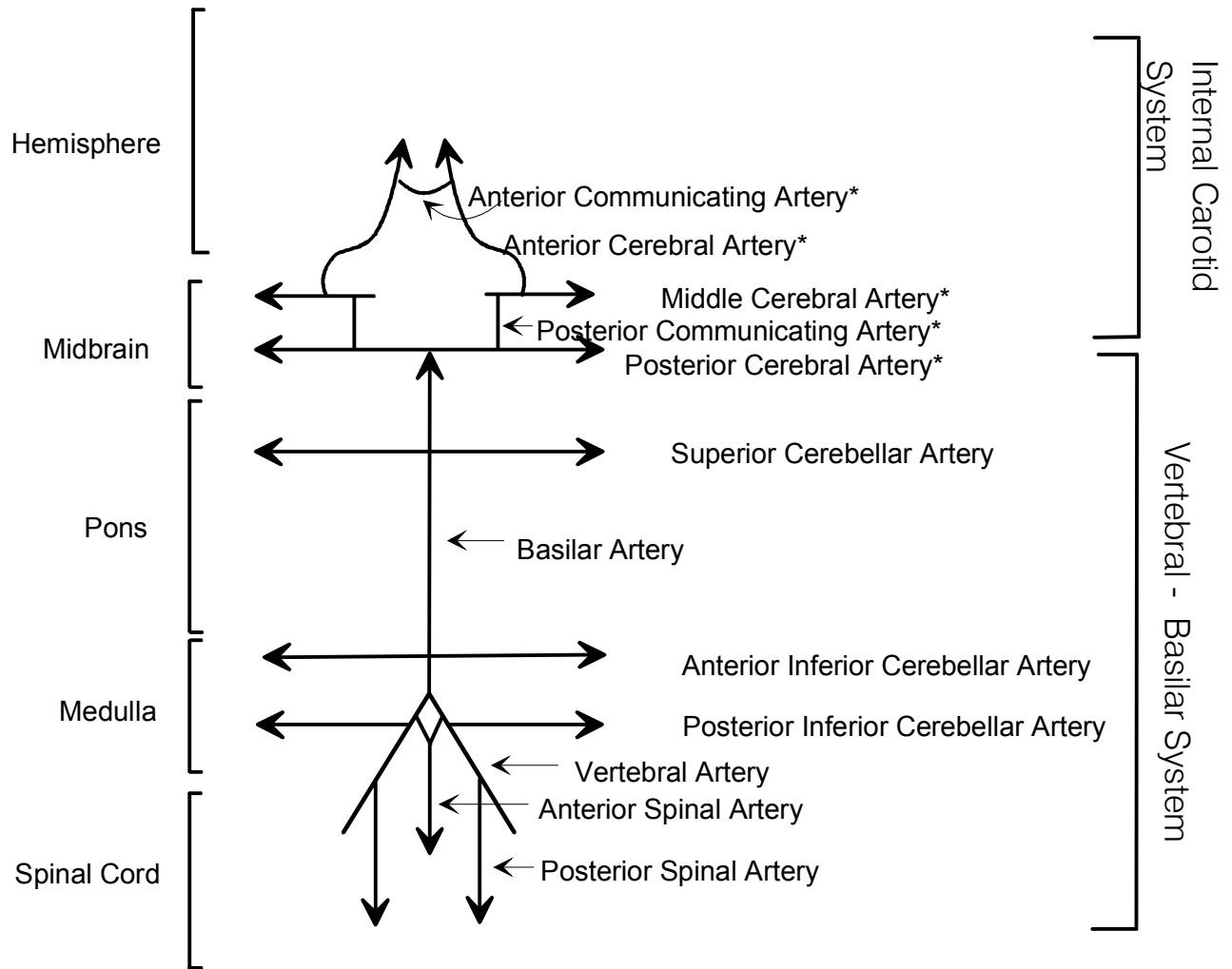


Figure 4-1. Schematic representation of the major arterial supplies to the CNS. Components of the Circle of Willis are indicated by asterisks.