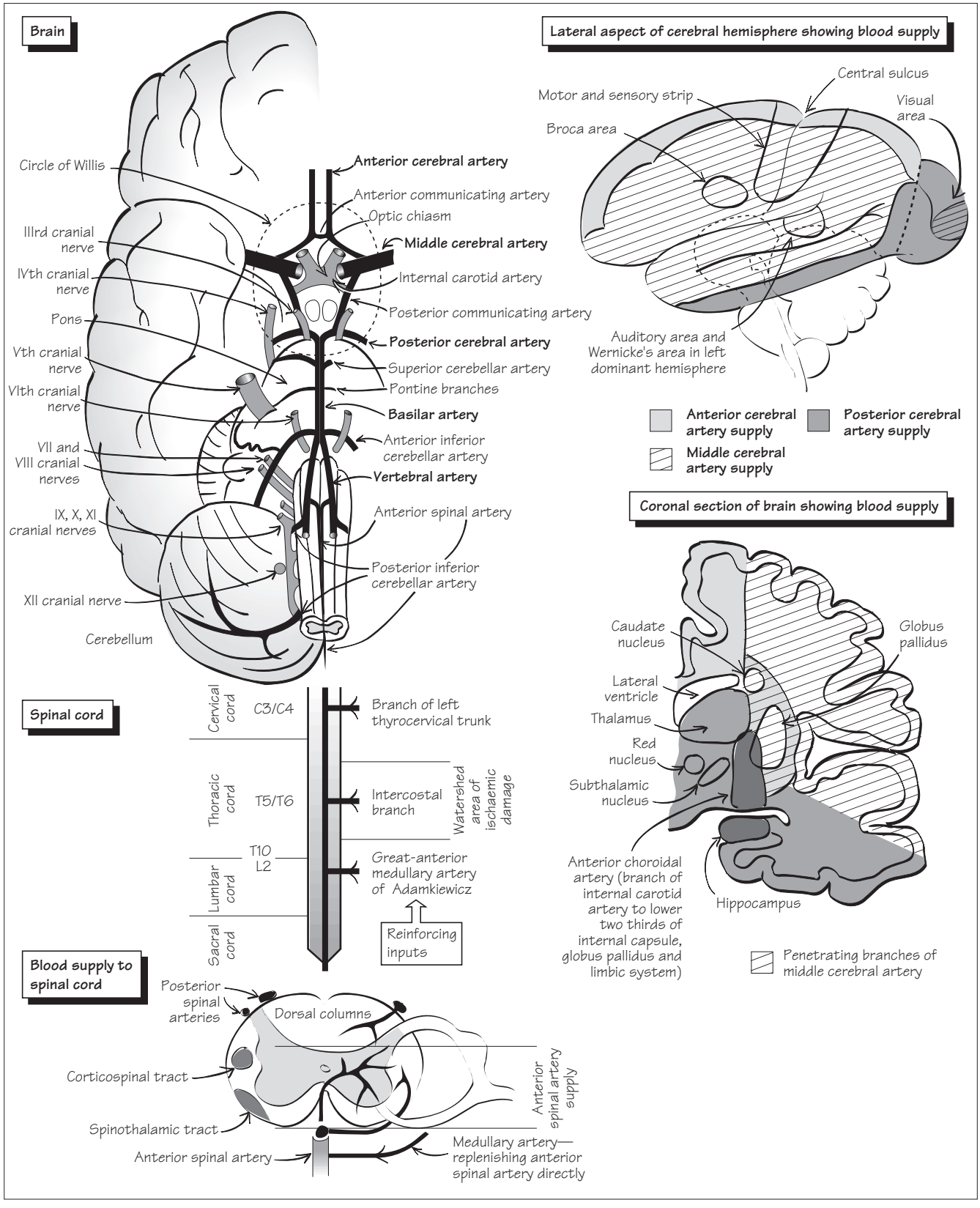
17 Blood supply of the central nervous system



Blood supply to the brain

The arterial blood supply to the brain comes from four vessels: the right and left internal carotid and vertebral arteries. The **vertebral arteries** enter the skull through the foramen magnum and unite to supply blood to the brainstem **(basilar artery)** and posterior parts of the cerebral hemisphere **(posterior cerebral arteries)**—the whole network constituting the posterior circulation. The **internal carotid arteries (ICAs)** traverse the skull in the carotid canal and the cavernous sinus before piercing the dura and entering the middle cranial fossa just lateral to the optic chiasm. They then divide and supply blood to the anterior and middle parts of the cerebral hemispheres **(anterior and middle cerebral arteries; ACAs and MCAs, respectively)**. In addition, the posterior and anterior cerebral circulations anastomose at the base of the brain in the **circle of Willis**, with the anterior and posterior communicating arteries offering the potential to maintain cerebral circulation in the event of a major arterial occlusion. Such a situation is not uncommonly seen in atherosclerotic disease where a slowly progressive stenosis of the ICA allows the collateral system to develop prior to the final occlusion of the vessel. These patients remain asymptomatic or may experience transient neurological disturbances as microthrombi are thrown off from the stenosing vessel ***(transient ischaemic attacks or TIAs)*** which stop without a significant deficit once the vessel is completely occluded.

The **ICA** prior to its terminal bifurcation supplies branches to the pituitary (hypophysial arteries), the eye (ophthalmic artery), parts of the basal ganglia (globus pallidus) and limbic system (anterior choroidal artery) as well as providing the posterior communicating artery. The **MCA** forms one of the two terminal branches of the ICA and supplies the sensorimotor strip surrounding the central sulcus (with the exception of its medial extension which is supplied by the ACA) as well as the auditory and language cortical areas in the dominant (usually left) hemisphere. Therefore, occlusion of the MCA causes a contralateral paralysis that affects the arm and the lower part of the face and arm especially, with contralateral sensory loss or inattention and a loss of language if the dominant hemisphere is involved (see Chapters 20, 27, 30 and 36). In addition, there are a number of small penetrating branches of the MCA that supply subcortical structures such as the basal ganglia and internal capsule (see below).

The two **ACAs**, which form the other major terminal vessel of the ICA, are connected via the anterior communicating artery and supply blood to the medial portions of the frontal and parietal lobes as well as the corpus callosum. There is an inconstant branch of the ACA, the recurrent artery of Heubner, which supplies part of the basal ganglia (neostriatum) and descending motor pathways in the internal capsule. Occlusion of the ACA characteristically gives paresis of the contralateral leg with sensory loss, and on occasions deficits in gait and micturition with mental impairment and ***dyspraxia*** (see Chapters 20, 30 and 35).

The **vertebral arteries**, which arise from the subclavian artery, ascend to the brainstem via foramina in the transverse processes of the upper cervical vertebrae. At the level of the lower part of the pons the vertebral arteries unite to form the basilar artery which then ascends before dividing into the two **posterior cerebral arteries (PCAs)** at the superior border of the pons. Each vertebral artery *en route* to forming the basilar artery has a number of branches including the posterior spinal artery, the posterior inferior cerebellar artery (PICA) and the anterior spinal artery. These spinal arteries supply the upper cervical cord (see below), whereas the PICA supplies the lateral part of the medulla and cerebellum. Occlusion of this vessel gives rise to the ***lateral medullary syndrome of Wallenberg***.

The **basilar artery** has a number of branches: the anterior inferior cerebellar artery (AICA); the artery to the labyrinth; pontine branches; and the superior cerebellar artery. Occlusion of these branches gives a characteristic clinical picture that can be predicted from the anatomy of the brainstem (see Chapter 13).

The **PCAs** supply blood to the posterior parietal cortex, the occipital lobe and inferior parts of the temporal lobe. Occlusion of these vessels causes a visual field defect (usually a homonymous hemianopia with macular sparing, as this cortical area receives some supply from the MCA; see Chapter 24), amnesic syndromes (see Chapter 45), disorders of language (see Chapter 27) and, occasionally, complex visual perceptual abnormalities (see Chapter 25). The PCA has a number of central perforating or penetrating branches which supply the midbrain, thalamus, subthalamus, posterior internal capsule, optic radiation and cerebral peduncle. Occlusion of these vessels produces midbrain syndromes with a combination of cranial nerve palsies and motor abnormalities; in the case of thalamic involvement, they may also produce a syndrome of pain and dysaesthesia that is hard to treat (see Chapter 22). The small perforating arteries that arise from both the PCA and MCA are commonly affected in hypertension when their occlusion produces small **lacunar infarcts**.

Apart from occlusion, **haemorrhage** from cerebral vessels can occur which may be into the brain substance (intracerebral), the subarachnoid space or both. Such haemorrhages usually occur either in the context of trauma, hypertension or rupture of congenital aneurysms on the circle of Willis (***berry aneurysms***).

Venous drainage of the brain

Venous drainage of the brainstem and cerebellum is directly into the dural venous sinuses adjacent to the posterior cranial fossa. The cerebral hemispheres in contrast have internal and external veins—the external cerebral veins drain the cortex and empty into the superior sagittal sinus (see Chapter 16). This sinus drains into the transverse sinus, then the lateral sinus, before emptying into the internal jugular vein. The internal cerebral veins drain the deep structures of the cerebral hemisphere to the great vein of Galen and thence into the straight sinus. Occlusion of either of these venous systems can occur, causing raised intracranial pressure with or without focal deficits.

Blood supply to the spinal cord

The **blood supply to the spinal cord** comes in the form of a single anterior spinal artery and paired posterior spinal arteries. The anterior spinal artery arises from the vertebral arteries and extends from the level of the lower brainstem to the tip of the conus medullaris. It supplies the ventral surface of the medulla and the anterior two-thirds of the spinal cord. The posterior spinal arteries supply the dorsal third of the spinal cord, and also take their origin from the vertebral arteries. At certain sites along the spinal cord there are a number of reinforcing inputs from other arteries (see figure).

Vascular insults to the spinal cord occur most commonly at the watershed areas in the cord, namely the lower cervical and lower thoracic cord. Occlusion of the anterior spinal artery produces a loss of power and spinothalamic sensory deficit with preservation of the dorsal column sensory modalities (joint position sense and vibration perception; see Chapter 31). Posterior spinal artery occlusions are rare and produce a loss of dorsal column sensory modalities.