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Original Article

Superficial temporal artery to proximal posterior cerebral artery bypass through the anterior temporal approach

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Abstract

Background: The superficial temporal artery (STA) to proximal posterior cerebral artery (PCA) (P2 segment) bypass is one of the most difficult procedures to perform because the proximal PCA is located deep and high within the ambient cistern. STA to proximal PCA bypass is usually performed through a subtemporal approach or posterior transpetrosal approach, and rarely through a transsylvian approach. The aim of this study was to describe the operative technique of STA to proximal PCA bypass through a modified transsylvian approach (anterior temporal approach).

Methods: STA to proximal PCA bypass was performed through an anterior temporal approach in three patients with intracranial aneurysm. We describe the details of the surgical technique.

Results: The STA was successfully anastomosed to the proximal PCA in all cases. One patient suffered hemiparesis and aphasia due to infarction in the anterior thalamoperforating artery territory.

Conclusions: STA to proximal PCA bypass can be performed through an anterior temporal approach in selected patients. We recommend that every precaution, including complete hemostasis, placement of cellulose sponges beneath the recipient artery to elevate the site of the anastomosis, and placement of a continuous drainage tube at the bottom of the operative field to avoid blood contamination during the anastomosis, should be taken to shorten the temporary occlusion time.

Key Words: Anterior temporal approach, bypass, posterior cerebral artery, superficial temporal artery, transsylvian approach

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INTRODUCTION

Clipping of complex or giant aneurysms may be difficult or even impossible because such aneurysms often incorporate the parent artery or adjacent arterial branches into their base or fundus.[7] Similarly, clipping of recurrent aneurysms after endovascular coil embolization may be impossible because of the stenting or obstructing effect of the coils on the aneurysm neck.[7] Treatment options for such aneurysms include clip occlusion of the aneurysm together with the branching vessel, parent artery proximal occlusion, and trapping. However, these procedures interrupt the normal cerebral circulation and carry the risk of brain ischemia. Therefore, cerebral revascularization is now widely accepted as an important precaution to prevent brain ischemia as part of the treatment of complex or giant intracranial aneurysms.[7]

Selection of the cerebral revascularization procedure depends on several factors, including the patient's symptoms, the site of the lesion, the collateral circulation, and the required surgical skill.[7] Several techniques are now available for posterior circulation bypass surgery, including occipital artery (OA) to posterior inferior cerebellar artery (PICA), superficial temporal artery (STA) to superior cerebellar artery (SCA), and STA to posterior cerebral artery (PCA) bypasses.[1-5,12,13,20,26] Ausman *et al*. performed the first intracranial posterior revascularization procedure for vertebrobasilar insufficiency in the form of OA to PICA bypass in 1976,[1] and the first STA to SCA bypass in 1979.[2] Since then, OA to PICA and STA to SCA bypasses have been the two main procedures for augmentation of compromised posterior circulation.[3,4,13,21] STA to PCA bypass also provides blood flow to the distal posterior circulation. However, STA to PCA bypass is one of the most difficult procedures to perform because the proximal PCA is located deep and high within the ambient cistern.[22] The PCA is divided into four segments.[27] The P1 extends from the PCA origin to its junction with the posterior communicating artery; the P2 includes anterior (P2A) and posterior (P2P) segments, the P2A begins at the posterior communicating artery and ends at the most lateral aspect of the cerebral peduncle, and the P2P extends from the most lateral aspect of the cerebral peduncle to the posterior edge of the lateral surface of the midbrain; the P3 extends from the posterior edge of the lateral surface of the midbrain and ends at the origin of the parieto-occipital sulcus along the calcarine fissure; and the P4 corresponds to the parts of the PCA that run along or inside both the parieto-occipital sulcus and the distal part of the calcarine fissure. In most cases, the P2 segment of the PCA is used as the recipient vessel.

STA to P2 segment of PCA (STA-P2) bypass is usually performed through a subtemporal approach or posterior transpetrosal approach, and rarely through a transsylvian approach.[5,22,24-27] The subtemporal approach requires significant retraction that can injure the temporal lobe and cause edema or intraparenchymal hemorrhage postoperatively,[9] especially if the P2 is in a high position. The posterior transpetrosal approach provides a safe and sufficient operative field for STA-P2 bypass without excessive temporal lobe retraction,[10,14,15,20,22] but requires a complete understanding of the petrous bone anatomy and carries risks of cerebrospinal fluid leaks, hearing loss, and added surgical time for mastoidectomy and rhomboid drilling.[10,14,15,20,22] The anterior temporal approach is a modified distal transsylvian approach and is essentially the same as the temporopolar approach described by Sano.[18] The main advantage of this approach over the subtemporal approach is avoidance of the need for forceful temporal lobe elevation. The anterior temporal approach provides a wide operative field in the retro-carotid space, and can be used for the treatment of basilar tip aneurysms, basilar artery-SCA aneurysms, PCA aneurysms, and internal carotid artery-posterior communication artery (IC-PC) aneurysms.[8,11,18,20] However, the anterior temporal approach has been rarely discussed for the performance of STA-P2 bypass.

In the current study, we describe the operative technique of STA-P2 bypass through the anterior temporal approach.

MATERIAL AND METHODS

Patient population

This study was conducted with the approval of the ethics committee of the National Defense Medical College. The committee concluded that written informed consent was not required because of the retrospective nature of the investigation. STA-P2 bypass was performed through an anterior temporal approach in three patients with intracranial aneurysm.

Technique: Anterior temporal approach[8,11,18,20]

The patient is placed in the supine position with the head turned approximately 45° to the opposite side and tilted toward the floor. The head should be placed slightly above the level of the heart. A frontotemporal skin incision is performed, and the STA is carefully dissected out. The skin flap is separated from the temporal fascia down to the fat pad over the zygoma. The muscle is cut anteriorly and inferiorly and is retracted posteriorly. The bone flap includes the anterior temporal squama down to the temporal floor anteriorly. The sphenoid ridge is removed as far as the superior orbital fissure. After opening the dura, the superficial sylvian veins are separated from the temporal lobe and moved to the frontal lobe. The anterior temporal artery is completely separated from the medial surface of the temporal lobe. The temporal lobe is retracted posteriorly. The arachnoid is cut between the uncus and the anterior choroidal artery as well as between the uncus and oculomotor nerve. The carotid, crural, ambient, and interpeduncular cisterns are completely opened, and then the basilar artery, SCA, and PCA are identified.

Technique: STA-P2 bypass

The PCA is dissected free from the arachnoid, and the P2 segment of the PCA is exposed. A portion with no perforating vessels is selected as the site for the anastomosis. The fascial layer is stripped from the severed end of the STA. The tip of the STA is then cut into a shape matching the anastomotic site. Cellulose sponges are placed beneath the recipient artery to lift the site for the anastomosis. A 5 Fr. silastic feeding tube is placed at the bottom of the operative field to avoid blood contamination during the anastomosis. The recipient artery is prepared by placing temporary clips across the vessel and performing a small arteriotomy. After two stay sutures have been placed, anastomosis of the STA to P2 is performed using 10-0 nylon interrupted sutures.

RESULTS

Case 1

A 30-year-old male underwent clipping through an anterior temporal approach for an unruptured intracranial aneurysm at the right P2 segment of the PCA [Figure 1a]. The aneurysm was angioplastically clipped [Figure 1b]. Ten months later, follow-up computed tomography (CT) angiography demonstrated regrowth of the aneurysm [Figure 1c]. The patient underwent aneurysm trapping with STA-P2 bypass through an anterior temporal approach [Figure 1d and e]. Temporary occlusion during the bypass procedure lasted for 51 min. No neurological deterioration was observed postoperatively. Postoperative CT angiography revealed good bypass patency and complete obliteration of the aneurysm [Figure 1f]. The patient was discharged 1 month later with a modified Rankin Scale (mRS) score of 0.

Case 2

A 75-year-old female underwent clipping of an unruptured basilar tip aneurysm through a right pterional approach in 1994 in another hospital. The patient suffered subarachnoid hemorrhage in 1998. Angiography revealed ruptured IC-PC aneurysm and neck remnant of the basilar tip aneurysm. Clipping of the IC-PC aneurysm and coating of the basilar tip aneurysm were performed through a left subtemporal approach in another hospital. The patient also underwent ventriculo-peritoneal shunting for normal pressure hydrocephalus. Regrowth of the basilar tip aneurysm was detected in 2012 [Figure 2a], and the patient was admitted to our hospital with an mRS score of 4. Significant neurological findings on admission included severe memory disturbance and gait disturbance. The patient underwent partial clipping of the basilar artery trunk, right STA-SCA bypass, and right STA-P2 bypass through a right anterior temporal approach [Figure 2b and c]. Temporary occlusion during the STA-P2 bypass procedure lasted for 38 min. Postoperative CT angiography revealed good bypass patency and partial obliteration of the aneurysm [Figure 2d]. The patient experienced impaired consciousness and right oculomotor palsy. The patient was transferred to a rehabilitation hospital 1 month later with an mRS score of 5.

Case 3

A 70-year-old female was incidentally diagnosed with a large aneurysm at the left C1 portion of the internal carotid artery and was admitted to our hospital [Figure 3a]. No significant neurological finding was detected. The patient underwent aneurysm clipping with left STA-middle cerebral artery bypass and external carotid artery-radial artery-M2 bypass through a right anterior temporal approach. STA-P2 bypass was performed to preserve the blood supply through the posterior communicating artery, which was clipped together with the aneurysm [Figure 3b and c]. Temporary occlusion during the STA-P2 bypass procedure lasted for 25 min. Postoperative CT angiography revealed good bypass patency and complete obliteration of the aneurysm [Figure 3d]. Postoperative magnetic resonance imaging revealed infarction in the left

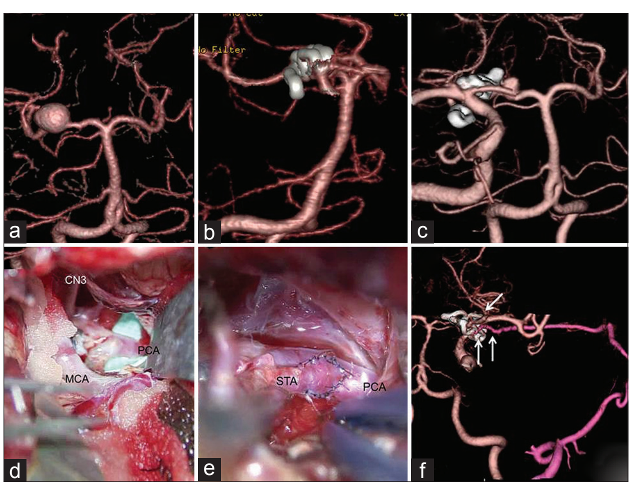

Figure 1: (a) 3-D CTA showing the right P2 aneurysm. (b) 3-D CTA after clipping demonstrating complete clipping. c, 3-D CTA revealing aneurysmal regrowth. (d and e) Intraoperative images. (f) postoperative 3-D CT angiogram revealing the good bypass patency (arrows)

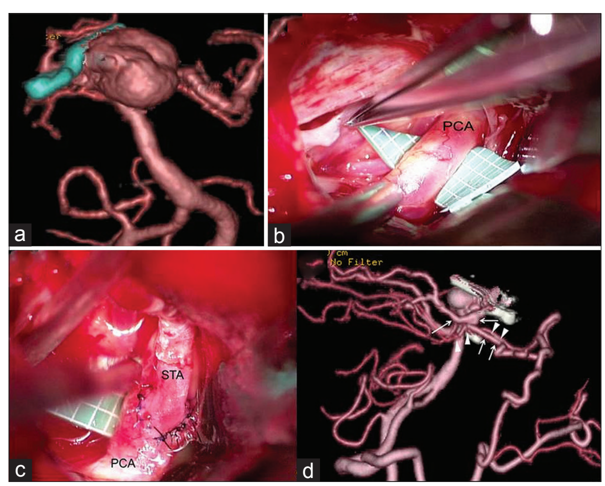

Figure 2: (a) 3-D CTA showing regrowth of the basilar tip aneurysm. (b and c) intraoperative images. (d) postoperative 3-D CT angiogram revealing good patency of the STA-P2 bypass (arrows) and STA-SCA bypass (arrowheads)

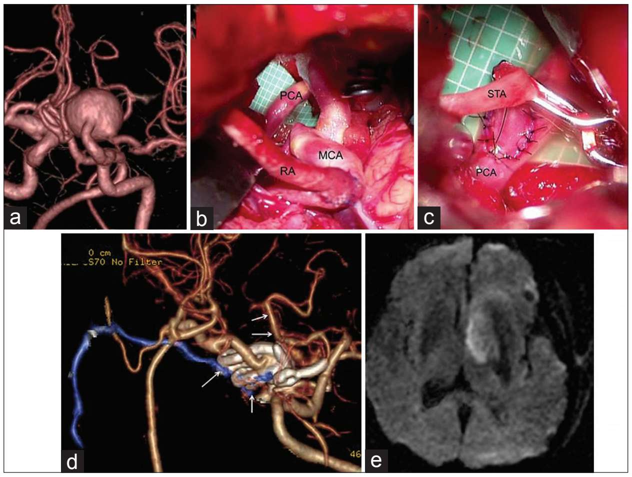

Figure 3: (a) 3-D CTA showing an aneurysm at the left C1 portion. (b and c) intraoperative images. d, postoperative 3-D CT angiogram revealing good bypass patency (arrows). (e) postoperative MR image revealing infarction in the left anterior thalamoperforating artery territory

anterior thalamoperforating artery territory [Figure 3e]. The patient experienced right oculomotor palsy, aphasia, and mild right hemiparesis. The patient was discharged 2 months later with an mRS score of 2.

DISCUSSION

The current study indicated that STA-P2 bypass procedures can be successfully performed via the anterior temporal approach, the same surgical approach used for clipping, parent artery proximal occlusion, and trapping.

Only one previous patient has been treated by STA-P2 bypass by other than the subtemporal approach and posterior transpetrosal approach. The pretemporal approach described by de Oliveira *et al*.[6] is essentially the same as the anterior temporal approach, and has been used to perform STA-P2 bypass in a patient with large PCA aneurysm.[26]

The anterior temporal approach offers excellent exposure of the interpeduncular and crural cisterns, P1, P2A, and medical posterior choroidal artery, but the P2P is difficult to access.[25] The P2 segment is usually selected as the recipient artery for STA-PCA bypass,[5,14,22,24,25] but a suitable site for anastomosis is not always found because many branches including the peduncular perforating, medial and lateral posterior choroidal, and thalamogeniculate arteries frequently arise from the P2A or P2P segment. Furthermore, a high-positioned PCA sometimes makes an anastomotic procedure difficult. All approaches to the PCA have limitations in exposure of critical structures within the perimesencephalic cisterns, and these limitations may not be readily apparent on preoperative imaging studies but may become apparent during the course of an operation.[25] Therefore, operators should be ready to change to other approaches such as the subtemporal or posterior transpetrosal approach if the STA-P2 bypass cannot be performed via the anterior temporal approach.

In our series, the temporary occlusion time ranged from 25 to 51 min (mean, 38 min). The PCA territory contains rich collateral vascular networks.[16,23,27] However, long temporary occlusion time can increase the risk of ischemia to the occipital lobes with new visual field deficits,[17] so we recommend that every precaution, including complete hemostasis, placement of cellulose sponges beneath the recipient artery to elevate the site of the anastomosis, and placement of a continuous drainage tube at the bottom of the operative field to avoid blood contamination during the anastomosis, should be taken to shorten the temporary occlusion time.

CONCLUSION

STA-P2 bypass can be performed via an anterior temporal approach in selected patients. We recommend that every precaution, including complete hemostasis, placement of cellulose sponges beneath the recipient artery to elevate the site of the anastomosis, and placement of a continuous drainage tube at the bottom of the operative field to avoid blood contamination during the anastomosis, should be taken to shorten the temporary occlusion time.

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