Middle meningeal to middle cerebral arterial bypass for cerebral revascularization

Case report

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A case is reported of successful anastomosis of the middle meningeal artery to a cortical branch of the middle cerebral artery. Based on the analyses of 50 random angiograms, the authors discuss the circumstances in which such an anastomosis might be practical and indicated.

KEY WORDS • cerebral revascularization • extra-intracranial bypass • meningoima • middle meningeal artery

Since the inception of microvascular cerebral revascularization, the superficial temporal artery (STA) or occipital branches of the external carotid artery have been the choice for anastomosis to the middle cerebral artery (MCA) distribution. Donor vessel caliber and location were primary considerations. Unusual circumstances in a recent case led us to select the middle meningeal artery (MMA) as a donor vessel with satisfactory results. This instance of a successful anastomosis of a meningeal to a cortical artery prompted an analysis of random selected angiograms to determine the circumstances in which such an anastomosis might be practical and indicated.

Case Report

This 61-year-old man presented in May, 1978, with left hemiparesis of 10 months' duration. In June, 1977, he had experienced a focal seizure in the left foot, followed by weakness of the lower extremity, which persisted with little improvement. He continued to have sporadic focal seizures in the left leg, always preceded by numbness. In addition, he complained of clumsiness of the left hand. He denied headaches or visual disturbance.

Examination. He had a monoparetic left leg with weakness most marked distally causing increasing footdrop and circumductive gait. Mild left facial paresis was present, but the left arm was only subjectively clumsy. All sensory modalities were intact except impaired position sense at the toes. Visual acuity and fundi were normal but the patient manifested a left inferior quadrantanopsia. Reflexes were accentuated on the left with unsustained ankle clonus and an extensor Babinski response. Cerebellar testing was normal.

Flow and static technetium-99 brain scans demonstrated a dense right parietal parasagittal globular uptake. Computerized tomography revealed a discrete, contrast-enhancing mass at the parietal cortical surface adjacent to the sagittal sinus, with no mass effect (Fig. 1). Unrelated to the mass was a large, irregular area of decreased attenuation throughout the temporal lobe and inferior parietal lobe, consistent with old infarction. Selective right internal carotid angiography documented complete MCA occlusion with delayed retrograde filling of the middle cerebral vasculature via collateral channels from the left anterior cerebral artery (ACA). A faint arterial blush and draped arteries and veins identified the high parasagittal convexity mass (Fig. 2 left). Selective right external carotid angiography identified multiple branches of the external carotid system which were filling the mass. Among these branches was an enlarged MMA, of angiographic caliber equal to the STA (Fig. 2 right).
Operation. A parasagittal meningioma was presumed. Fear of further compromise of middle cerebral artery blood flow by interruption of ACA-MCA collateral anastomoses during tumor removal led us to consider a prophylactic MCA revascularization as a first stage. The presence of an enlarged MMA of the same caliber as the corresponding STA suggested use of the former as a donor vessel. A distinct advantage in accessibility of the donor artery had been anticipated and this was experienced, reducing substantially the duration of the revascularization procedure. In addition, the diversion of MMA blood flow from the tumor to the brain seemed both novel and advantageous for the tumor removal at a second stage. The MMA was dissected from between the dural leaves and the two flanking meningeal veins. The anastomosis was accomplished with 12 interrupted 10-0 monofilament nylon sutures by one of us (R.S.).

Postoperative Course. Two weeks postoperatively, the anastomosis was demonstrated by selective external carotid angiography to be irrigating the MCA distribution (Fig. 3). The fibrous meningioma was then removed without incident. There has been no worsening of the patient's deficit, and, moreover, he spontaneously reported the return of subjective normal dexterity in the left hand immediately after the bypass procedure.

Discussion

Fifty random and unselected common carotid arteriograms in adults were reviewed to compare

**TABLE 1**

<table>
<thead>
<tr>
<th>Feature</th>
<th>STA</th>
<th>MMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>diameter range (mm)</td>
<td>1.0–2.3</td>
<td>0.8–1.4</td>
</tr>
<tr>
<td>average diameter (mm)</td>
<td>1.7</td>
<td>1.1</td>
</tr>
<tr>
<td>percent larger than 1.2 mm</td>
<td>90</td>
<td>40</td>
</tr>
<tr>
<td>percent visualized</td>
<td>92</td>
<td>78</td>
</tr>
<tr>
<td>percent not visualized</td>
<td>8</td>
<td>22</td>
</tr>
</tbody>
</table>

Fig. 1. Computerized tomography scan demonstrates a high-density lesion consistent with a right falx meningioma.

Fig. 2. Preoperative arteriograms. **Left:** Right internal carotid arteriogram demonstrates draped vessels (small arrows), and middle cerebral artery occlusion (large arrow). **Right:** Right external carotid arteriogram demonstrates superficial temporal artery (curved arrow), and middle meningeal artery (straight arrow). Tumor vessels are apparent at the distal branches of the middle meningeal artery (arrowheads).
caliber, location, and availability of the MCA and of the STA (Table 1). Age range of subjects was 37 to 78 years. Males predominated 5:1.

The MMA is ordinarily two-thirds the diameter of the STA at locations corresponding to potential anastomosis sites. The MMA has an average angiographic diameter of 1.1 mm (range: 0.8 to 1.4 mm); the STA, 1.7 mm (range: 1.0 to 2.4 mm). Certain pathological states place increased demand on the external carotid artery circulation leading to enlargement of vessel caliber and increased flow rate. The MMA, like the STA, is a muscular artery capable of dilating to meet demand.

The MMA was angiographically demonstrable in 78% of the cases while the STA was demonstrable in 92% of the cases. In three of four cases in which the STA was angiographically absent, the MMA was present, and at least 1 mm in diameter. Thus, in at least 6% of unselected random cases, the MMA could be a potential donor artery for cerebral revascularization, when the STA is unavailable because of atresia, surgery, injury, occlusion, or embolization. Since the angiographic caliber of the MMA is greater than 1.2 mm in 40% of instances, it would seem reasonable to consider it as the donor vessel in appropriate circumstances.

Summary

In the case presented, the blood supply to the MCA depended on the collateral channels from the anterior cerebral artery. This artery was at potential risk during tumor removal, leading us to perform prophylactic cerebral revascularization. The MMA was enlarged in the presence of a meningioma, and served as the donor vessel, both adequately and expediently, while at the same time its diversion from the tumor's circulation aided in subsequent tumor extirpation. To the best of our knowledge, this is the first case report of a successful MMA to MCA bypass.

References


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