Internal maxillary artery to middle cerebral artery bypass

The cervical carotid system has been used as a source of donor vessels for radial artery or saphenous vein grafts in cerebral bypass. Internal maxillary artery to middle cerebral artery bypass has been described as an alternative, with reduction of graft length potentially correlating with improved potency.

The internal maxillary artery to middle cerebral artery “middle” flow bypass allows for shorter graft length with both the proximal and distal anastomoses within the same microsurgical field. These unique variable flow grafts represent an ideal opportunity for use of the cephalic vein of the forearm, which is more easily harvested than the wider saphenous vein graft and which has good match size to the M1/M2 segments of the middle cerebral artery. The vessel wall is supple, which facilitates handling during anastomosis. There is lower morbidity potential than utilization of the radial artery. Going forward, the cephalic vein will be the preferred choice for external carotid-internal carotid transplanted conduit bypass for Nossek et al. 1.

The internal maxillary artery (IMA) has been proposed as a donor to decrease invasiveness, but its length is insufficient for direct intra intracranial bypass surgery. Feng et al., reported interposition of a superficial temporal artery (STA) graft for high-flow IMA to middle cerebral artery (MCA) bypass using a middle fossa approach.

Twelve specimens were studied. A 7.5-cm STA graft was obtained starting 1.5 cm below the zygomatic arch. The calibers of STA were measured. After a pterional craniotomy, the IMA was isolated inside the infratemporal fossa through a craniectomy within the lateral triangle (lateral to the posterolateral triangle) in the middle fossa and transposed for proximal end-to-end anastomosis to the STA. The Sylvian fissure was split exposing the insular segment of the MCA, and an STA-M2 end-to-side anastomosis was completed. Finally, the length of graft vessel was measured.

Average diameters of the proximal and distal STA ends were 2.3 ± 0.2 and 2.0 ± 0.1 mm,
respectively. At the anastomosis site, the diameter of the IMA was 2.4 ± 0.6 mm, and the MCA diameter was 2.3 ± 0.3 mm. The length of STA graft required was 56.0 ± 5.9 mm.

The STA can be used as an interposition graft for high-flow IMA-MCA bypass if the STA is obtained 1.5 cm below the zygomatic arch and the IMA is harvested through the proposed approach. This procedure may provide an efficient and less invasive alternative for high-flow EC-IC bypass.

The maxillary artery runs parallel to the frontal branch of the superficial temporal artery and is located on average 24.8 ± 3.8 mm inferior to the midpoint of the zygomatic arch. The pterygoid segment of the MaxA is most appropriate for bypass with a maximal diameter of 2.5 ± 0.4 mm. The pterygoid segment can be divided into a main trunk and terminal part based on anatomic features and use in the bypass procedure. The main trunk of the pterygoid segment can be reached extracranially, either by following the deep temporal arteries downward toward their origin from the MaxA or by following the sphenoid groove downward to the terminal part of the pterygoid segment, which can be followed proximally to expose the entire MaxA. In comparison, the prebifurcation diameter of the superficial temporal artery is 1.9 ± 0.5 mm. The average lengths of the mandibular and pterygoid MaxA segments are 6.3 ± 2.4 and 6.7 ± 3.3 mm, respectively.

The MaxA can be exposed without zygomatic osteotomies or resection of the middle fossa floor. Anatomic landmarks for exposing the MaxA include the anterior and posterior deep temporal arteries and the pterygomaxillary fissure.

Long Wang published all internal maxillary artery (IMA) bypasses performed between January 2010 and July 2018 in a single-center, single-surgeon practice.

In total, 12 patients (9 males, 3 females) with Complex middle cerebral artery aneurysms (CMCAAs) managed by high-flow IMA bypass were identified.

The mean size of CMCAAs was 23.7 mm (range 10–37 mm), and the patients had a mean age of 31.7 years (range 14–56 years). The aneurysms were proximally occluded in 8 cases, completely trapped in 3 cases, and completely resected in 1 case. The radial artery was used as the graft vessel in all cases. At discharge, the graft patency rate was 83.3% (n = 10), and all aneurysms were completely eliminated (83.3%, n = 10) or greatly diminished (16.7%, n = 2) from the circulation. Postoperative ischemia was detected in 2 patients as a result of graft occlusion, and 1 patient presenting with subarachnoid hemorrhage achieved improved modified Rankin Scale scores compared to the preoperative status but retained some neurological deficits. Therefore, neurological assessment at discharge showed that 9 of the 12 patients experienced unremarkable outcomes. The mean interval time from bypass to angiographic and clinical follow-up was 28.7 months (range 2–74 months) and 53.1 months (range 19–82 months), respectively. Although 2 grafts remained occluded, all aneurysms were isolated from the circulation, and no patient had an unfavorable outcome.

The satisfactory result in the present study demonstrated that IMA bypass is a promising method for the treatment of CMCAAs and should be maintained in the neurosurgical armamentarium. However, cases with intraoperative radical resection or inappropriate bypass recipient selection such as aneurysmal wall should be meticulously chosen with respect to the subtype of MCA aneurysm.

Videos

Internal Maxillary Artery to M2 Middle Cerebral Artery Bypass With Modified Superficial Temporal Artery Graft: 3-Dimensional Operative Video.

A video demonstrates a 37-year-old female who presented with a 1-month history of severe headache. Her complex middle cerebral artery (MCA) aneurysm was treated by IMaxA bypass with radial artery graft. Preoperative neuroimaging revealed a giant, fusiform, thrombosed aneurysm that extensively involved the sphenoidal (M1) and insular (M2) segments of the MCA. After a multidisciplinary discussion, the reversal high-flow IMaxA bypass was performed, followed by proximal MCA occlusion. We approached the aneurysm using a frontotemporal craniotomy with zygomatic osteotomy to expose the pterygoid segment of IMaxA (IM2), which is defined as the “SHI” IMaxA bypass method. Simultaneously, the radial artery graft was harvested and prepared before being anastomosed in an end-to-end fashion to the IM2 using No. 9-0 polypropylene. The free end of the RAG was then brought to the sylvian fissure and anastomosed to the M2 in an end-to-side manner. The proximal part of M1 after the bypass takeoff was then occluded with a permanent aneurysm clip (Aesculap Instruments Corp., Tutlingen, Germany). Complete elimination of the aneurysm with a patent graft artery was observed postoperatively, and the patient was discharged with intact neurologic function (modified Rankin Scale score 0).

References


4) https://thejns.org/focus/view/journals/neurosurg-focus/46/2/article-pE10.xml

5) Benet A, Meybodi AT, Feng X, Lawton MT. Internal Maxillary Artery to M2 Middle Cerebral Artery