Experimental model for maxillary artery to middle cerebral artery anastomosis in dogs

Technical note

SYOJI ASARI, M.D., SUSUMU OHARA, M.D., HIROYUKI FUJISAWA, M.D. TOSHIAKI KAGEYAMA, M.D., AND KEIZO MATSUMOTO, M.D.

Department of Neurological Surgery, Okayama University Medical School, Okayama, and Department of Neurological Surgery, Tokushima University Medical School, Tokushima, Japan

End-to-side anastomoses between the maxillary artery and a branch of the middle cerebral artery were performed as an experimental model for extracranial-intracranial shunt in dogs. Anastomoses were carried out after occlusion of the middle cerebral artery. Eighteen of 21 shunts were patent (86%) 2 weeks after the procedure.

KEY WORDS □ maxillary artery □ middle cerebral artery □ microvascular surgery □ end-to-side anastomosis

In 1967, operative anastomosis between the superficial temporal artery (STA) and a branch of the middle cerebral artery (MCA) to create a new extracranial-intracranial bypass was reported by Yasargil. This procedure has been used to study the effect of such a shunt on experimental acute stroke in dogs. The STA of the dog is small in caliber and is difficult to manipulate in overcoming distance. The patency rate with this model is low.

The maxillary artery, however, has vigorous blood flow, is of large caliber, and is located close to the MCA. Accordingly, we have developed the technique of using this vessel as a shunt in dogs.

Materials and Methods

Twenty-one mongrel dogs, weighing 10 to 15 kg, were anesthetized with an intramuscular injection of ketamine, 5 to 10 mg/kg. The dogs were supported by artificial ventilation, and placed in the lateral position with their mouth kept wide open by tightly rolled gauze sponges. Through a Y-shaped temporoparietal skin incision, the temporal muscle was removed with rongeurs and the masseter muscle was reflected posteriorly. The coronoid process was partially excised to expose the base of the skull. A small burr hole, 10 to 15 mm in diameter, was drilled in the exposed subtemporal area. Under the operating microscope, the dura was opened and the origin of the MCA was exposed. The artery was carefully ligated with 7-0 silk suture. During these procedures, great care was taken to keep intact the maxillary artery which runs across the pterygopalatine fossa.

Using ×16 or ×25 magnification, we opened the arachnoid adjacent to the M2 segment of the MCA, and dissected this segment free from the cerebral cortex for a distance of about 10 mm. A rubber dam was placed under the dissected segment in order to protect the cerebral cortex.

The maxillary artery, which is the main continuation of the external carotid artery, may be divided into three parts: the mandibular portion, the pterygoid portion, and the pterygopalatine portion (Fig. 1). The third portion is used as a donor artery in this experiment. In the pterygopalatine fossa, the maxillary artery lies lateral and inferior to the periorbita after leaving the anterior alar foramen, and then leaves the pterygopalatine fossa to enter the infraorbital canal.

The maxillary artery gives off many branches that supply the deep structures of the head in this region. The first large branch is the orbital artery, which
FIG. 1. Operative drawing showing the maxillary artery and a branch of the middle cerebral artery, and their spatial relationship.

arises from the maxillary artery at the anterior alar foramen. The second large branch is the common trunk of the sphenopalatine and major palatine arteries; it arises from the maxillary artery just distal to the origin of the minor palatine artery. Between these two branches, the maxillary artery was isolated with its surrounding connective tissue. A temporary clip was placed on the proximal part of the maxillary artery. The infraorbital artery, which is a continuation of the maxillary artery, and the common trunk of the sphenopalatine and major palatine arteries were ligated. The maxillary artery was cut with sharp microscissors just proximal to the infraorbital artery and the common trunk. Connective tissue and adventitia of the donor artery were carefully removed only at the anastomosis site.

The techniques of microvascular anastomosis have been described in detail elsewhere, and the suturing techniques in this procedure are similar to those reported previously. Two fine temporary clips were applied at either end of the dissected segment of the MCA, and a longitudinal incision was made between the two clips. The maxillary artery was then brought into the operative field, and interrupted single sutures were placed with 10-0 monofilament nylon suture to complete the anastomosis under ×16 or ×25 magnification. Twelve interrupted single sutures were made routinely. The temporary clip of the maxillary artery was released to wash out air, and then the distal and proximal clips of the MCA were removed. Finally, the clip on the donor artery was removed, and a new collateral circulation was established.

All wounds were irrigated with saline solution and closed in layers. The dura was closed around the anastomosis site. No local or systemic heparinization was used. Selective external carotid angiography was performed with injection of 60% Conray, 4 cc, 2 weeks after the anastomosis.

Results

All animals with the maxillary-MCA anastomosis recovered rapidly from anesthesia; no animals died during or after operation. Of the 21 dogs, angiography revealed 18 patent anastomoses, with three occluded (patency rate of 86%). In the patent cases, angiography showed normal or rich perfusion of the entire territory of the MCA through the new shunt (Fig. 2). There were no clinical deficits postoperatively in animals with patent anastomoses.

Discussion

In our previous experience with STA-MCA anastomosis in dogs, the patency rate was not entirely satisfactory. We therefore attempted to produce an experimental model of end-to-side anastomosis using the maxillary artery of the dog, which is the largest terminal branch of the external carotid artery. This artery has good blood flow and is of a size suitable for end-to-side anastomosis to the recipient artery; also, it is located very close to the proximal part of the middle cerebral artery (Fig. 3). These characteristics of the maxillary artery seem to favor it as a donor vessel to the MCA, and have brought better results in our series.
Experimental maxillary-middle cerebral artery anastomosis

**Fig. 2.** Angiogram, anteroposterior view *(left)* and lateral view *(right)*, showing a patent anastomosis between the maxillary artery and a branch of the middle cerebral artery 2 weeks after surgery. There is excellent filling of the entire territory of the middle cerebral artery through the shunt. *Arrows* indicate the site of anastomosis.

**Fig. 3.** Anatomical drawings, lateral view *(left)* and basal view *(right)*, showing the spatial relationship of the superficial temporal artery (STA), maxillary artery (MA), and middle cerebral artery (MCA). The STA is the smallest terminal branch of the external carotid artery (ECA) and lies far distant from the MCA.
of anastomoses than those reported with other previous experimental extracranial-intracranial shunts.\textsuperscript{1,2}

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References


Address reprint requests to: Syoji Asari, M.D., Department of Neurological Surgery, Okayama University Medical School, 2-5-1 Shikat-cho, Okayama, Japan.