ATLAS OF CEREBROVASCULAR DISEASE

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PREFACE

Vascular disorders of the central nervous system are among the more common problems of modern man. In spite of their prevalence and importance, it is often difficult for physicians to find adequate illustrations of these lesions and discussion of their clinical-pathological correlation. We hope that this atlas will help solve this problem by providing numerous illustrations and our interpretations of diverse vascular lesions, both common and uncommon. While this atlas is directed principally to pathologists, neurologists, and neurosurgeons, it is hoped that other physicians will benefit from the numerous illustrations of lesions with which they deal clinically.

These patients were from the clinical services of our neurological and neurosurgical colleagues at the University of Iowa and University of Texas Medical Branch. To them, and especially to Drs. A. L. Sahs, Maurice Van Allen, and George Perret at Iowa City and Drs. John Calverley, Bruce Peters, and Robert Grossman at Galveston, we extend our special acknowledgement. The assistance of Mr. James H. Rapp and Miss Lou Cinda Holt in preparing many of the photographs was of great value to us.

Our special thanks to our secretary, Ms. Gail Stewart, for the large job of typing and retyping the manuscript.

WILLIAM F. MCCORMICK
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CONTENTS

Chapter 1

Vascular Anatomy and Anomalies

Arterial Anatomy

An understanding of the normal arterial anatomy, the normal arterial perfusion areas, and the more common anomalous arterial configurations is important in clinicopathological correlation of "stroke" syndromes. The nomenclature used by different authors is variable and can be confusing. We will use only the more common English names for the various vessels. Only the larger arteries and some of the more commonly diseased smaller arteries are discussed here. In the illustrations in this chapter each artery (or vein) has an identification number (letter) that remains the same throughout. These numbers (letters) also appear in parentheses when the vessel is discussed in the text. For more details, one of several excellent anatomical atlases or neuroanatomy textbooks[1–3] should be consulted. We have found the atlas by Stephens and Stilwell to be of great value.[1]

Configurations of the intracranial extraparenchymal arteries not conforming to the form described by Willis and subsequent anatomists have been called "anomalies."[4] In actual fact, the classic circle of Willis is seen in less than half of all adults. We have seen it in only slightly more than 40 per cent of our patients.[5] The great majority of these anomalies are clinically innocent; however, they may be misinterpreted by less experienced angiographers and thus may have unwarranted clinical significance assigned to them. This is especially true of hypoplastic vessels, which are often thought to be arteries in spasm. The major clinical significance of anomalous configurations of the arteries at the base of the brain is lack of an adequate collateral blood supply. This is seen most frequently in patients with a hypoplastic proximal anterior cerebral artery, a hypoplastic anterior communicating artery, and an "embryonic" posterior communicating artery. (See Chapter 3 for an illustration of the serious consequences of carotid thrombosis in a patient with such an anomaly.) Far less commonly, anomalous arterial configurations can cause neurological symptoms by direct compression of neural tissue.

When the usual technique of removing the brain at autopsy is used, the internal carotid arteries (5) are cut intradurally fairly close to the anterior

clinoid processes. For this reason, the ophthalmic arteries (7), shown in Figure 1, are not available for study on the usual fixed brain specimen.

If a small amount of time is taken at autopsy to uncover and expose the cavernous sinuses and the cavernous portions of the internal carotid arteries, valuable information can be gained in some patients. Aneurysms of the cavernous portion of the internal carotid artery or severe stenotic or occlusive lesions are encountered sufficiently often to justify this procedure.

The major arteries from the base of the brain of an adult, including the circle of Willis, are shown in Figure 2. While this is a relatively convenient way to visualize these larger vessels, their identification in situ is of far more practical importance.

Figure 1. Base of skull showing the origin of the ophthalmic artery from the internal carotid artery.

5. Internal carotid artery
7. Ophthalmic artery

Figure 2. Arteries dissected from the base of the brain.

1. Distal anterior cerebral artery
2. Anterior communicating artery
3. Recurrent artery of Heubner
4. Proximal anterior cerebral artery
5. Internal carotid artery
6. Middle cerebral artery
8. Posterior communicating artery
9. Anterior choroidal artery
12. Trunk of anterior group of cortical branches of middle cerebral artery
13. Trunk of posterior group of cortical branches of middle cerebral artery
14. Posterior cerebral artery
15. Premammillary artery
16. Superior cerebellar artery
17. Basilar artery
18. Anterior inferior cerebellar artery
19. Vertebral artery
20. Posterior inferior cerebellar artery
21. Anterior spinal artery
22. "Trigeminal" artery

INTERNAL CAROTID ARTERIES

The first major intradural branches of the internal carotid arteries are the posterior communicating arteries (8) (Figs. 2 through 8). These paired arteries are highly variable in size, and anomalous forms are common, usually as unilateral or bilateral hypoplasia, shown in Figure 9, or as persistence of the

Text continued on page 10.

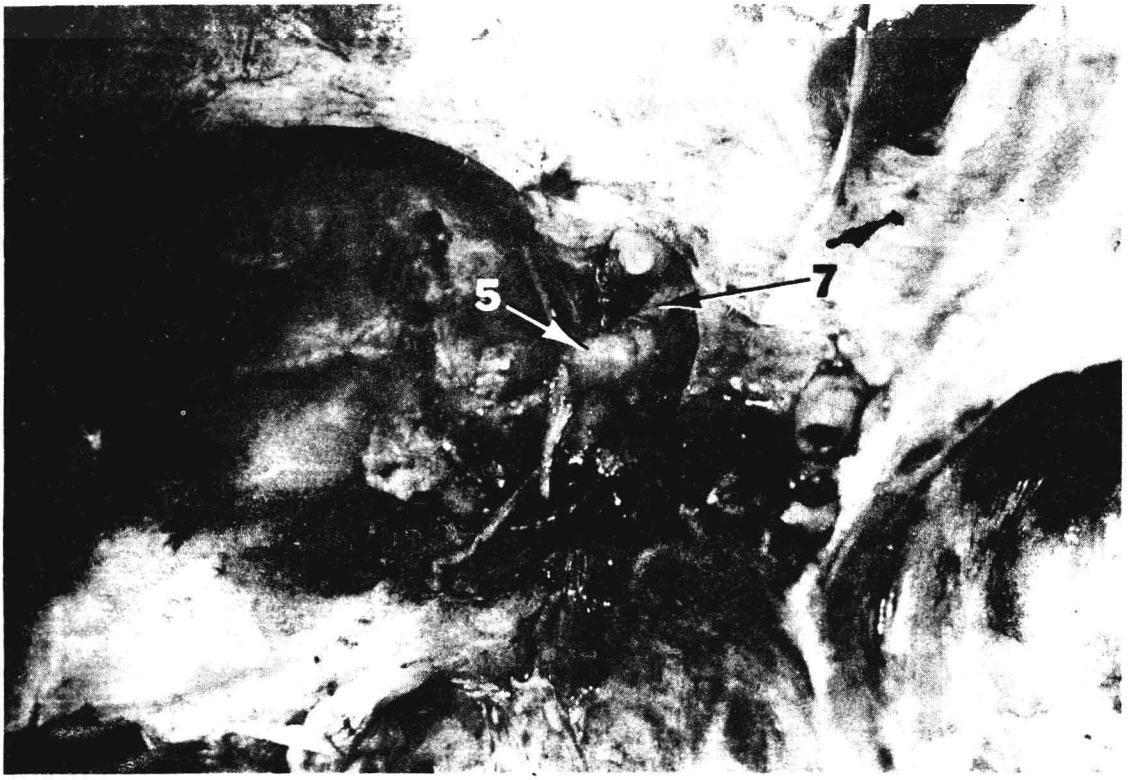

Figure 1

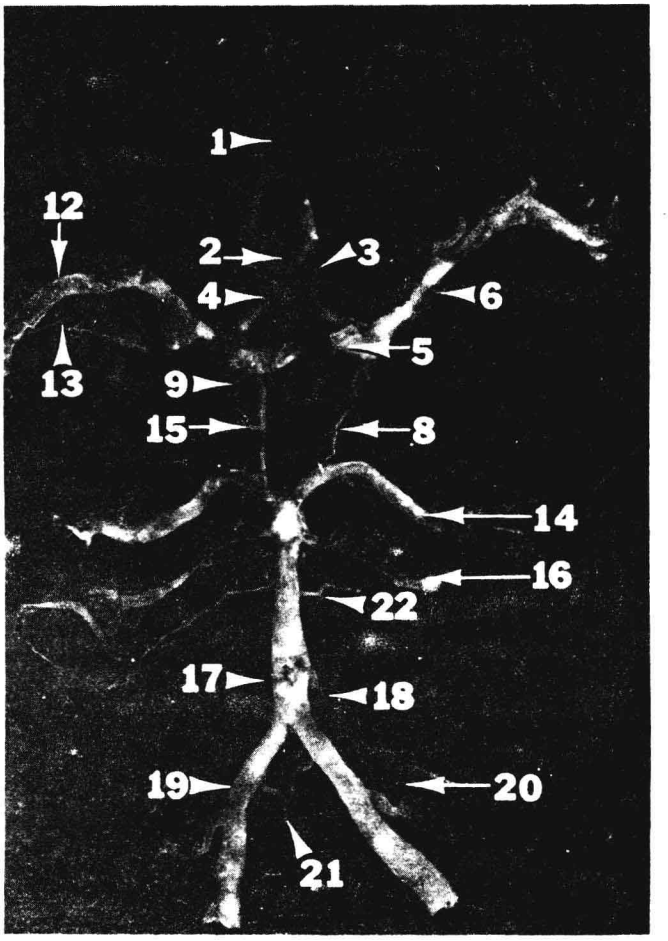

Figure 2

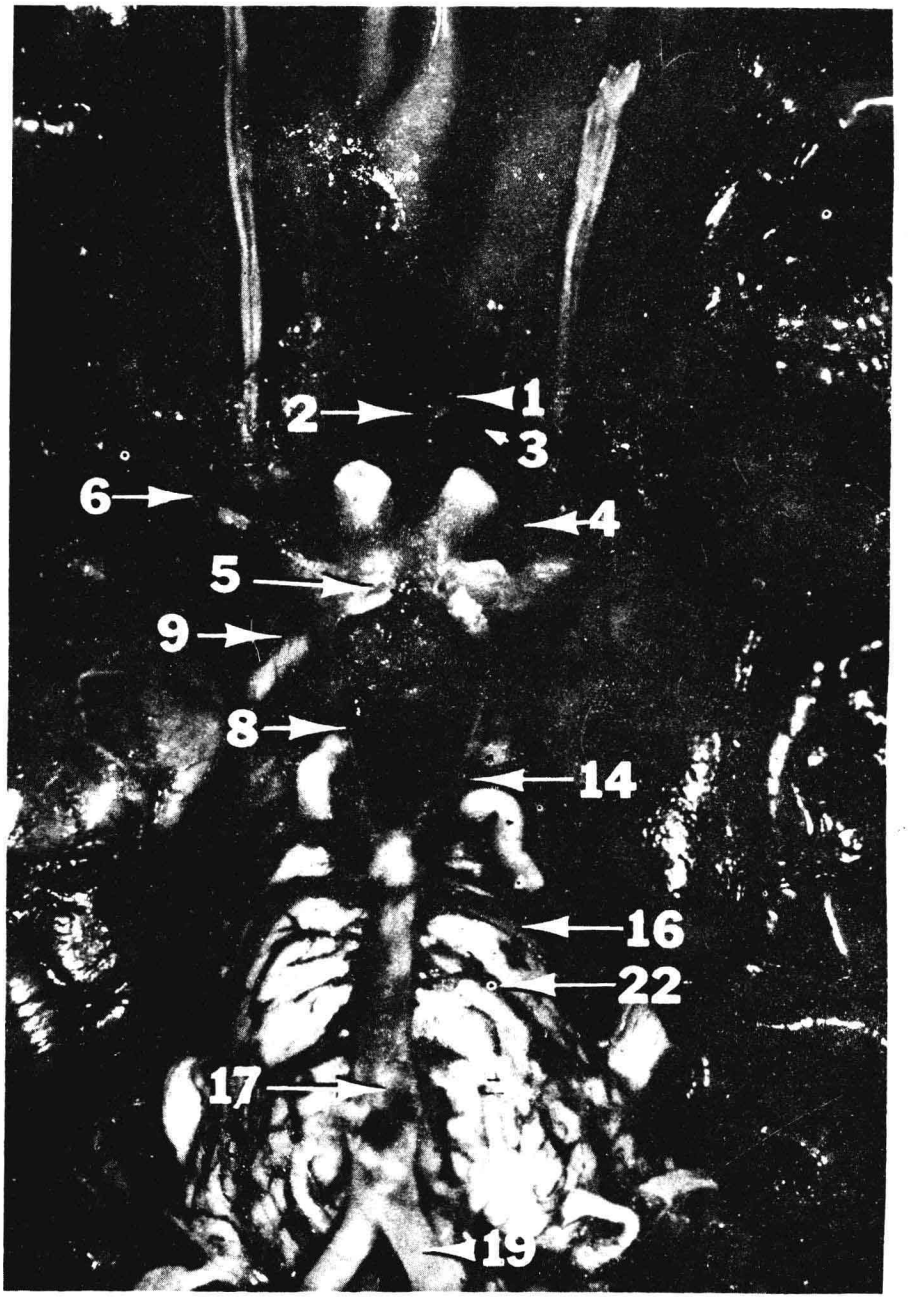

Figure 3. Ventral surface of the brain showing the arteries in situ.

1. Distal anterior cerebral artery
2. Anterior communicating artery
3. Recurrent artery of Heubner
4. Proximal anterior cerebral artery
5. Internal carotid artery
6. Middle cerebral artery
8. Posterior communicating artery
9. Anterior choroidal artery
14. Posterior cerebral artery
16. Superior cerebellar artery
17. Basilar artery
19. Vertebral artery
22. "Trigeminal" artery

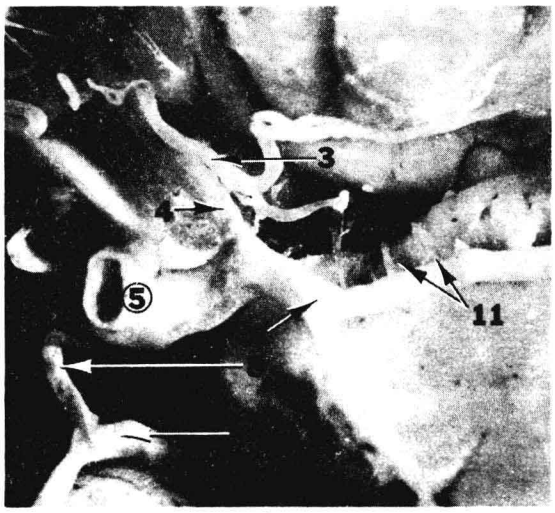

Figure 4. Arteries at the base of the brain exposed by removal of the left temporal pole.

3. Recurrent artery of Heubner and its branches
4. Proximal anterior cerebral artery
5. Internal carotid artery
6. Middle cerebral artery
8. Posterior communicating artery
11. Lateral striate arteries
14. Posterior cerebral artery

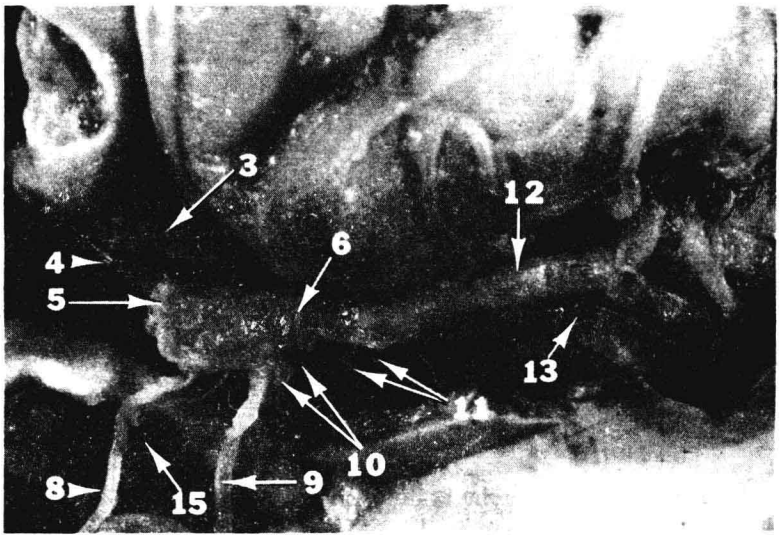

Figure 5. Arteries at the base of brain exposed by removal of the left temporal pole.

3. Recurrent artery of Heubner
4. Proximal anterior cerebral artery
5. Internal carotid artery
6. Middle cerebral artery
8. Posterior communicating artery
9. Anterior choroidal artery
10. Medial striate arteries
11. Lateral striate arteries
12. Trunk of anterior group of cortical branches of middle cerebral artery
13. Trunk of posterior group of cortical branches of middle cerebral artery
15. Premammillary artery

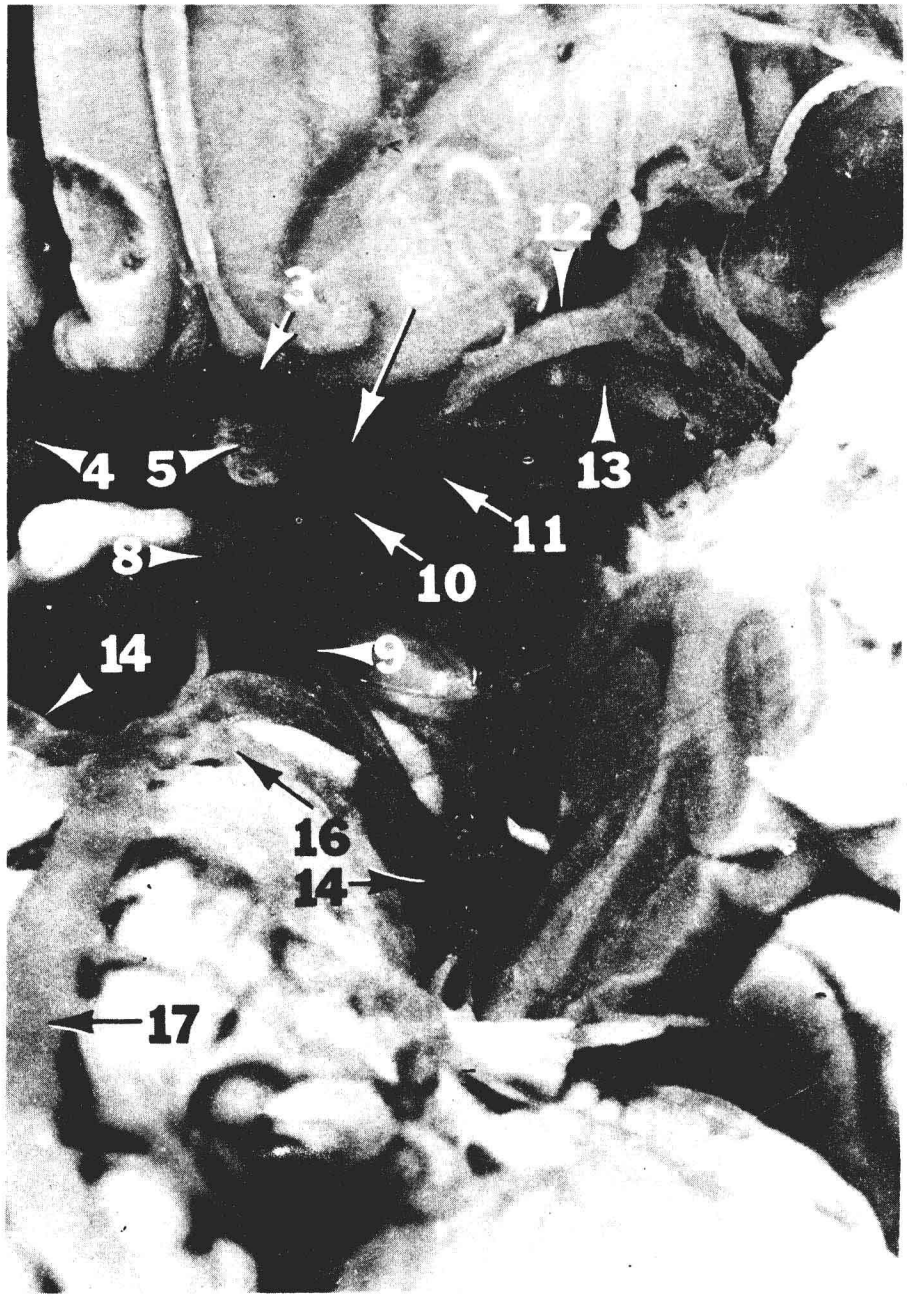

Figure 6. Arteries at the base of the brain exposed by removal of the left temporal pole and medial portion of the temporal lobe.

3. Recurrent artery of Heubner
4. Proximal anterior cerebral artery
5. Internal carotid artery
6. Middle cerebral artery
8. Posterior communicating artery
9. Anterior choroidal artery
10. Medial striate arteries
11. Lateral striate arteries
12. Trunk of anterior group of cortical branches of middle cerebral artery
13. Trunk of posterior group of cortical branches of middle cerebral artery
14. Posterior cerebral artery
16. Superior cerebellar artery
17. Basilar artery

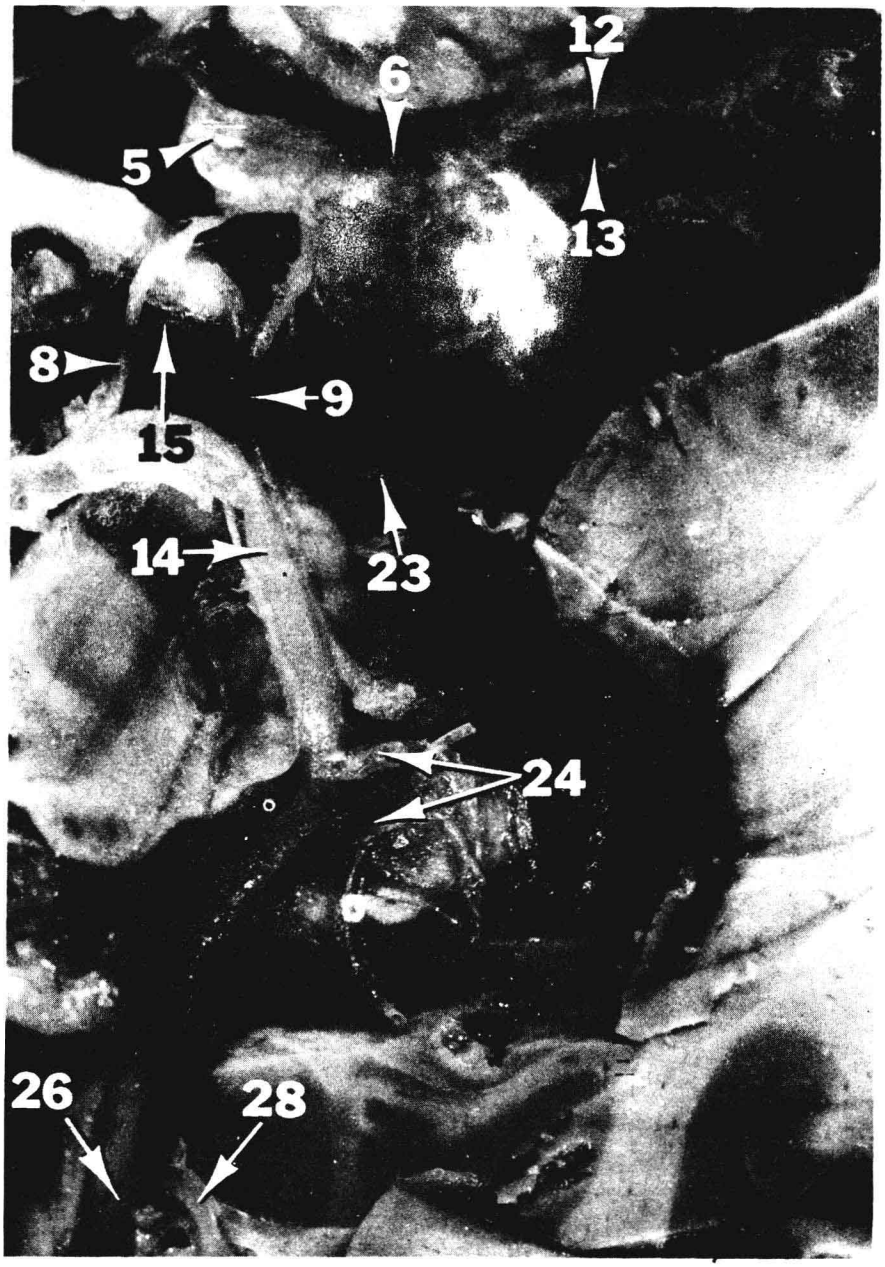

Figure 7. Arteries at the base of the brain exposed by removal of the cerebellum, brain stem, left temporal pole, and ventromedial portion of the left temporal lobe.

5. Internal carotid artery
6. Middle cerebral artery
8. Posterior communicating artery
9. Anterior choroidal artery
12. Trunk of anterior group of cortical branches of middle cerebral artery
13. Trunk of posterior group of cortical branches of middle cerebral artery
14. Posterior cerebral artery
15. Premammillary artery
23. Pallidal branch of anterior choroidal artery
24. Lateral posterior choroidal arteries (a group of at least four vessels)
26. Calcarine branch of posterior cerebral artery
28. Posterior temporo-occipital branch of posterior cerebral artery

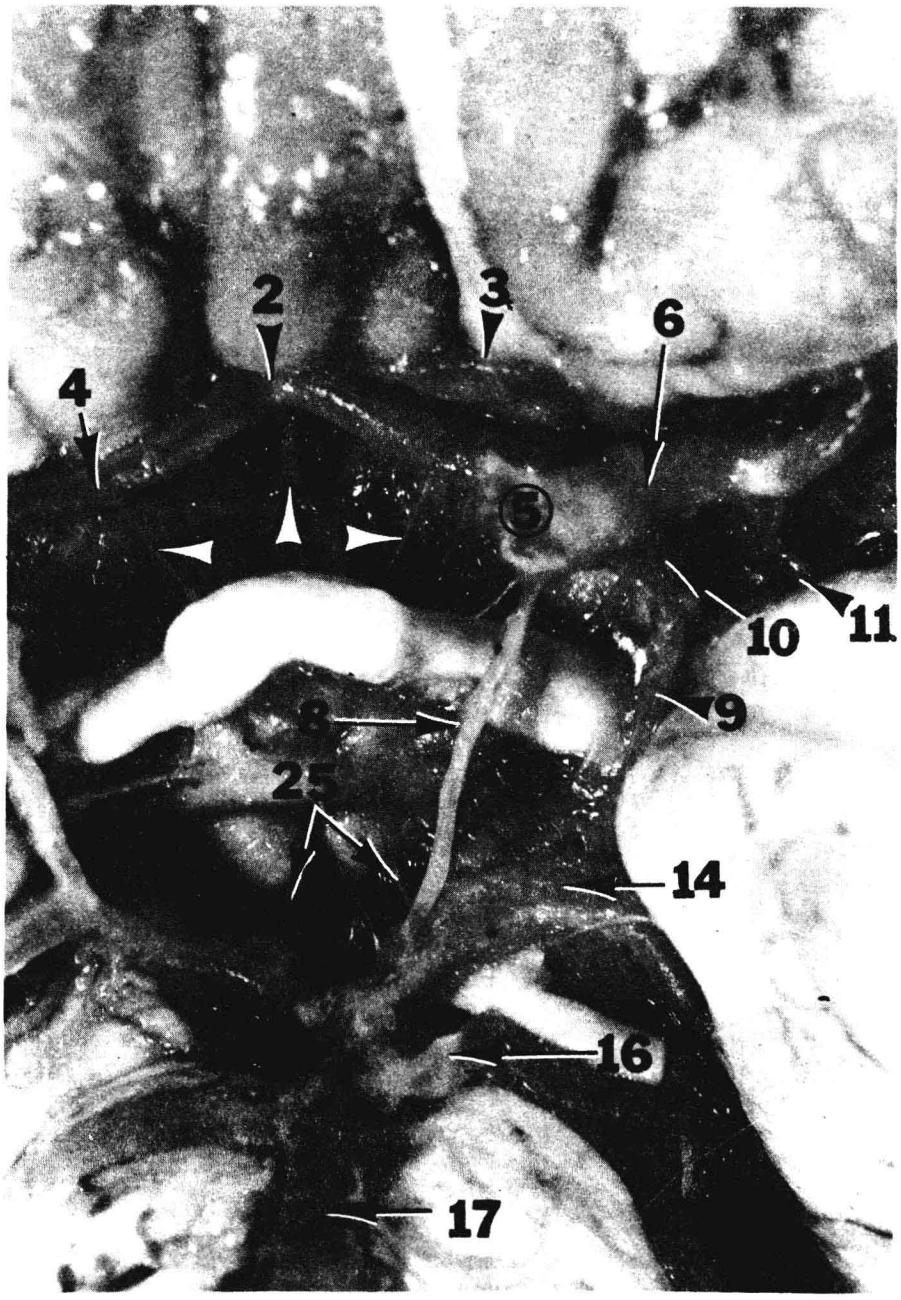

Figure 8. Arteries at the base of the brain. The unlabeled white arrowheads indicate perforating arteries from the anterior cerebral arteries.

2. Anterior communicating artery
3. Recurrent artery of Heubner
4. Proximal anterior cerebral artery
5. Internal carotid artery
6. Middle cerebral artery
8. Posterior communicating artery
9. Anterior choroidal artery
10. Medial striate arteries
11. Lateral striate arteries
14. Posterior cerebral artery
16. Superior cerebellar artery
17. Basilar artery
25. Thalamoperforating arteries

Figure 9. Arteries at the base of the brain. The right posterior communicating artery (arrow) is hypoplastic.

embryonic or fetal forms (Fig. 10). They form the lateral portions of the circle of Willis and serve as a major anastomosis between the carotid and vertebrobasilar systems. A rather large branch of the posterior communicating artery, the premammillary artery (15), is found in the majority of specimens (Figs. 2, 5, and 7). The premammillary arteries supply portions of the anterior and ventral anterior thalamic nuclei. A variable number of smaller "perforating" arteries arise from the posterior communicating arteries to supply portions of the optic chiasm, optic tracts, posterior hypothalamus, and cerebral peduncles.

The next major branches of the internal carotid arteries are the anterior choroidal arteries (9) (Figs. 2, 3, and 5 through 8). These vessels are quite variable in size and somewhat variable in origin. While arising from the carotids in 80 to 90 per cent of all specimens, they may arise from the middle cerebral or even the posterior communicating arteries in a few patients (Fig. 11). The anterior choroidal arteries give rise to multiple small branches that supply portions of the optic tract, globus pallidus, internal capsule, uncus, amygdala and pyriform cortex, anterior hippocampus, dentate fascia, lateral geniculate body, middle third of the cerebral peduncle, substantia nigra, ventral thalamus, and choroid plexus of the lateral ventricle (Fig. 12). Anastomoses between the anterior choroidal arteries and the lateral posterior choroidal arteries (24) (three or four on each side) are present (Fig. 7). The anterior choroidal arteries are quite susceptible to compression in patients with central transtentorial herniation, and thus infarcts of the optic tracts and globi pallidi may result (see Figs. 428 to 430 in Chapter 5).

The internal carotid arteries terminate by bifurcating to form the anterior cerebral (4) and middle cerebral (6) arteries. Between the origin of the anterior choroidal arteries and the internal carotid bifurcation, a few small perforating arteries arise and pass into the perforate substance (Figs. 2 through 8).

Figure 10. Arteries at the base of the brain. The posterior communicating artery has a unilateral embryonal configuration.

Figure 10