Topographic Surgical Anatomy of the Parasylvian Anterior Temporal Artery for Intracranial-Intracranial Bypass

Ali Tayebi Meybodi[1,2], Dylan Griswold[1,2], Halima Tabani[1,2], Michael T. Lawton[1,2], Pooneh Mokhtari[2], Andre Payman[2], Arnau Benet[1-3]

■ BACKGROUND: **The anterior temporal artery (ATA) is an appealing donor artery for intracranial-intracranial bypass procedures. However, its identification may be difficult. Current literature lacks useful landmarks to help identify the ATA at the surface of the sylvian fissure. The objective of this study was to define the topographic anatomy of the cortical segment of the ATA relative to constant landmarks exposed during the pterional approach.**

■ METHODS: **The temporopolar artery (TPA), ATA, and middle temporal artery (MTA) were examined in 16 cadaveric specimens. The topographic anatomy and key landmarks of the arteries at the sylvian fissure were recorded. The distance between the point of emergence from the sylvian fissure to the lesser sphenoid wing and anterior tip of the temporal lobe was measured. The features of the inferior frontal gyrus relative to each of the arteries at the sylvian fissure were also recorded.**

■ RESULTS: **The average distances from the lesser sphenoid wing to the TPA, ATA, and MTA were 3.7 mm, 21.2 mm, and 37 mm. The mean distances from the temporal pole were TPA, 14.7 mm; ATA, 32.0 mm; and MTA, 45.4 mm. The differences between the average distances were statistically significant (*P* < 0.0001). The ATA most frequently faced pars triangularis, whereas the TPA always faced pars orbitalis. The MTA was always found posterior to the junction of pars triangularis and pars opercularis.**

■ CONCLUSIONS: **This article provides topographic evidence for efficient identification of the ATA in the parasylvian space. The key relationship and landmarks identified in this study may increase efficiency and safety when harvesting the ATA for intracranial-intracranial bypass.**

INTRODUCTION

The anterior temporal artery (ATA) supplies the anterior part of the superior, middle, and inferior temporal gyri.[1] In most cases, the ATA supplies a cortical territory in which an infarct would not cause major neurologic deficits.[2,3] This feature makes the ATA an excellent intracranial donor artery and decreases the ischemia time related to harvesting the donor artery in an intracranial-intracranial (IC-IC) bypass. For this reason, the ATA is considered a favored source of donor blood during IC-IC bypass procedures.[2,4] When the ATA arises as an early branch (<30%),[5,6] it is a favorable candidate for revascularization after a proximal occlusion of the middle cerebral artery (MCA). In cases where the ATA has a distal origin (M2), it is still a good choice for revascularization of distal MCA lesions (aneurysms) requiring bypass. It can also be used as a donor to bypass to the posterior circulation recipients.[2]

The ATA can be used in both side-to-side and end-to-side bypasses.[2,4] The ATA is typically exposed after opening the

Key words
- Aneurysm
- Intracranial-intracranial bypass
- Middle cerebral artery
- Revascularization
- Sylvian fissure

Abbreviations and Acronyms
ATA: Anterior temporal artery
IC-IC: Intracranial-intracranial
LSW: Lesser sphenoid wing
MCA: Middle cerebral artery
MTA: Middle temporal artery
SCA: Superior cerebellar artery
TPA: Temporopolar artery

From the [1]Department of Neurological Surgery, [2]Skull Base and Cerebrovascular Laboratory, and [3]Department of Otolaryngology Head and Neck Surgery, University of California, San Francisco, San Francisco, California, USA

To whom correspondence should be addressed: Arnau Benet, M.D. [E-mail: arnaubenet@gmail.com]

Citation: World Neurosurg. (2016) 93:67-72.
http://dx.doi.org/10.1016/j.wneu.2016.05.050

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

sylvian fissure widely and exposing the M1 MCA trunk and main branches. However, the complexity and variability of the branching pattern of the MCA often makes identification of the ATA difficult in the depths of the sylvian fissure, where multiple MCA branches intermingle. The identification of the ATA in the depths of the sylvian fissure can prove difficult and carry additional risks intrinsic to splitting the sylvian fissure, especially if it is arising from the inferior trunk of the MCA.

An alternative choice would be localizing the parasylvian ATA before splitting the sylvian fissure. However, localization of the parasylvian ATA may prove difficult early in the case. Adjacent cortical branches of the MCA include the middle temporal artery (MTA) posteriorly and the temporopolar artery (TPA) anteriorly. The TPA is usually a small branch supplying the temporal pole and may include more than 1 arterial channel.[5,6] The MTA supplies the middle parts of the superior and middle temporal gyri and the middle and posterior parts of the inferior temporal gyrus.[1] When the surgeon is dissecting the sylvian fissure, the ATA, MTA, and TPA may be mistaken for each other at the superficial part of the sylvian fissure. This situation can be even more problematic with a tight swollen sylvian cistern after subarachnoid hemorrhage or when a neoplastic lesion distorts the natural anatomy. Harvesting the MTA as a donor artery can endanger important higher cortical functions, as it may cause ischemia of the posterior temporal lobe.[5,6] The small TPA can be a suboptimal donor for a bypass.

Identification of the ATA at the surface of the sylvian fissure would greatly help the surgeon in protecting the artery and would help guide the sylvian fissure split. For such localization, it is important to know the location of the M3—M4 junction of the ATA in relation to identifiable, constant surrounding landmarks. In this study, we sought to delineate the topographic location of the parasylvian ATA to facilitate its localization using bony and cortical references available during early cortical exposure of a standard pterional approach.

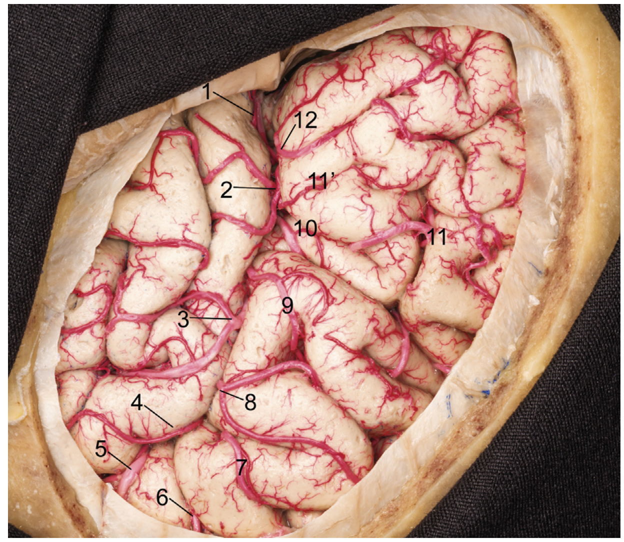

Figure 1. Surgical simulation of left pterional craniotomy, with the cortical branches of the middle cerebral artery. 1, temporopolar artery; 2, anterior temporal artery; 3, middle temporal artery; 4, posterior temporal artery; 5, temporo-occipital artery; 6, angular artery; 7, posterior parietal artery; 8, anterior parietal artery; 9, central artery; 10, precentral artery; 11 and 11′, prefrontal artery; 12, orbitofrontal artery. (Used with permission from the Skull Base and Cerebrovascular Laboratory, University of California, San Francisco.)

MATERIALS AND METHODS

We prepared 16 cadaveric specimens according to our published protocol for embalming.[7] The head was positioned laterally using a 3-pin head holder (Freedom Clamp; Mizuho America, Inc., Union City, California, USA). A large pterional craniotomy was then turned over the frontal, parietal, and temporal lobes. Using a high-speed drill, the sphenoid ridge was flattened as done routinely for a pterional approach to the central skull base. The dura mater was then opened in a curvilinear fashion. The arachnoid was taken, and the sylvian fissure was opened to identify the branching pattern of the MCA tree. The 12 cortical branches of the MCA were identified along the opercula of the sylvian fissure. To ensure correct naming, 2 experienced anatomists (A.T.M. and A.B.) identified the cortical (M4) MCA branches independently (**Figure 1**).

Using a previously described segmentation scheme of the MCA,[5] the M3—M4 junction was identified for the TPA, ATA, and MTA; separate M3—M4 junction points were recorded for duplicate arteries. Next, the approximate point of intersection between the tangential plane on the superior temporal gyrus and the lesser sphenoid wing (LSW) was identified. Also, the anterior-most point of the temporal lobe (temporal tip) was marked. The distances from each M3—M4 junction to the LSW and to the temporal tip were measured using a navigation system (Stryker Corporation, Kalamazoo, Michigan, USA) (**Figure 2**). For M3—M4 points anterior to the LSW, the distance was recorded as negative, and for points lying posterior to the LSW, the value was recorded as a positive number. Also, the location of M3—M4 junctions of the TPA, ATA, and MTA were assessed in relation to the inferior frontal gyrus in the frontal operculum. Specifically, we determined the part of the frontal operculum (i.e., pars orbitalis, pars triangularis, pars opercularis, or precentral gyrus) opposing the M3—M4 junction of each of the 3 arteries.

Statistical analysis included Student t test to compare means.

RESULTS

In 16 cadaveric specimens, 19 ATAs were identified (1 specimen had a previously cut ATA, and 4 specimens had duplicated cortical ATAs). There were 17 TPAs (1 duplicated TPA) and 16 MTAs. In all specimens, the TPA faced pars orbitalis. Less than half of the ATAs faced the junction between pars triangularis and pars orbitalis (9 of 19); 8 ATAs (42%) were found opposite pars triangularis or the junctional point between pars triangularis and pars opercularis. In 2 of 19 specimens (11%), the ATA faced the anterior aspect of pars opercularis. Except for 1 MTA that faced the junction of pars triangularis and opercularis, the rest (94%) were found posterior to that point (i.e., opposite the precentral gyrus or