Distribution of the Occipital Branches of the Posterior Cerebral Artery Correlation With Occipital Lobe Infarcts

Slobodan V. Marinković, MD, Milan M. Milisavljević, MD, Vera Lolić-Draganić, MD, and Miroslav S. Kovačević, MD

The occipital branches of the posterior cerebral artery were examined in 31 human brains. The authors determined the origin, course, and region of supply of each occipital branch: the parieto-occipital, calcarine, posterior temporal, and common temporal arteries, as well as the lingual gyrus artery. These vessels were found in all the brains examined except the lingual gyrus artery, which was present in only 8.3%. The occipital branches were noted to supply variable cortical regions. In addition, they sometimes took part in irrigation of deep forebrain structures. It was concluded that occlusion of a certain occipital artery may cause varying clinical signs and symptoms in different patients. The neurologic deficits that may occur following the isolated occlusion of individual occipital branches of the posterior cerebral artery are discussed. (Stroke 1987;18:728-732)

The occipital lobe is involved in many aspects of visual function.1-3 The knowledge of its arterial supply is essential in understanding the syndromes occurring in occlusive cerebrovascular disease. Although several authors4-10 have described the cortical (leptomeningeal) branches of the posterior cerebral artery (PCA), there is a lack of detailed information concerning the regions of supply of the individual branches. The aim of this study was 1) to determine the variability of the regions supplied by individual occipital branches, and 2) to compare the anatomic data to the neurologic deficits produced by occlusion of individual occipital arteries.

Subjects and Methods

Thirty-one human brains taken from patients aged 22-63 years were used for the anatomic study. Both right and left PCAs were perfused with a saline solution, then injected with 10% India ink and gelatin or with a radiopaque substance (Micropaque), and fixed in 10% formaldehyde solution for 3 weeks or more. We microdissected all the branches of the PCA and examined the origin, course, and distribution of their terminal vessels. We drew each specimen and counted the frequency of the relevant variations. One brain was used for making a plastic cast of the PCA, according to a previously described injection method.11

Results

The main cortical branches of the PCA are the parieto-occipital artery, the calcarine artery, and the anterior, middle, and posterior temporal arteries (Figure 1). The temporal vessels often arise from a common trunk called the common temporal artery. A few of the mentioned cortical branches supply the occipital lobe: the parieto-occipital and calcarine arteries, the posterior or common temporal artery, and, when present, the lingual gyrus artery.

Parieto-Occipital Artery

The parieto-occipital artery originated from the PCA in either the ambient (in 15% of the brains examined) or quadrigeminal cistern (18.3%), or in the calcarine sulcus (66.7%). The artery was almost always singular (98.3%). It entered the rostral portion of the calcarine sulcus and then continued along the parieto-occipital sulcus. In 1 of the mentioned sulci, the artery divided into 2 (Figure 1), 3, or 4 terminal stems, the branches of which were distributed to the medial and sometimes the lateral surface of the occipital and parietal lobes. In addition to the floor and banks of the parieto-occipital sulcus, these branches also supplied 10-40% of the precuneus and 10-20% of the cuneus (Figure 2a), 50-90% of the precuneus and 10-20% of the cuneus (Figure 2b), 10-30% of the precuneus and 20-50% of the cuneus (Figure 2c), 40-90% of the precuneus and 50-80% of the cuneus (Figure 2d), 40-90% of the precuneus and 80-90% of the cuneus (Figure 2e), 10-20% of the precuneus and 50-80% of the cuneus (Figure 2f), or 10-20% of the precuneus and 80-90% of the cuneus (Figure 2g).

The parieto-occipital artery gave rise to the following collateral vessels: the calcarine branch (in 20% of the brains examined), the anterior (3.3%) or middle (1.7%) or posterior (3.3%) temporal arteries, the hippocampal branches (3.3%), the thalamogeniculate branches (15%), the medial (5%) or lateral (23.3%) posterior choroidal arteries, and the branch to the splenium of the corpus callosum (48.3%). In 23.3% of the cases, the parieto-occipital artery supplied the lateral occipital gyri and the superior pari-
Main cortical branches of the posterior cerebral artery. 1, Anterior temporal arteries; 2, middle temporal artery; 3, posterior temporal artery; 4, parieto-temporal artery dividing into 2 terminal stems (4’ and 4’’); 5, right posterior cerebral artery; 6, basilar artery. Plastic cast, dorsal view.

Calcarine Artery

This artery had the same origin as the parieto-occipital artery (Figure 1), namely, they both arose from the same site of the distal segment of the PCA or from the same terminal stem (called the medial occipital artery) of the PCA. The calcarine artery was singular in 80% of the cases and double in 20%. In the latter group, 1 of the 2 vessels always originated from the parieto-occipital artery.

The single calcarine artery, which arose in the ambient or quadrigeminal cistern or in the proximal part of the calcarine sulcus, entered the latter and ran along it. In half of the cases the artery divided into 2, and more rarely into 3, terminal stems. One of the 2 terminal stems usually coursed along the floor of the calcarine sulcus, while the other was more superficially located. When 2 calcarine arteries were present, the smaller one, which arose from the parieto-occipital artery, supplied the rostral or superficial part of the calcarine sulcus.

In addition to the floor and the dorsal and ventral bank of the calcarine sulcus, the calcarine artery also supplied 80–90% of the cuneus (Figure 3a), 80–90% of the cuneus and most of the lingual gyrus (Figure 3b), 50–80% of the cuneus (Figure 3c), 50–80% of the cuneus and most of the lingual gyrus (Figure 3d), 20–50% of the cuneus (Figure 3e), 20–50% of the cuneus and most of the lingual gyrus (Figure 3f), 10–20% of the cuneus (Figure 3g), or 10–20% of the cuneus and most of the lingual gyrus (Figure 3h).
The proximal part of the calcarine artery gave off one or more of the following collateral branches: the middle (in 1.7% of the brains examined) or posterior (5%) temporal arteries, the hippocampal vessels (8.3%), and branches to the medial geniculate body (1.7%), the medial (1.7%) or lateral (1.7%) posterior choroidal arteries, and the splenial branch (1.7%). In 13.3% of the cases, the calcarine artery supplied not only the medial surface, but also a part of the lateral surface of the occipital lobe.

**Lingual Gyrus Artery**

This artery was present in 8.3% of the brains examined. It arose from the terminal stem of the PCA, close to the most rostral part of the calcarine sulcus. The artery coursed along the lingual gyrus, which it supplied entirely (Figure 4a). In 1 case, the lingual gyrus artery gave off a branch to the caudal part of the calcarine sulcus.

**Posterior Temporal Artery**

The posterior temporal artery was present in 60% of the cases (Figure 1). It was singular and very rarely duplicated (only 2.8% of the brains examined). The artery arose in the ambient cistern, either from the PCA (86.1%) or from the parieto-occipital (5.5%) or calcarine (8.3%) arteries. It coursed caudally and laterally, along the ventral surface of the hemisphere. The artery supplied the ventral surface of the occipital and the ventrocaudal portion of the temporal lobes. More precisely, it nourished the caudal part of the parahippocampal gyrus, the lingual gyrus (Figure 4c), the caudal half or two-thirds of the occipito-temporal (fusiform) gyrus (Figure 4, b and c), and the caudal third or half of the inferior temporal gyrus. In 41.6% of the cases, it irrigated a part of the lateral occipital gyrus, including the occipital pole, as well. In 3.4% of the brains, the artery gave off a branch to the caudal part of the calcarine sulcus. Finally, the proximal portion of the artery gave rise to the hippocampal branches (in 61.1% of the brains examined) and to the lateral posterior choroidal artery (2.8%).

**Common Temporal Artery**

This common stem of the temporal arteries is also called the lateral occipital artery or the tempo-occipital artery. It arose as the second terminal stem of the PCA in 40% of the cases. The origin was in the ambient cistern, usually at the level of the lateral geniculate body. The artery coursed across the parahippocampal...
gyrus and then distributed its branches to the ventral surface of the temporal and occipital lobes. The common temporal trunk almost entirely supplied the parahippocampal, occipito-temporal, and inferior temporal gyri (Figure 4d). In addition, it also supplied the lingual gyrus in 28.4% of the hemispheres (Figure 4e). The proximal part of the common temporal artery gave rise to the hippocampal branches (in 55.4% of the brains examined) and to the lateral posterior choroidal artery (12.5%).

Discussion

Our anatomic results clearly showed that the individual cortical branches of the PCA have variable regions of supply. Thus, the parieto-occipital artery irrigated almost the entire precuneus and cuneus in certain specimens (Figure 2, d and e), but in others it supplied only a narrow strip along the parieto-occipital sulcus (Figure 2a). The extent of a region supplied by a cortical artery depends mainly on the size and territory of the ramifications of that artery as well as on the size of the neighboring cortical branches of the posterior, anterior, or middle cerebral arteries. Some cortical regions may have various sources of blood supply. For example, the lingual gyrus can be irrigated by the calcarine, posterior temporal, common temporal, or lingual gyrus arteries (Figures 3 and 4). Certain cortical regions are sometimes supplied by several arteries. Thus, the calcarine cortex receives its main blood supply from the calcarine artery. In addition, the parieto-occipital artery gave off a branch to the rostral or superficial calcarine cortex in 20% of the cases, and in some other specimens (Figure 2, e and g) it supplied the rostrodorsal striate cortex. Finally, the temporal arteries sometimes gave off branches to the caudal portion of the calcarine cortex.

The last anatomic fact of possible clinical significance is the finding that some of the occipital arteries also gave off branches to the thalamus, geniculate bodies, internal capsule, and splenium of the corpus callosum. This means that occlusion of such an artery may be followed not only by infarction of certain cortical regions, but also of the deep forebrain structures.

In general, our results are in accordance with the data from the literature. However, there are some differences concerning the anatomic features and regions of supply of certain arteries.

According to Zeal and Rhoton, the parieto-occipital artery occasionally supplies the caudal part of the paracentral lobule. However, in all the specimens we have examined, this part of the paracentral lobule was nourished by the paracentral and/or the superior parietal branch of the anterior cerebral artery.

We found the lingual gyrus artery in 8.3% of the cases studied. This vessel was actually observed by Smith and Richardson, but it was incorrectly identified as the posterior temporal artery, or even as the second calcarine artery. The lingual gyrus artery, however, has all the features of a separate branch of the PCA.

The vessels that may supply the ventral surface of the occipital and temporal lobes are the common temporal artery; the posterior, middle, and anterior temporal arteries; and the hippocampal vessels. The common temporal artery was seen more frequently in our study than in other reports. The posterior temporal artery is one of the largest temporal vessels. It occasionally originated from the parieto-occipital or calcarine arteries instead of from the main stem of the PCA. The middle temporal artery is the least constant vessel, supplying the rostral portions of the parahippocampal, occipito-temporal, and inferior temporal gyri. The anterior temporal artery may arise as a single trunk or as multiple branches and nourishes the rostroventral part of the temporal lobe. According to Zeal and Rhoton, there are 1 or 2 hippocampal arteries; however, we found as many as 5 arteries in the same specimen (personal observation). They originated from the main stem of the PCA and/or from the initial portions of the temporal arteries. The hippocampal vessels supplied the uncus and hippocampal formation.

Occlusion of a given occipital or a temporal artery leads to brain tissue ischemia in its region of supply. The size and extent of the ischemic zone depends on 1) the size of the region supplied by the affected artery, 2) the cause of the occlusion, 3) the efficiency of the arterial anastomoses, and 4) the characteristics of the general and local brain vasculature and blood flow.

This is the reason for discrepancies between the expected and the real size and shape of the ischemic zone in some patients.

As a result, various neurologic signs and symptoms may follow the occlusion of these branches of the PCA. Isolated occlusion of the parieto-occipital artery, which often takes part in supplying the most rostral or rostrodorsal part of the striate cortex, may cause an incongruous homonymous hemianopia or inferior quadrantanopia sparing central fixation. Because of the damage to the parietal (precuneal) cortex, visual disorientation and metamorphopsia could also develop. In almost half of the patients, the parieto-occipital artery gives off the splenial branch, which nourishes the callosal fibers connecting the right visual areas to the left angular gyrus. Hence, occlusion of the left parieto-occipital artery in some patients can produce impaired color naming or pure alexia.

Isolated occlusion of the calcarine artery may produce a complete homonymous hemianopia. However, when the most caudal part of the striate cortex is supplied by the temporal branches of the PCA or the temporo-occipital or angular gyrus arteries, a homonymous hemianopia sparing central fixation will develop. Because of the additional participation of the parieto-occipital artery in irrigation of the rostral or superficial striate cortex, an incongruous homonymous hemianopia is also possible. Occlusion of a small branch of the mentioned arteries may produce a small central or peripheral scotoma.

Unilateral occlusion of the posterior temporal or the common temporal arteries (which supply, among other regions, the fusiform and often the lingual gyri) may
cause pure alexia or hemiachromatopsia and color anomia. In cases with bilateral infarctions in the temporo-occipital regions, the patients may have achromatopsia, visual object agnosia, and prosopagnosia. Finally, ischemia of the hippocampus (bilateral or on the left side only) may cause the impairment of memory.

References
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