Anatomy of the Middle Cerebral Artery: The Temporal Branches

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Abstract: Nineteen out of 23 middle cerebral arterial specimens had as the first major branch of the middle cerebral artery a sizable anterior temporal artery; a trunk forming the anterior and middle temporal branches; a trunk forming the anterior, middle, and posterior temporal arteries; or a trunk forming temporal and angular arterial branches. Patients harboring middle cerebral stenoses or occlusions who have correlating cerebral ischemic symptoms may be considered as candidates for microsurgical cerebral revascularization. However, if such patients undergo intracranial surgery, the superficial temporal artery should probably be joined to a supra-Sylvian arterial branch, rather than to a temporal arterial branch, in order to avoid delivering the new blood supply proximal to the stenotic or occluded segment.

Additional Key Words: cerebral atherosclerosis, cerebral ischemia, cerebral embolism and thrombosis, microsurgical cerebral revascularization, temporal lobe

Introduction

Ring and Waddington1-3 have described the terminal configuration of the middle cerebral artery, as well as the branching pattern of the artery within the Sylvian fissure. The configuration of the lenticulostriate arteries has been described by many authors, including Kaplan,4 Stephens and Stilwell,5 and Jain.6 Foix and Lévy7 described an anterior temporal branch coursing from the middle cerebral artery near its origin, and Vander Eecken8 mentions an anterior temporal artery as well as an inconstant temporopolar artery. The origins of the temporopolar artery and the anterior temporal artery have been illustrated by Stephens and Stilwell9 in their meticulous photographic study of the cerebral vasculature, and the angiographical anatomy of the temporopolar branches has been illustrated by Dahlström et al.10 However, descriptions of the middle cerebral temporal branches which we found in the literature did not correlate with our preliminary observations of these arterial branches. We undertook this study to define further the arterial anatomy of the temporal lobe, hoping to find immediate application of our findings in the field of microsurgical cerebral revascularization.

Methods

Twelve human brains were injected, fixed, and dissected. Twenty-three middle cerebral arterial specimens were obtained. (One specimen was inadvertently discarded after only one middle cerebral artery had been dissected.) Both middle cerebral arteries of each fresh brain were injected with an acrylic compound after the brain had been removed from the cranial cavity.* The brains were then fixed in formalin. Each middle cerebral arterial complex was then dissected and mapped from the origin to the terminal branches over the convolutions. We used the arterial nomenclature of Ring and Waddington, and attempted to define grossly the central sulcus, in order to relate the arterial branches to this convolutional landmark. The 23 middle cerebral artery specimens fell into nine groups, oriented to the anatomical configuration of the arterial supply of the temporal lobe. Obviously, the grouping of the specimens would have been different if they had been oriented to the configuration of the central sulcus arteries, the angular artery, or some other branch of the middle cerebral arterial complex.

Results

In 19 out of the 23 middle cerebral arterial specimens, the first major branch of the middle cerebral arterial complex was either an artery supplying the anterior temporal lobe or a large trunk
The first large branch of the middle cerebral artery (MCA) is a large arterial trunk which supplies the entire temporal lobe by forming the temporopolar artery (TPA), anterior temporal artery (ATA), middle temporal artery (MTA), and posterior temporal artery (PTA). The lenticulostriate arteries (LSA) arise from the main middle cerebral trunk.

which divided into several temporal arterial branches. In some cases this large trunk terminated as the anterior and middle temporal arteries; in other cases it continued posteriorly to terminate as the posterior temporal artery or the angular artery. This branch or trunk arose from the middle cerebral artery proximal or opposite to the lenticulostriate arteries in 12 of the 19 cases, and distal to the

Temporal lobe arterial zones, determined by the distance from the tip of the temporal lobe at which the temporal arterial branches emerged from the Sylvian fissure.
lenticulostriate arteries in seven cases. After arising from the middle cerebral artery, this arterial channel coursed over the superior surface of the temporal pole and anterior temporal lobe. Individual branches of this artery then emerged from the Sylvian fissure and ran posteroinferiorly over the superior temporal gyrus to supply the anterior, middle, and posterior aspects of the temporal lobe (fig. 1).

The temporopolar artery arose either as a separate branch from the middle cerebral artery or

Figure 3
Arterial zones of the middle cerebral artery. OBF: orbitofrontal arterial complex; OPF: operculofrontal arterial complex; CSA: central sulcus arteries; PPA: posterior parietal artery; and ANG: angular artery.

Figures 4 and 5
Group I. Seven specimens. First major MCA branch formed ATA, MTA and PTA. ACA: anterior cerebral artery; ACH: anterior choroidal artery; ACM: anterior communicating artery; AHB: recurrent artery of Heubner; and PCM: posterior communicating artery.

Group II. Five specimens. First major MCA branch formed ATA, MTA, PTA, and ANG.
as a branch of the temporal trunk, and traveled in the pia-arachnoid anteroinferiorly over the anterior and medial aspects of the temporal pole.

The course of the angular artery as it emerged from the Sylvian fissure was defined approximately by a line extended horizontally from the posterior termination of the Sylvian fissure. In the intact human, this line is approximately parallel to the anthropological baseline, mentioned by Taveras and Wood.11

During the arterial dissections, the arterial branches emerging from the Sylvian fissure were arbitrarily grouped into anterior, middle, or posterior temporal branches. In some specimens, the distance between the emerging arterial branch and the tip of the temporal pole was measured.

Figure 2 illustrates that the arterial branches tended to fall into three groups defined by the distance between the temporal pole and the point at which they emerged from the Sylvian fissure. These measurements formed the basis for the arterial zones of the temporal lobe illustrated in figure 3. Figure 3 also illustrates the other middle cerebral arterial zones of the hemisphere, adapted from Ring and Waddington.

Figures 4 through 12 illustrate the nine groups into which these specimens could be classified. One specimen from each group is illustrated, oriented for clarity as though it were the left middle cerebral arterial complex. Such right-left inversion in the case of some specimens may represent an anatomical oversimplification, since the studies of LeMay and Culebras12 and of Geschwind and Levitsky13 have indicated that there are specific arterial and cortical differences between the dominant and the nondominant cerebral hemispheres.

The total number of middle cerebral arteries dissected (23) is small and doubtless a number of other variations would have become evident if more specimens had been included in this series. In 14 specimens the first major branch of the middle cerebral artery was an anterior temporal-middle temporal-posterior temporal trunk, a temporal-angular trunk, or an anterior temporal-middle temporal trunk (Groups I, II, VI, and VII).
In three specimens, the first major branch was the anterior temporal artery which was followed immediately by a middle temporal-posterior temporal-angular trunk (Group III). In two specimens the first major branch was the anterior temporal artery, with the middle and posterior temporal branches arising more distally from the middle cerebral complex (Groups VIII and IX). In the remaining four specimens, the orbitofrontal and operculofrontal complexes arose proximal to the origins of the temporal branches (Groups IV and V).

The configurations of the two middle cerebral arteries in any one brain tended to be asymmetrical. Table 1 illustrates the anatomical groupings of the left or right middle cerebral arterial complex from each numbered anatomical specimen.

**Discussion**

In 1967 Donaghy and Yasargil, working independently at that time, each constructed in a patient a superficial temporal artery-cortical artery vascular bypass in an effort to relieve symptoms of cerebrovascular insufficiency. This procedure has now been done by many neurosurgeons throughout the world, but evaluation of the procedure as a means of mitigating the effects of cerebrovascular disease remains in the embryonic stage. The study we have presented here indicates that neurosurgeons must proceed with great caution as they choose vessels on the surface of the cerebral hemisphere to receive a new blood supply from the scalp arteries. Yasargil has recommended that an arterial branch lying on the temporal lobe be used as a convenient recipient for such microsurgical anastomoses. However, in cases of middle cerebral artery stenosis or occlusion, such an artery may not be a suitable recipient. Figure 13 illustrates the cerebral angiogram of a patient who harbored an occlusion of the middle cerebral artery. This patient was not deemed a candidate for microsurgical revascularization. However, if this patient had been subjected to such surgery, and if an artery lying on the anterior temporal lobe had been used as the recipient vessel, the angiogram demonstrates that any new collateral blood delivered from the superficial temporal artery via the anastomosis either would have been carried into the middle cerebral artery proximal to the occlusion, or would have been carried distally into the terminal branches of the temporal arteries. None would have been delivered to the ischemic area of the cerebral hemisphere distal to the middle cerebral artery occlusion.

It should be noted that Reichman has anastomosed the superficial temporal artery to supra-Sylvian cortical arteries with good technical success.
MIDDLE CEREBRAL ARTERY

There are cases in which a temporal lobe arterial branch might represent the preferred recipient vessel when considering a patient for microsurgical cerebral revascularization. In patients harboring surgically inaccessible internal carotid stenoses or occlusions, microsurgical anastomosis of the superficial temporal artery to an anterior temporal arterial branch might result in the delivery of a new blood

FIGURE 11
Group VIII. One specimen. First major MCA branch was ATA. First branch after OBF formed MTA and PTA.

FIGURE 12
Group IX. One specimen. First major MCA branch was ATA. MCA terminated as PPA, ANG, and MTA. Several small PTA branches arose from ANG.

FIGURE 13
Anteroposterior angiographical view demonstrating acute left MCA occlusion. The arrows mark the large arterial trunk which supplies the temporal lobe after arising from the MCA proximal to the occlusion.
supply proximal to the lenticulostriate arteries close to the origin of the middle cerebral artery. Such an anastomosis in these cases would be ideal for potentially perfusing the ischemic middle cerebral arterial tree.

The hemodynamic consequences of each middle cerebral arterial configuration remain to be assessed. The basic investigation of pulsatile cerebral hemodynamics has barely begun.

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References
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