

Clinical Implications of Vascular Anatomy

The brain is perfused by four major vessels, the paired carotid and vertebral arteries. These originate extracranially as branches off the aorta and great vessels and course through the neck and base of the skull to reach the intracranial cavity (Fig. 116-1). The carotid and its branches constitute the anterior circulation, and the vertebral arteries and its branches the posterior circulation. Anterior and posterior circulations communicate with one another through the posterior communicating arteries. The left and right sides of the anterior circulation communicate with each other through the anterior communicating artery. The major vessels at the base of the brain and these communicating vessels constitute the Circle of Willis, the anastomotic network that allows for collateral blood flow when individual vessels are stenotic or occluded. Because variants in the circle of Willis are common, collateral flow may not be sufficient in many cases of blockage, and the risk of ischemic stroke, therefore, depends on a patient's individual anatomy.

The right common carotid artery usually begins as a branch from the innominate artery, whereas the left common carotid artery originates directly from the aortic arch. The common carotid arteries bifurcate into the internal and external carotid arteries, usually at the level of the fourth cervical vertebrae. The

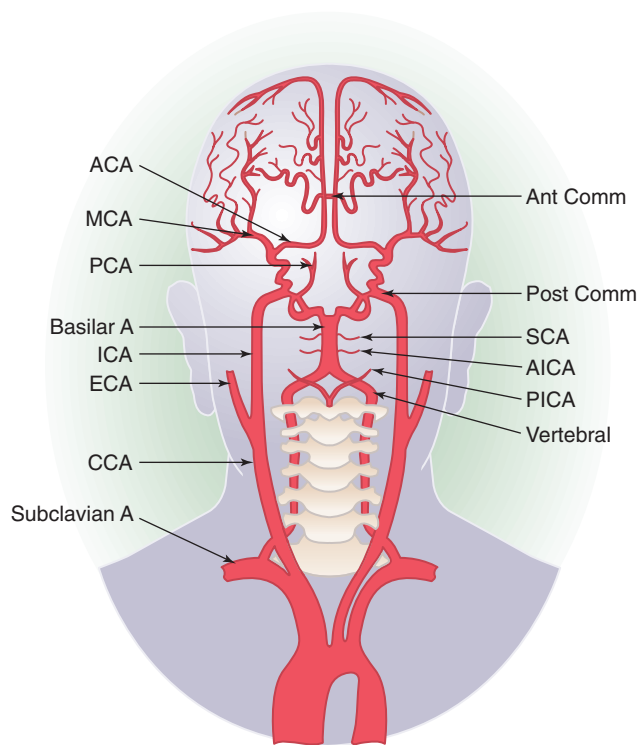


FIGURE 116-1 Coronal view of the extracranial and intracranial arterial supply to the brain. Vessels forming the circle of Willis are highlighted. A, Artery; ACA, anterior cerebral artery; AICA, anterior inferior cerebellar artery; Ant Comm, anterior communicating artery; CCA, common carotid artery; ECA, external carotid artery; ICA, internal carotid artery; MCA, middle cerebral artery; PCA, posterior cerebral artery; PICA, posterior inferior cerebellar artery; Post Comm, posterior communicating artery; SCA, superior cerebellar artery. (Modified from Lord R: Surgery of occlusive cerebrovascular disease, St. Louis, 1986, Mosby.)

internal carotid arteries have no branches in the neck and face, and enter the cranium through the carotid canal. There are four main segments of each internal carotid artery: cervical, petrous, cavernous, and supraclinoid. The siphon is the term used to describe the hairloop turn made by the cavernous and supraclinoid segments, and it is at this level that the ophthalmic artery originates, providing the first major branch of the internal carotid artery and supplying blood flow to the optic nerve and retina. Thus, internal carotid artery disease commonly causes ocular ischemia, leading to a transient ischemic attack (*amaurosis fugax*) or infarction of the optic nerve or retina, a warning sign of impending cerebral stroke. The internal carotid arteries then give off the superior hypophyseal, posterior communicating, and anterior choroidal arteries, before terminating intracranially by dividing into the middle and anterior cerebral arteries. In addition to the eye, the paired carotid systems supply approximately 80% of the hemispheric blood flow, including the frontal, parietal, and anterior temporal lobes. In up to 15% of individuals, the posterior cerebral artery (PCA) also arises directly from the internal carotid artery (the so-called fetal origin PCA), so that the entire hemisphere including the occipital lobe is supplied by the internal carotid artery. The anterior choroidal artery supplies a number of structures in addition to the choroid plexus, including the inferior portion of the posterior limb of the internal capsule, the hippocampus, and portions of the globus pallidus, posterior putamen, lateral geniculate, amygdala, and ventrolateral thalamus.

The middle cerebral artery (MCA) is the largest branch of the internal carotid artery. Its first portion, or stem, is often referred to as the M1 segment, and this usually bifurcates into superior and inferior divisions or, less often, trifurcates into three major divisions (upper, middle, and lower). The MCA stem gives rise to the medial and lateral lenticulostriates, which supply the extreme capsule, claustrum, putamen, most of the globus pallidus, part of the head and the entire body of the caudate, as well as the superior portions of the anterior and posterior limbs of the internal capsule. The divisions of the MCA supply almost the entire lateral cortical surface of the brain, including the insula, operculum, and frontal, parietal, temporal, and occipital cortices.

The anterior cerebral artery (ACA) also has a proximal, or A1, segment, which ends at the junction with the anterior communicating artery. The ipsilateral ACA then continues as the distal, or A2, segment. An important branch is the recurrent artery of Heubner, which supplies the head of the caudate nucleus, and several cortical branches supply the medial and orbital surfaces of the frontal lobe.

The vertebral arteries generally originate from the subclavian arteries, course through the transverse foramina of the cervical vertebrae, pierce the dura, and enter the cranial cavity through the foramen magnum. The two vertebral arteries join to form the basilar artery at the level of the pontomedullary junction. Anterior and posterior spinal arteries and the posterior inferior cerebellar artery (PICA), which supplies the inferior surface of the cerebellum, arise from the distal segments of the vertebrals. The lateral medulla is supplied by the multiple, perforating branches of PICA or the direct penetrating branches of the vertebral artery. Occlusion of the distal vertebral artery may, therefore, cause