When we think of the human brain, we usually envision the cerebral hemispheres. In this chapter, we will review the functional anatomy of the cerebral hemispheres by studying their blood supply and the clinical-anatomical correlations that can be made when the blood supply is transiently or permanently disrupted. We will discuss the blood supply and functional anatomy of the brainstem and cerebellum in Chapters 14 and 15; the spinal cord blood supply was discussed in Chapter 6. Understanding the blood supply of the brain provides a useful review of regional brain anatomy, since blood vessel territories typically overlap several spatially adjacent functional systems. In addition, knowledge of blood vessel territories is clinically useful, since it enables the localization of common stroke syndromes on clinical grounds, allowing the prompt initiation of proper diagnostic and therapeutic interventions.

Review of Main Functional Areas of Cerebral Cortex

We will now briefly review the main functional areas of the cerebral cortex that are commonly affected by cerebral infarcts (Figure 10.1). Additional details can be found in other chapters that discuss motor, somatosensory, visual, and association cortex at greater length (see Chapters 2, 6, 7, 11, and 19).

Recall that the face and hand areas of the sensorimotor homunculi are on the lateral convexities, while the leg areas are in the interhemispheric fissure (see Figure 6.2). In the dominant, usually left hemisphere, Broca’s area lies in the inferior frontal gyrus, just anterior to the articulatory areas of the primary motor cortex, a location well suited for planning the articulatory program (see Figure 10.1A; see also Figure 19.2 and KCC 19.4). Meanwhile, Wernicke’s area lies in the superior temporal gyrus, adjacent to the primary auditory cortex (see also Figure 12.16) and is involved in language processing.

Association cortex in the nondominant, usually right, hemisphere (especially the right parietal lobe) is important for attention to the contralateral body and space. Primary visual cortex for the contralateral visual hemifield lies along the calcarine fissure of the occipital lobe (see Figure 10.1B; see also Figure 11.15). The optic radiations, white matter pathways carrying visual information from the thalamus to the visual cortex, pass under the parietal and temporal cortex (see Figure 10.1A); they can be damaged in infarcts of these lobes, causing contralateral visual field deficits.
Circle of Willis: Anterior and Posterior Circulations

The arterial supply to the cerebral hemispheres is derived from the anterior circulation provided by the bilaterally paired internal carotid arteries, as well as by the posterior circulation provided by the bilateral vertebral arteries (Figure 10.2). The anterior circulation arises from the common carotid arteries originating at the aorta or brachiocephalic arteries (see Figure 4.20A). At the carotid bifurcation, the common carotid splits, forming the internal carotid and external carotid arteries (see Figure 4.19). The vertebral arteries, which supply the posterior circulation, arise from the subclavian arteries (see Figure 4.20B) and then ascend (see Figure 4.19) through foramina in the transverse processes of the cervical vertebrae (foramina transversaria; see Figure 10.2B) before entering the foramen magnum and joining to form the basilar artery. These anterior and posterior circulations meet in an anastomotic ring called the circle of Willis, from which all major cerebral vessels arise (Figure 10.3). The circle of Willis provides abundant opportunities for collateral flow; however, anatomical variants are common, and a complete full-caliber ring is present in only approximately 34% of individuals. The main arteries supplying the cerebral hemispheres are the anterior, middle, and posterior cerebral arteries. The anterior cerebral arteries (ACAs) and middle cerebral arteries (MCAs) are the terminal branches of the internal carotid arteries. The anterior cerebral arteries anastomose anteriorly at the anterior communicating artery (AComm). The anterior and posterior circulations are linked to each other via the posterior communicating arteries (PComms), which connect the internal carotids to the posterior cerebral arteries, thereby joining the ante-

FIGURE 10.2 Anterior and Posterior Circulations  Anterior circulation arises from the internal carotid arteries, while posterior circulation arises from the vertebral arteries.
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Prior and posterior circulations. The posterior cerebral arteries (PCAs) arise from the top of the basilar artery, which in turn is formed by the convergence of the two vertebral arteries. In addition to the posterior cerebral arteries, several branches to the brainstem and cerebellum arise from the vertebrobasilar system, as we will discuss in Chapters 14 and 15.

The internal carotid artery has several named segments during its course (see Figure 10.2). These can be well visualized in the angiogram images in Figures 4.16A,C and 4.18B. First comes the relatively vertical cervical segment in the neck, followed by a sharp horizontal bend as the internal carotid enters the temporal bone as the petrous segment. Next comes the cavernous segment as the internal carotid begins an S-shaped turn, also known as the carotid siphon, within the cavernous sinus (see Figure 13.11). It then passes the anterior clinoid process (see Figure 5.2B) to pierce the dura and bends posteriorly to enter the subarachnoid space as the supraclinoid, or intracranial segment (see Figure 4.16C). Although there are several smaller branches, the main branches of the supraclinoid internal carotid artery can be remembered by the mnemonic OPAAM (if you can remember “OPAAM”), which stands for the Ophthalmic, Posterior communicating, Anterior choroidal, Anterior cerebral, and Middle cerebral arteries. The ophthalmic artery usually arises from the bend in the internal carotid just after it enters the dura (see Figure 4.16A,C). The ophthalmic artery enters the optic foramen with the optic nerve and provides the main blood supply to the retina.

Sometimes, in an alternative nomenclature, the terms A1, M1, and P1 are used for the initial segments of the ACA, MCA, and PCA, respectively, and second- and third-order branches are referred to as A2, A3, and so on.
Anatomy and Vascular Territories of the Three Main Cerebral Arteries

The three main cerebral arteries (ACA, MCA, and PCA) give rise to numerous branches that travel in the subarachnoid space over the surface of the brain and into the sulci. Small, penetrating branches arise from these vessels to supply the superficial portions of the brain, including the cortex and underlying white matter. The deep structures of the brain, such as basal ganglia, thalamus, and internal capsule, are supplied by small, penetrating branches that arise from the initial segments of the main cerebral arteries near the circle of Willis at the base of the brain. We will now review the vascular territories of the superficial and deep structures of the cerebral hemispheres.

Vascular Territories of the Superficial Cerebral Structures

The anterior cerebral artery passes forward to travel in the interhemispheric fissure as it sweeps back and over the corpus callosum (Figure 10.4). Two major branches commonly seen are the pericallosal and callosomarginal arteries (see Figures 4.16C and 4.18B). The anterior cerebral artery thus supplies most of the cortex on the anterior medial surface of the brain, from the frontal to the anterior parietal lobes (Figure 10.5), usually including the medial sensorimotor cortex (see Figure 10.1B).

The middle cerebral artery turns laterally to enter the depths of the Sylvian fissure (see Figure 10.3). Within the Sylvian fissure it usually bifurcates into the superior division and the inferior division (Figure 10.6). This is somewhat variable, and sometimes there are three or even four main branches of the middle cerebral artery. The branches of the middle cerebral artery form loops as they pass over the insula and then around and over the operculum to exit the Sylvian fissure onto

REVIEW EXERCISE

What are the three main arteries of the cerebral hemispheres (see Figure 10.2)? Which arise from the anterior circulation and which arise from the posterior circulation in most individuals?
the lateral convexity (see Figures 4.16A,C and 4.18B). The superior division supplies the cortex above the Sylvian fissure, including the lateral frontal lobe and usually including the peri-Rolandic cortex (see Figure 10.6). The inferior division supplies the cortex below the Sylvian fissure, including the lateral temporal lobe and a variable portion of the parietal lobe. The middle cerebral artery thus supplies most of the cortex on the dorsolateral convexity of the brain (see Figure 10.5).

The posterior cerebral artery curves back after arising from the top of the basilar and sends branches over the inferior and medial temporal lobes and over the medial occipital cortex (see Figures 4.17, 4.18, and 10.4). The posterior cerebral artery territory therefore includes the inferior and medial temporal and occipital cortex (see Figure 10.5).

**Vascular Territories of the Deep Cerebral Structures**

The most important penetrating vessels at the base of the brain are the lenticulostriate arteries. These small vessels arise from the initial portions of the mid-

**FIGURE 10.5 Regions of Cortex Supplied by the Anterior Cerebral Artery (ACA), Middle Cerebral Artery (MCA), and Posterior Cerebral Artery (PCA)** (A) Lateral view. (B) Medial view. (C) Inferior view.

**FIGURE 10.6 Superior and Inferior Divisions of the Middle Cerebral Artery (MCA)** The MCA bifurcates in the Sylvian fissure, giving rise to the MCA inferior and MCA superior divisions.
Middle cerebral artery before it enters the Sylvian fissure (Figure 10.7), and they penetrate the anterior perforated substance (see Figure 2.11C) to supply large regions of the basal ganglia and internal capsule (Figure 10.8). In hypertension, the lenticulostriate arteries and other similar small vessels are particularly prone to narrowing, which can lead to lacunar infarction (see KCC 10.4), as well as to rupture, causing intracerebral hemorrhage (see KCC 5.6).

Other small vessels supply deep structures as well, with some variability (see Figures 10.7 and 10.8). The anterior choroidal artery arises from the internal carotid artery (see Figure 10.3). Its territory includes portions of the globus pallidus, putamen, thalamus (sometimes involving part of the lateral geniculate nucleus), and the posterior limb of the internal capsule (see Figure 6.9B) extending up to the lateral ventricle (see Figures 10.8 and 10.9B). Recall that the posterior limb of the internal capsule contains important motor pathways through the corticobulbar and corticospinal tracts (see Figures 6.9 and 6.10). Thus, lacunar infarction in either the lenticulostriate or anterior choroidal territories often causes contralateral hemiparesis. The recurrent artery of Heubner comes off the initial portion of the anterior cerebral artery to supply portions of the head of the caudate, anterior putamen, globus pallidus, and internal capsule (see Figures 10.7–10.9). Other variable branches may also come off the initial portions of the anterior cerebral arteries to supply deep structures. Small, penetrating arteries that arise from the proximal posterior cerebral arteries near the top of the basilar artery include the thalamoperforator arteries (see Figure 10.8) (as well as the thalamogeniculate and posterior choroidal arteries), which supply the thalamus and sometimes extend to a portion of the posterior limb of the internal capsule. As we will see in Chapter 14, small, penetrating vessels arising from the top of the basilar artery also supply the midbrain (see Figure 14.21A).

The superficial and deep territories of the main cerebral arteries are summarized in coronal and axial sections in Figure 10.9.

**REVIEW EXERCISE**

In the angiographic images shown in Figures 4.16B and 4.17B, identify (1) the lenticulostriate arteries arising from the middle cerebral artery, (2) the recurrent artery of Heubner arising from the anterior cerebral artery, and (3) the thalamoperforator and posterior choroidal arteries arising from the posterior cerebral arteries.
FIGURE 10.8 Blood Supply to Deep Cerebral Structures  

(A) Blood vessels supplying the basal ganglia and thalamus. (B) Blood supply to the internal capsule and globus pallidus.
FIGURE 10.9 Summary of Superficial and Deep Blood Supply to the Cerebral Hemispheres

(A) Coronal section. (B) Axial section.

- Caudate
- Thalamus
- Internal capsule
- Putamen
- Globus pallidus
- Hippocampal formation
- Lateral ventricle
- Occipital lobe
- Temporal lobe
- Putamen
- Globus pallidus
- Hippocampal formation
- Anterior choroidal artery
- PCA deep branches
- PCA
- MCA superior division
- MCA inferior division
- MCA deep branches
- ACA deep branches
- ACA