The anterior temporal artery: an underutilized but robust donor for revascularization of the distal middle cerebral artery

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OBJECTIVE The anterior temporal artery (ATA) supplies an area of the brain that, if sacrificed, does not cause a noticeable loss of function. Therefore, the ATA may be used as a donor in intracranial-intracranial (IC-IC) bypass procedures. The capacities of the ATA as a donor have not been studied previously. In this study, the authors assessed the feasibility of using the ATA as a donor for revascularization of different segments of the distal middle cerebral artery (MCA).

METHODS The ATA was studied in 15 cadaveric specimens (8 heads, excluding 1 side). First, the cisternal segment of the artery was untethered from arachnoid adhesions and small branches feeding the anterior temporal lobe and insular cortex, to evaluate its capacity for a side-to-side bypass to insular, opercular, and cortical segments of the MCA. Any branch entering the anterior perforated substance was preserved. Then, the ATA was cut at the opercular-cortical junction and the capacity for an end-to-side bypass was assessed.

RESULTS From a total of 17 ATAs, 4 (23.5%) arose as an early MCA branch. The anterior insular zone and the frontal parasylvian cortical arteries were the best targets (in terms of mobility and caliber match) for a side-to-side bypass. Most of the insula was accessible for end-to-side bypass, but anterior zones of the insula were more accessible than posterior zones. End-to-side bypass was feasible for most recipient cortical arteries along the opercula, except for posterior temporal and parietal regions. Early ATAs reached significantly farther on the insular MCA recipients than non-early ATAs for both side-to-side and end-to-side bypasses.

CONCLUSIONS The ATA is a robust arterial donor for IC-IC bypass procedures, including side-to-side and end-to-side techniques. The evidence provided in this work supports the use of the ATA as a donor for distal MCA revascularization in well-selected patients.

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KEY WORDS intracranial-intracranial bypass; pterional craniotomy; sylvian fissure; aneurysms; vascular disorders

SURGICAL treatment of complex middle cerebral artery (MCA) aneurysms is challenging because aneurysm obliteration is technically demanding and often requires revascularization of the distal MCA territory. Extracranial (EC)-intracranial (IC) bypass techniques are commonly used for this purpose,^{14,18,20,22,29,30} but IC-IC bypass techniques are gaining attention as they offer matched donor-recipient arterial calibers, spare the patient from multiple incisions, and require fewer suture lines, which may increase bypass patency.^{2,17,26,31} Four main techniques of IC-IC bypass are typically used to treat complex MCA aneurysms: 1) reanastomosis, which involves using the

parent artery as the donor; 2) interpositional bypass, which uses a graft vessel between another donor artery and the recipient; 3) in situ anastomosis, which connects 2 parallel arteries that are close to each other; and 4) reimplantation, which connects the recipient artery to the side of the parent artery.³¹ Each of these bypass techniques carries its own requirements and risks,^{26,31} including the risk to the vascular territory of the donor artery during the bypass procedure, which is a disadvantage of all IC-IC bypasses.

The anterior temporal artery (ATA) is an intracranial artery whose occlusion does not cause significant clinical neurological deficit, an uncommon feature of the intracra-

ABBREVIATIONS AA = angular artery; AP = anterior parietal; ATA = anterior temporal artery; CA = central artery; EC = extracranial; IC = intracranial; MCA = middle cerebral artery; MT = middle temporal; OF = orbitofrontal; PC = precentral; PF = prefrontal; PP = posterior parietal; PT = posterior temporal; TO = temporooccipital; TP = temporopolar.

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nial arteries.^{13,15,26,31,32} Consequently, the ATA is a potential donor for IC-IC bypasses because its temporary occlusion during the anastomosis does not add any clinically significant ischemia to that already produced by temporary occlusion of the recipient artery. The ATA has not been widely used as an arterial donor in the bypass armamentarium.^{10,19,34,35} In this study, we sought to define the role of the ATA for revascularization of the MCA territory using simulated bypasses in cadavers.

Methods

Eight cadaveric heads (15 sides examined) were prepared for surgical simulation in the Skull Base and Cerebrovascular Laboratory of the University of California, San Francisco, using our customized formula.⁵ A large pterional craniotomy was completed with the head in the lateral position using a 3-pin head holder (Mizuho). After opening the dura in a curvilinear fashion, the sylvian fissure was widely opened from the distal end to the proximal end to expose the MCA completely. The 12 named cortical branches (M_4 segments) were identified according to the cortical gyral location of the arteries (Fig. 1A).¹⁰ The arterial tree was drawn from the origin of the MCA to the distal peri-sylvian cortical branches; specifically, the pattern of ATA origin was recorded (early or non-early MCA branch; early branches originate from the MCA prior to its bifurcation). Next, the cisternal segment of the ATA was freed from arachnoid adhesions. Small branches feeding the anterior aspect of the temporal lobe and insular cortex were cut. The perforating branches (if any) to the anterior perforating substance were preserved (Fig. 1B). Two protocols were used to assess the capacity of this artery for bypass using different bypass techniques.

Side-to-Side Bypass

The artery was mobilized to evaluate the feasibility of completing a side-to-side bypass to the most distant M_2 , M_3 , and M_4 branches of the MCA. A successful bypass was determined when a tension-free, side-to-side bypass of a length 3 times the diameter of the recipient artery was possible (Fig. 1C). The exact gyral location of the by-

pass, the diameter of the recipient artery at the bypass, and the distance from the bypass to the limen insulae were recorded. The bypass feasibility was not tested for the temporopolar (TP) artery as the recipient because it would not have clinical relevance. Distance measurements were performed with a frameless stereotactic navigation system (Stryker) and the diameters were measured with a handheld caliper.

End-to-Side Bypass

In the next step, the ATA was divided at the $M_{3,4}$ junction and the possibility of completing an end-to-side bypass was recorded for M_2 , M_3 , and M_4 segments of the MCA in the same sequence as for a side-to-side bypass.

Insular Dimensions

To further clarify the exact location of the bypass points to the insular segments of the MCA, the anatomy of the insula was conceptualized into a tetragon consisting of 2 triangles attached at the central sulcus of the insula. The short and long gyri of the insula were reconstructed by trisecting and bisecting the anterior and posterior segments of the superior limiting sulcus, respectively, and connecting to the limen insulae. The lengths of the sulci between the short gyri and the sulcus between the anterior long gyrus and posterior long gyrus were calculated trigonometrically. The insular surface was classified into 6 different zones (I–VI) to facilitate interpretation of data as follows: Zone I, anterior to and including the anterior limiting sulcus; Zone II, anterior short gyrus including the sulcus between the anterior short gyrus and the middle short gyrus; Zone III, middle short gyrus including the sulcus between the middle short gyrus and the posterior short gyrus; Zone IV, posterior short gyrus including the central insular sulcus; Zone V, anterior long gyrus including the sulcus between the anterior long gyrus and the posterior long gyrus; and Zone VI, posterior long gyrus including the inferior limiting sulcus of the insula. The average location of the bypass point on each insular zone was calculated as $L_R = P/L \times 100$, in which L_R is the average location of the bypass point on each insular zone defined as a percentage of the length of that zone, P is the average distance of the bypass

FIG. 1. Cadaveric dissection photographs. **A:** Twelve cortical branches of the MCA: TP artery (1), ATA (2), MT artery (3), PT artery (4), TO artery (5), AA (6), PP artery (7), AP artery (8), CA (9), PC artery (10), PF artery (11 and 11'), and OF artery (12). **B:** Opening the sylvian fissure and exposing the ATA (2 branches, numbered 1 and 2; dashed line). IFG = inferior frontal gyrus; TPA = TP artery. **C:** Side-to-side double-barrel bypass from the ATAs (numbered as 1 and 2; contoured with yellow lines) to the OF artery (12) and CA (9) (contoured with dashed green lines). The interrupted green lines outline the course of the recipient arteries. The yellow line outlines the course of donor ATAs. Figure is available in color online only.

TABLE 1. Origin and course of the ATA in 15 specimens

ATA Type	No.	Cisternal Length (mm)*	Proximal Diameter (mm)*	Distal Diameter (mm)*	Shrinkage (mm)*	% Hypoplastic ATA	
						At Origin	At M ₃₋₄
All	17	36.0 ± 12.1	1.3 ± 0.3	1.1 ± 0.3	0.2 ± 0.2	18	41
Early branching	4	51.4 ± 5.8	1.4 ± 0.3	1.3 ± 0.4	0.1 ± 0.1		
Non-early branch	13	31.3 ± 9.2	1.2 ± 0.4	1.0 ± 0.2	0.2 ± 0.2		

* Means ± standard deviations.

point to the limen insula, and *L* is the total length of the insular zone.

Results

Origin and Course of the ATA

There were 17 ATAs in 15 specimens. Four ATAs (23.5%) originated as an early branch from the MCA. There was a significant difference between the cisternal lengths of early ATAs and those from non-early ATAs ($p < 0.05$). Table 1 summarizes the characteristics of the ATAs examined in this study.

Side-to-Side Bypass

M₂ Segments. The ATA reached 33%–59% of the lengths of the insular zones on average for a side-to-side bypass (Table 2, Fig. 2A). Zones I–III accounted for the farthest bypass possible on the insula. Twenty-five percent of the insular segment bypasses reached the M₂₋₃ junction. This was highest for Zones I and VI (53% and 42%, respectively). The early ATAs reached an average of 3 mm farther on the insular surface than non-early ATAs (20.7 ± 3.1 vs 17.7 ± 2.6 mm; $p < 0.05$).

M₃ Segments. The frontal operculum (containing the orbitofrontal [OF], prefrontal [PF], and precentral [PC] arteries) was most frequently reached by the ATA for a side-to-side bypass. However, the M₃ central artery (CA) was not a favorable target for side-to-side bypass (24% reached; Table 3, Fig. 2B). The parietal and occipital opercula were barely reached for a side-to-side bypass. On the other hand, the temporal operculum was often reached for a side-to-side bypass (71%).

M₄ Segments. When using the side-to-side technique, the OF (on the pars orbitalis) and PF (on the posterior part

of the inferior frontal gyrus) arteries were the recipients most frequently reached (71% and 53%, respectively; Table 4, Fig. 2C). The bypass points on the M₄ segments were all located on the parasylvian area. The maximum reach of early ATAs to M₄ segments (28.3 ± 6.5 mm) was not significantly different from that of non-early ATAs (26.6 ± 1.8 mm; $p = 0.23$).

End-to-Side Bypass

M₂ Segments. The ATA reached 56%–81% of the lengths of the insular zones when an end-to-side technique was used (Table 2, Fig. 2D). The M₂₋₃ junction was reached more frequently (average = 86%) in Zones I–III, while it was reached least frequently in Zone V (41%). Except for Zones I and VI, the bypass point reached $\geq 70\%$ of the length of the respective sulcus, and Zones II–V were most reachable. Early branching ATAs reached farther on the insular surface (38.4 ± 6.7 mm) compared with non-early branching ATAs (31.6 ± 3.3 mm; $p < 0.01$).

M₃ Segments. The M₃ branches on the frontal and temporal lobes had the highest rate of successful bypass (Table 3, Fig. 2E). However, the parietal lobe was not reached for end-to-side bypass in many specimens, and the M₃ parietal and angular arteries (AAs) were reached in less than 50% of the specimens.

M₄ Segments. The M₄ segments of the frontal and temporal lobes were most frequently reached for end-to-side bypass (Table 4, Fig. 2F). Conversely, M₄ segments of the parietal and occipital lobes could not be reached in most specimens. The average distance from the bypass point to the limen insulae was 42 mm. The cisternal length of the ATA did not correlate with the maximum distance of the bypass point from the limen insulae (Pearson correlation coefficient = 0.57). Also, maximum reach for cortical re-

TABLE 2. Results of side-to-side and end-to-side bypass to the M₂ segment

Insular Zone*	Side-to-Side				End-to-Side			
	Relative Location on Analogous Zone	Mean Distance ± SD (mm)	Mean Diameter ± SD (mm)	Frequency of M ₂₋₃ Bypasses (%)	Relative Location on Analogous Zone	Mean Distance ± SD (mm)	Mean Diameter ± SD (mm)	Frequency of M ₂₋₃ Bypasses (%)
I	0.54	16.9 ± 3.5	1.2 ± 0.4	53	0.63	19.6 ± 6.7	1.1 ± 0.2	96
II	0.59	16.6 ± 2.9	1.5 ± 0.4	20	0.81	22.6 ± 6.2	1.5 ± 0.4	77
III	0.50	14.7 ± 2.8	1.8 ± 0.3	0	0.81	23.9 ± 5.9	1.6 ± 0.4	84
IV	0.36	14.4 ± 2.9	2.0 ± 0.5	0	0.75	26.3 ± 7.8	1.8 ± 0.3	53
V	0.33	11.0 ± 2.3	2.4 ± 0.3	0	0.71	27.6 ± 7.3	2.0 ± 0.6	41
VI	0.34	15.2 ± 3.7	1.7 ± 0.4	42	0.56	25.6 ± 9.1	1.8 ± 0.4	70

* See text for description of insular zones.

FIG. 2. Illustration showing the average farthest anastomosis for different bypass choices from the ATA to recipient branches of the MCA. **A:** Average maximum reach of the ATA for a side-to-side bypass to the insular segment of the MCA on different insular zones relative to the average length of each insular zone (see Table 2 for detailed results and text for description of insular zones). Yellow triangle represents Zone I of the insula, which is the area anterior to the anterior short gyrus, including the anterior limiting sulcus. **B:** Percentage of specimens with a successful side-to-side bypass to the M₃ segment. **C:** Percentage of specimens with a successful side-to-side bypass to the M₄ segment. **D:** Average maximum reach of the ATA for an end-to-side bypass to the insular segment of the MCA on different insular zones relative to the average length of each insular zone. Yellow triangle represents Zone I of the insula, which is the area anterior to the anterior short gyrus, including the anterior limiting sulcus. See Table 2 for detailed results. **E:** Percentage of specimens with a successful end-to-side bypass to the M₃ segment. **F:** Percentage of specimens with a successful end-to-side bypass to the M₄ segment. Copyright Arnau Benet. Published with permission. Figure is available in color online only.

cipients was not significantly different between the early and non-early ATAs ($p = 0.20$).

Case Illustration

A 24-year-old male patient with a history of infective endocarditis and previous septic embolic strokes of both hemispheres presented with generalized tonic-clonic seizure. Computed tomography of the head showed a large intraparenchymal hemorrhage in the territory of the right MCA (Fig. 3A). Digital subtraction angiography showed a tapering right M₁ MCA giving rise to a nonsaccular aneurysm without a discernible neck. The aneurysm dome gave rise to 1 viable efferent branch on the frontal side. The ATA originated as an early branch from the M₁ MCA (Fig. 3B and C). After the distal segment of the ATA was released, it was mobilized to reach the efferent branch coming off the aneurysm. The aneurysm was trapped and the efferent branch was reimplanted onto the mobilized

ATA (Fig. 3D–G). Postoperative angiography showed obliteration of the aneurysm and bypass patency (Fig. 3H). The patient was discharged without any new neurological deficit.

Discussion

A feasibility assessment of different bypass techniques using the ATA for revascularization of the distal MCA shows that the ATA can be used as a donor for IC-IC bypass to various recipient arteries on the MCA tree. All previously published studies on the ATA are descriptive and address the anatomical features and variability of the ATA.^{9,10,34} Bederson and Spetzler were among the first to use the ATA to complete a bypass in a case of a pre-bifurcation MCA aneurysm.³ Our team has reported the use of the ATA as a donor artery in IC-IC bypass procedures, including an ATA-superior cerebellar artery bypass and

TABLE 3. Results of side-to-side and end-to-side bypass to the M₃ segment

Recipient Territory	Side-to-Side			End-to-Side		
	Ratio of Successful Bypass (%)	Mean Distance $\pm$ SD (mm)	Mean Diameter $\pm$ SD (mm)	Ratio of Successful Bypass (%)	Mean Distance $\pm$ SD (mm)	Mean Diameter $\pm$ SD (mm)
OF	76	17.6 $\pm$ 4.3	0.98 $\pm$ 0.3	94	20.0 $\pm$ 5.4	1.1 $\pm$ 0.5
PF	71	20.4 $\pm$ 6.4	1.25 $\pm$ 0.3	88	25.3 $\pm$ 6.7	1.3 $\pm$ 0.5
PC	53	18.5 $\pm$ 6.8	1.44 $\pm$ 0.3	94	27.7 $\pm$ 6.1	1.6 $\pm$ 0.4
CA	24	14.4 $\pm$ 3.6	1.83 $\pm$ 0.3	94	31.6 $\pm$ 6.1	1.7 $\pm$ 0.4
AP	—	—	—	41	38.4 $\pm$ 7.7	1.5 $\pm$ 0.2
PP	—	—	—	18	44.9 $\pm$ 9.6	1.6 $\pm$ 0.3
AA	6	20.0*	1.90*	41	35.4 $\pm$ 8.1	1.9 $\pm$ 0.6
TO	6	20.0*	1.90*	76	33.6 $\pm$ 5.8	1.8 $\pm$ 0.5
MT	47	20.58 $\pm$ 6.9	1.50 $\pm$ 0.3	82	21.1 $\pm$ 8.4	1.5 $\pm$ 0.4
PT	24	22.68 $\pm$ 9.1	1.68 $\pm$ 0.4	88	23.8 $\pm$ 9.9	1.7 $\pm$ 0.5

* Only 1 value, no standard deviation possible.

reimplantation of a frontal MCA trunk onto the ATA.^{1,26,31} However, none of these studies delineate the full potential of the ATA in IC-IC bypass surgery.

Early Branching ATA and Bypass for Proximal MCA Occlusions

Complex aneurysms and other pathologies affecting the proximal MCA may necessitate occlusion of the MCA trunk as part of their treatment strategy. Early MCA branches (e.g., an early ATA) arising proximal to the site of occlusion can serve as an optimal donor in such cases.

The first early temporal branch usually arises from the main MCA trunk at an average distance of 6–8.5 mm from the ICA bifurcation.^{6,33} Our results show that in 23.5% of specimens, the ATA originates as an early branch, having an average diameter of 1.4 mm. The early ATAs were larger than 1 mm at their origin in all specimens. This large diameter may make them suitable as a low-flow donor. The early branching, cisternal length, and diameter of the ATA can be appreciated preoperatively. However, the actual mobility of the cisternal segment ATA may be difficult or impossible to predict, and therefore the feasibility

for bypass to a specific target vessel on the MCA candelabra may prove difficult before surgery.

Constancy of Early ATA Diameter

Along their cisternal course, early ATAs suffered little shrinkage (mean 0.1 mm) in diameter. Thus, the relatively constant diameter of the ATA along its cisternal course makes it a reliable donor for bypass to one of the postbifurcation distal MCA branches.

Maximal Mobility of Early ATA

An optimal bypass matches the diameters of donor and recipient arteries.^{26,27} Our results show that recipient arteries on Zones I and II match the diameter of the ATAs. This implies that in cases of a proximal MCA occlusion, an early ATA can be optimal for revascularization of the distal MCA, preferably on insular Zones I and II. Moreover, based on our results, an early ATA provides great mobility of its cisternal segment, thus allowing for reaching farther to the recipients on the insular surface (both for side-to-side and end-to-side bypasses). This increased mobility may not be needed in cases of proximal MCA occlusion,

TABLE 4. Results of side-to-side and end-to-side bypass to the M₄ segment

Recipient Territory	Side-to-Side			End-to-Side		
	Ratio of Successful Bypass (%)	Mean Distance $\pm$ SD (mm)	Mean Diameter $\pm$ SD (mm)	Ratio of Successful Bypass (%)	Mean Distance $\pm$ SD (mm)	Mean Diameter $\pm$ SD (mm)
OF	71	22.2 $\pm$ 3.8	0.9 $\pm$ 0.2	88	31.2 $\pm$ 8.8	0.9 $\pm$ 0.2
PF	53	25.9 $\pm$ 4.4	1.1 $\pm$ 0.2	94	36.8 $\pm$ 6.7	1.1 $\pm$ 0.2
PC	24	20.7 $\pm$ 3.0	1.2 $\pm$ 0.1	94	36.1 $\pm$ 7.9	1.2 $\pm$ 0.3
CA	—	—	—	82	36.0 $\pm$ 7.7	1.4 $\pm$ 0.3
AP	—	—	—	12	44.3 $\pm$ 15.4	1.3 $\pm$ 0.1
PP	—	—	—	6	65.0*	1.5*
AA	—	—	—	6	60.0*	1.0*
TO	—	—	—	29	42.4 $\pm$ 7.3	1.6 $\pm$ 0.4
MT	24	27.2 $\pm$ 8.3	1.2 $\pm$ 0.2	71	29.4 $\pm$ 5.6	1.2 $\pm$ 0.41
PT	6	26*	1.3*	65	35.4 $\pm$ 8.3	1.3 $\pm$ 0.3

* Only 1 value, no standard deviation possible.

FIG. 3. Illustrative case of mobilization of an early ATA to revascularize an insular branch of the MCA. **A–C:** Axial CT scan (A), digital subtraction angiogram (B), and 3D digital subtraction angiogram (C). This mycotic aneurysm of the right MCA gave rise to massive intracranial rupture in a 24-year-old man with infective endocarditis and multiple previous septic embolic strokes. An efferent M_2 branch originated from the dome of the aneurysm (yellow arrow). The red arrow indicates an early branching ATA. **D and E:** The aneurysm was exposed via splitting of the sylvian fissure and trapped. **F and G:** The cisternal course of the ATA was released and mobilized to reach the efferent branch coming off the aneurysm. The MCA branch was reimplanted onto the mobilized ATA. **H:** Postoperative angiogram showing bypass patency. Red arrow indicates the anastomosis. Figure is available in color online only.

where the closest postbifurcation artery would be a desired recipient; however, it is of value when M_2 MCA occlusion is required. On the other hand, significantly longer cisternal length of the early ATAs did not show a significant difference from non-early ATAs regarding maximal reach to the cortical MCA. In other words, the early ATA is a more favorable candidate for revascularization in cases of proximal and insular MCA occlusions, but it does not offer much more than non-early ATAs when revascularization of the cortical segment of the MCA is necessary.

Bypass Using the ATA for Distal MCA Occlusions

Distal MCA aneurysms are rare (1%–6% of all cerebral

aneurysms).^{7,12,16,28,30,38} Most distal MCA aneurysms have an unfavorable configuration for clipping.^{16,30} Previous reports do not address the specific gyral location of the distal MCA aneurysms.^{7,16,23,24} Several reports show that distal MCA aneurysms require bypass more often than any other distal aneurysm.^{23,30}

ATA for Bypass to Insular MCA

Our results show that the ATA mobilizes to reach all insular zones (M_2 segment; Table 2). However, maximal mobility was recorded in the anterior insular zones (Zones I–III) for side-to-side bypasses, and in Zones I–V for end-to-side bypasses (Fig. 2A and D). We found that a side-to-side bypass would provide the best caliber match in insular Zones I and II while avoiding a cortical infarct in the ATA territory (Table 2). The posterior zones of the insula (IV–VI) have arteries with larger diameters, making the ATA a suboptimal candidate for revascularization. Nevertheless, with properly matched donor and recipient diameters, side-to-side bypass is feasible within the proximal third of the posterior insular zones. The reach increases to more than half of the posterior lengths of gyri if an end-to-side bypass is used (Fig. 2A and D).

ATA for Bypass to Opercular and Cortical MCA

According to our results, the optimal bypass technique (end-to-side vs side-to-side) can be determined by specific locations for bypasses to M_3 and M_4 segments (Fig. 2B, C, E, and F, and Fig. 4). The parietal and occipital lobe arteries (i.e., anterior parietal [AP] and posterior parietal [PP] arteries, and the AA) were the least accessible at the M_3 and M_4 level, rendering the ATA suboptimal for bypass on these territories. On the other hand, the M_3 and M_4 arteries of the anterior frontal region (i.e., the OF and PF arteries) were easily reached with both bypass techniques (end-to-side having better mobility than side-to-side). However, the best option for the CA, posterior temporal (PT), and MT arteries would be using ATA end-to-side. Also, if the ATA is chosen for bypass to the temporooccipital (TO) artery, end-to-side bypass to the M_3 TO artery may provide the best outcome.

Our results show that the caliber of the ATA, when used side-to-side, matched all reached M_4 branches (i.e., frontal and temporal lobe parasylvian M_4 branches). However, the OF, PF, and PC branches provided the best caliber match to the ATA at the M_3 level (Table 3). Therefore, if a side-to-side bypass is needed to the M_3 segment of the MCA, the best recipient arteries would be those of the anterior frontal lobe.

Eloquence of ATA Cortical Territory

The clinical consequences specific to ATA occlusion are not reported in the literature.^{11,36} However, studies on anterior temporal lobectomy for temporal lobe epilepsy generally show that resection of the anterior temporal cortex does not carry risk for major neurological deficits. There is clinical consensus that the resection of 3–4.5 cm of the anterior of the dominant temporal lobe and 4.5–6 cm of the nondominant temporal lobe is considered safe.^{4,8,21,25,37} However, extrapolation of such results to ligation of the ATA for end-to-side bypass may

FIG. 4. Graph depicting the relative frequency of successful end-to-side and side-to-side bypasses to different M₃ and M₄ arterial territories. C = central artery; ES = end-to-side bypass; SS = side-to-side bypass. Figure is available in color online only.

not be appropriate for all cases. The vascular territory of the ATA can be variable and the ATA may supply some parts of the eloquent PT cortex, especially if the middle temporal (MT) and/or PT arteries are not large. Therefore, it is important to evaluate the angiography or neurovascular imaging of the individual patient to determine if the ATA is supplying the temporal cortex beyond these “safe” distances, and therefore select the patients very carefully. Furthermore, possible morbidities of an anterior temporal infarct (including visual/spatial memory deficits) and the ways to prevent/minimize those complications need to be discussed with the patient prior to using the ATA for an end-to-side bypass.

Conclusions

The ATA is a useful donor for IC-IC MCA bypass to arteries lying on the anterior insula and opercular and cortical branches on the frontal and temporal lobes. Our results also show that the ATA is a suboptimal donor for bypass to the arteries of the parietal, occipital, and PT regions. However, arterial variability exists, and ATA redundancy may extend the reach to areas further than our results suggest. Caution is required when a sizable ATA supplies eloquent parts of the PT lobe. The ATA facilitates IC-IC bypasses with MCA aneurysms and is an important donor artery when the superficial temporal artery is diminutive or unavailable for an EC-IC bypass. The results of this study may encourage neurosurgeons to use the ATA in revascularization of the MCA territory. Clinical studies could supplement the results of our study regarding surgical outcomes of ATA-MCA bypass.

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Disclosures

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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Conception and design: Benet, Tayebi Meybodi, Lawton. Acquisition of data: Tayebi Meybodi, Griswold, Mokhtari, Payman. Analysis and interpretation of data: Tayebi Meybodi, Griswold. Drafting the article: Benet, Tayebi Meybodi. Critically revising the article: all authors. Reviewed submitted version of manuscript: Benet, Tayebi Meybodi. Approved the final version of the manuscript on behalf of all authors: Benet. Statistical analysis: Griswold. Administrative/technical/material support: Benet, Lawton. Study supervision: Benet, Lawton.

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