Distal Superficial Temporal Artery to Proximal Posterior Cerebral Artery Bypass by Posterior Oblique Transzygomatic Subtemporal Approach

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ABSTRACT

This article investigates the possibility for the distal superficial temporal artery (STA) to proximal posterior cerebral artery (PCA) direct bypass by subtemporal oblique posterior transzygomatic approach. Five adult cadaveric specimens were dissected. Cadaveric dissection protocol was approved by the Research Ethics Committee. A preauricular vertical skin incision was made, the trunk of STA was identified, and bifurcation, frontal, and parietal branches of the STA were followed distally. Posterior zygomatic arch osteotomy and microcraniotomy were then performed, and the dura was opened. The temporal lobe was retracted, interpeduncular and ambient cisterns were opened, and the P2 segment of the PCA was exposed. Parietal branch of STA and P2 segment of the PCA was anastomosed. The average length of the transected STA from the bifurcation and the zygomatic arch were 47.3 ± 2.1 mm and 71.4 ± 2.3 mm, respectively. The mean calibers of the parietal and frontal branch of the STA at this distance were 1.6 ± 0.1 and 1.4 ± 0.2 , respectively. The mean diameter of the P2 was 2.1 ± 0.2 mm. Because of the calibers of the parietal branch of the STA and proximal PCA are over 1.5 mm and 2.0 mm, respectively, this direct end-to-side bypass technique may be a reasonable alternative in suitable cases.

KEYWORDS: Bypass, superficial temporal artery, posterior cerebral artery, revascularization

Patients suffering from vertigo or dizziness frequently apply to the neurology, neurosurgery, or otolaryngology clinics for treatment. The pathology may arise from the central or peripheric system. One of the most common causes of central vertigo or dizziness is vertebro-basilar insufficiency (VBI).¹⁻⁴ Angioplasty or angioplasty with intravascular stent placement of the extracranial vertebral artery can be treatments for VBI

that is unsolved with medical therapy.⁵⁻⁷ Although the technical success rate is high and complications are rare, these procedures have a high rate of moderate-to-severe restenosis.⁸ Besides, several bypass techniques have been described for surgical treatment. Bypass, between the P2 segment of the posterior cerebral artery (PCA) and the external carotid artery (ECA) or vertebral artery (VA) is the most common revascularization technique for

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Received: February 26, 2010. Accepted: March 20, 2010.
Published online: May 14, 2010.
DOI: <http://dx.doi.org/10.1055/s-0030-1254405>.
ISSN 1531-5010.

posterior circulation.^{1-4,9,10} Meanwhile, these techniques using long graft materials tend to be associated with a low patency rate.^{4,10,11}

In this study, we aim to research the possibility for the direct bypass of the distal superficial temporal artery (STA) to the proximal PCA by using the subtemporal oblique posterior transzygomatic approach as an alternative to the external ECA or VA to PCA bypass using long grafts. This technique was practiced on cadavers to make sure that it could be performed safely on patients.

SUBJECTS AND METHODS

Five adult cadaveric specimens were dissected bilaterally between December 10, 2009, and January 10, 2010, at the university hospital. Cadaveric dissection protocol was approved by the Research Ethics Committee. In the supine position, the head was turned 70 degrees away from the side of dissection. A preauricular vertical skin incision was used. The skin and subcutaneous tissue were dissected forward, along with the superficial layer of the temporal fascia and pericranium. The trunk of STA was identified easily at the anterior of the tragus. Bifurcation, frontal, and parietal branches of the STA were followed distally. As the zygomatic bone was approached, an incision was made in the deep layer of the temporal fascia. The zygoma was exposed 3 cm away from its root, after the deep fascia and periosteum were dissected from the zygomatic arch. The deep fascia was dissected away from the masseter muscle in the facial region. The masseter muscle was divided from its attachment to the zygomatic bone, and the temporalis muscle was elevated from the temporal bone to perform a minicraniotomy (Fig. 1). Thirty-degree oblique posterior zygomatic arch osteotomy was achieved beginning just anterior-superior to the condylar fossa until 1 cm posterior to the zygomaticomaxillary suture. In that way, the integrity of the condylar fossa and temporomandibular function was protected. The zygomatic bone was removed and preserved for subsequent reattachment. The minicraniotomy began just above the zygomatic root, extending 2 cm superiorly and 3 cm anteriorly (Fig. 2). The dura of the middle cranial fossa was then separated under the surgical microscope, from a lateral to medial and from a posterior to anterior direction. The bone of the middle cranial fossa was rongeuared away down to the floor. After the temporal lobe was retracted, the interpeduncular and ambient cisterns were opened, and the P2 segment of the PCA was exposed intradurally. In our study, we found the average diameter of frontal branch-STA was smaller than parietal branch-STA at transected distance, so it was ligated. The parietal branch of the distal STA was passed through the craniotomy, inside the dura, until it reached the P2 segment to which it was directly anastomosed in an end-to-side fashion using continu-

Figure 1 A preauricular vertical incision, trunk of the STA, and zygomatic arch are seen.

ous suture with 8.0 nylon or 7.0 Prolene sutures (Ethicon, Inc., Somerville, NJ) (Fig. 3). The mean caliber of the frontal and parietal branches of the STA and PCA (P2 segment) were measured using an electronic micrometer.

RESULTS

The average length of the transected parietal or frontal branch of the distal STA from the bifurcation and the zygomatic arch were 47.3 ± 2.1 mm and 71.4 ± 2.3 mm, respectively. The mean calibers of the parietal and frontal branch of the distal STA at this distance were 1.6 ± 0.1 and 1.4 ± 0.2 , respectively. The mean diameter of the P2 was 2.1 ± 0.2 mm.

DISCUSSION

The VBI is a frequent reason for central vertigo or dizziness. Several bypass techniques are described for revascularization of the posterior circulation, such as the occipital artery (OA) to anterior inferior cerebellar artery, OA to posterior inferior cerebellar artery (PICA), STA to PCA or superior cerebellar artery bypasses, a long venous graft from the ECA or VA to PCA or a radial artery graft from the VA to the PICA.^{1-4,9,10,12-20} Procedures using the ECA or VA as

Figure 2 Thirty-degree oblique posterior zygomatic arch osteotomy and microcraniotomy are seen.

Figure 3 Retracted temporal lobe and parietal branch of the distal STA that passed through craniotomy are seen.

the donor vessel and the proximal PCA as the recipient in the bypass are known to be more protective.^{1,3,4,9,21} The VA is used as the proximal vessel if it is the same size as and is well connected to the other VA. The ECA is used as the proximal artery, if the VA is markedly dominant and the other VA is small.

Because anastomosis between the STA and the middle cerebral artery was described by Yasargil for treatment of cerebral revascularization, similar procedures have become popular.^{22,23} The gross anatomy of the STA has been reported in detail by Marano et al. They pointed out that a bifurcation was present above the zygoma in 96% of the specimens and no specimens with bifurcations below the zygoma.²⁴ The length of the STA between the zygoma and the bifurcation averaged 31.7 mm (range: 2 to 60 mm) in the 42 specimens.²⁴ However, Stock et al reported that 28% of the specimens had bifurcation at the arch and 7% of the specimens had bifurcations below the zygoma.²⁵

The average diameter of the STA at the level of the zygoma ($n = 50$) and the bifurcation ($n = 44$) was reported as 2.2 mm and 1.9 mm, respectively, by Marano et al.²⁴ Stock et al obtained a mean diameter at a point 10.0 mm proximal to the bifurcation of 2.03 mm in cadavers and 1.89 mm in angiographic specimens. The difference was attributed to the thickness of the vessel wall.²⁵

The average length of the frontal ($n = 42$) and parietal ($n = 45$) branch from the zygomatic arch to the point the vessel narrowed to 1 mm diameter was reported as 99.2 mm (range: 45 to 200 mm) and 106.0 mm (range: 35 to 163 mm), respectively, by Marano et al.²⁴

We performed an anatomical and a technical study to find out whether the diameter and the length of the distal STA are suitable to perform a direct anastomosis between distal (parietal or frontal branch) STA and proximal PCA and to see whether or not this surgery can be performed. In the present study, we used a posterior oblique transzygomatic subtemporal approach. The average length of the anastomosed parietal branches of the STA from the bifurcation was 47.3 ± 2.1 mm. We found that the mean calibers of parietal branches of the STA at this distance and P2 segment of proximal PCA are over 1.5 mm and 2.1 mm, respectively, suggesting this direct end-to-side bypass would provide sufficient blood flow.

Before performing an anastomosis, preoperative angiography would be useful to measure the caliber of the distal STA and PCA. Although the caliber of the distal STA is smaller, in selected patients with prominent STAs, a direct parietal or frontal branch of the STA to P2-anastomosis is a valuable option without the need of a graft and with only one suture site.

The advantages of the distal STA to proximal PCA bypass by subtemporal oblique posterior transzygomatic approach are as follows. (1) It would provide sufficient blood flow, as the mean caliber of parietal branches of the STA is larger than 1.5 mm. (2) ECA or VA to proximal PCA bypasses using long venous grafts provide high blood flow; however, they have lower patency rates (70 to 80%).¹¹ (3) Such a bypass is not technically more difficult than ECA to proximal PCA bypass and does not require a second incision in the cervical region. (4) The graft makes a bend where it enters the cranium in ECA to the proximal PCA bypass. However, the direct distal STA to P2–direct anastomosis made a slight bend and followed nearly a straight course, which is vital in patency because when bending increases and kinking occurs, the blood flow diminishes and the graft may occlude.¹¹ (5) This technique is a valuable option without the need of a graft and with only one suture site.

The dura, where the parietal branches of the STA enter, can be sealed with fibrin glue to prevent cerebrospinal fluid leakage. During this bypass, a posterior oblique zygomatic osteotomy is required, in which condylar fossa and temporomandibular function are protected. However, it is easy to conduct and it can be easily reapproximated with mini plaques.

CONCLUSION

The distal STA to proximal PCA direct bypass by subtemporal oblique posterior transzygomatic approach may be a viable alternative to “ECA to PCA” bypass using long venous grafts in suitable cases. Posterior oblique transzygomatic subtemporal approach was found to be appropriate for such a bypass procedure.

While currently this is a purely anatomical study, we hope that additional clinical trials will further determine the usefulness of this approach in the treatment of vertigo and dizziness.

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