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Case Report

Superficial temporal artery-superior cerebellar artery bypass and proximal occlusion through anterior petrosal approach for subarachnoid hemorrhage due to basilar artery dissection

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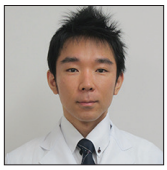

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ABSTRACT

Background: Subarachnoid hemorrhage (SAH) due to rupture of basilar artery dissection (BAD) is extremely rare and often has a poor prognosis. Since ruptured BAD has high rate of rebleeding and mortality, treatment to prevent rerupture is mandatory in the acute phase. However, to date, no optimal treatment has been established which satisfies secure prevention of rerupture and ischemia simultaneously. Herein, we report a case of SAH due to BAD treated with proximal occlusion of basilar artery with superficial temporal artery (STA)-superior cerebellar artery (SCA) bypass, preventing rebleeding securely and ensuring adequate blood flow in the upper basilar region.

Case Description: A 48-year-old male presenting with headache and altered mental status was found to have SAH and BAD. To prevent rerupture, proximal occlusion of basilar artery with STA-SCA bypass using anterior transpetrosal approach was performed. The postoperative course was relatively good and there is no evidence of recurrent arterial dissection.

Conclusion: Proximal occlusion of the basilar artery combined with STA-SCA bypass was successful in preventing rerupture of BAD and ensuring blood flow in the upper basilar region. Although there is controversy regarding acute treatment for ruptured BAD, direct proximal occlusion with sufficient revascularization using bypass skull base technique may be one of the optimal treatments even in this era of endovascular treatment.

Keywords: Basilar artery dissection, Bypass, Proximal occlusion, Superficial temporal artery-Superior cerebellar artery, Subarachnoid hemorrhage

INTRODUCTION

Basilar artery dissection (BAD) is very rare disease[25], and there are many unclear points regarding its natural history. The main clinical presentations of BADs are subarachnoid hemorrhage, brainstem infarction, or brainstem compression sign[8,20]. Subarachnoid hemorrhage due to BAD has a poor prognosis[16]. For unruptured BAD, observation and strict medical treatment may be considered[11], but it has been reported that the ruptured BAD treated conservatively had a

rerupture rate of 24%[17], and the prognosis for BAD rerupture is extremely hazardous[15]. Thus, the most important point in the treatment of subarachnoid hemorrhage due to BAD is to prevent rebleeding. However, to date, the standard treatment of BAD has not been established, and treatment strategy must be made case by case.

Here, we report a case of ruptured BAD treated by proximal occlusion of basilar artery in conjugation with superficial temporal artery (STA)-superior cerebellar artery (SCA) bypass using skull base technique in the acute phase.

CASE PRESENTATION

A 48-year-old man with no medical history was aware of intermittent headache 1 month before his visit. Suddenly, he woke up with a severe headache and did not show any improvement thereafter. During the emergency transportation, the state of consciousness deteriorated rapidly, and the Glasgow Coma Scale was detected as 7 (E1, V2, M4) on admission. Head computed tomography (CT) on admission revealed diffuse subarachnoid hemorrhage, especially thick in prepontine cistern (Fisher group 3), complicated by hydrocephalus [Figure 1a]. Digital subtraction angiography (DSA) showed spindle-shaped aneurysmal changes of basilar artery (BA) and double-lumen sign between the bifurcations with the superior cerebellar artery (SCA) and anterior inferior cerebellar artery (AICA) [Figure 1b and c]. Based on these findings, the patient was diagnosed with ruptured BAD. Since hydrocephalus had progressed, a ventricular drain was immediately placed through right anterior horn on the same day.

In this case, since BAD was in the acute stage of rupture, blocking the blood flow to the dissecting part was necessary to prevent rerupture. It was difficult to clip directly considering the shape of a dissecting aneurysm. Furthermore, trapping the lesion might cause brainstem infarction since the high-resolution CT showed perforators originating from the dissecting artery [Figure 1d].

Thus, we planned proximal ligation of BAD by direct clip just distal to AICA and STA-SCA bypass, intended to prevent repeated hemorrhage from BAD by blocking anterograde blood flow, preserve blood flow to AICA, and maintain adequate blood flow in upper BA including perforators originated around BAD.

Operation

Neuroanesthesia was induced and the patient was set in the supine-lateral position. Somatosensory evoked potentials of the four limbs, right auditory brainstem response, and right facial nerve function were monitored. The STA was harvested under the operating microscope. After cutting the zygoma and moving it downward with temporal muscle, a temporal craniotomy was performed with a 4-burr hole. The temporal base was flattened, and the middle fossa dura was detached from the middle skull base. The foramen spinosum was identified and the middle meningeal artery was coagulated and transected. Anterior petrosectomy was conducted by drilling the Kawase's triangle which is surrounded by the greater superficial petrosal nerve, arcuate eminence, and the lateral edges of mandibular nerve[7]. Dural incision was made in the middle cranial fossa and posterior fossa, and the superior petrosal sinus was cut at forward to preserve venous route from petrosal vein. Tentorium was cut posteriorly to preserve trochlear nerve. SCA was exposed by opening the ambient cistern, and the prepared STA was anastomosed to SCA [Figure 1e]. The patency of bypass blood flow was confirmed by a Doppler flowmetry. The hematoma in the subarachnoid space around trigeminal nerve was removed, and trochlear nerve was freed anteriorly by cutting the tent. The trigeminal nerve was exposed anteriorly, and BA was identified by following SCA proximally. The dissecting aneurysm and the bifurcation with AICA were confirmed in the proximal part. BA just distal to origin of AICA was almost normal and there were no perforators nearby [Figure 1f], and a clip was applied to this part. We confirmed that the blood flow to the dissection was blocked by Doppler flowmetry. The operation was completed by placing a cisternal drain. No significant change in neuromonitoring was observed throughout the procedures [Video 1].

Postoperative course

The postoperative course was relatively fair. To prevent obstruction of the bypass blood vessel, oral administration of aspirin (100 mg/day) was started. Postoperative diffusion-weighted magnetic resonance (MR) imaging showed an infarction in right midbrain which causes partial paralysis of the left limb [Figure 2a]. DSA performed on postoperative day 9 revealed no anterograde flow to the dissecting area with sufficient blood flow to bilateral AICA [Figure 2b], and the patency of the bypass was maintained well [Figure 2c]. Since normal pressure hydrocephalus progressed, the placement of ventriculoperitoneal shunt was performed. The patient was transferred to the hospital for rehabilitation due to the good progress. No clear recurrence of dissecting aneurysm, rebleeding, or infarction was observed on MR imaging and angiography performed 3 months after surgery.

DISCUSSION

BAD is a very rare disease, as intracranial arterial dissection tends to occur mostly in vertebral artery according to large case series[13,18,24]. Dissection can occur in any part

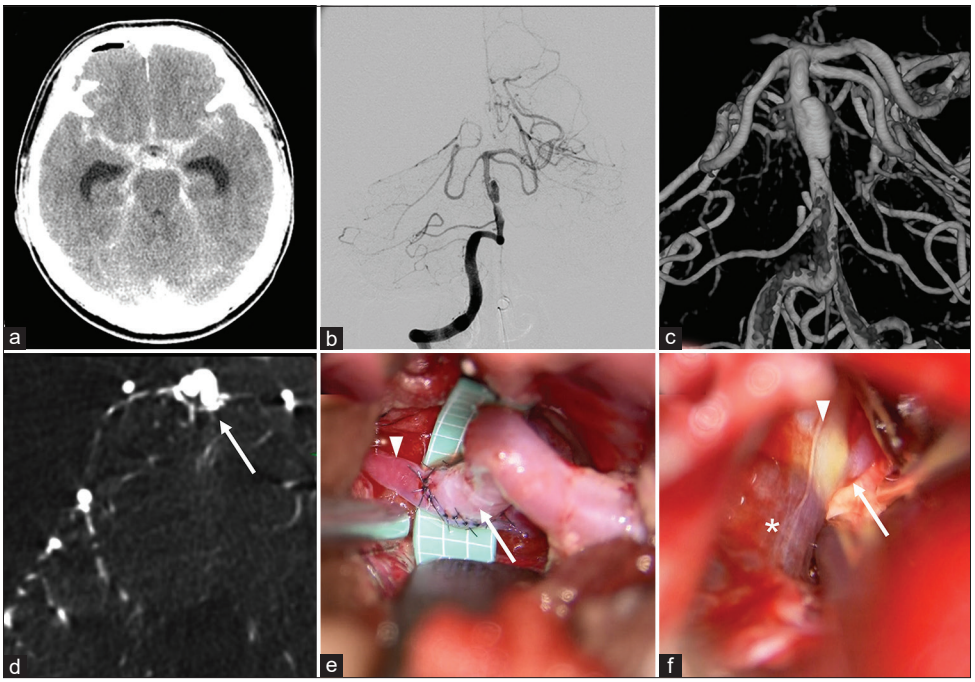

Figure 1: Preoperative imaging and intraoperative view. (a) Preoperative computed tomography scan showing a massive subarachnoid hemorrhage. (b) anteroposterior view of vertebral angiography showing spindle shaped aneurysmal changes of basilar artery (BA) between the bifurcations with the superior cerebellar artery (SCA) and anterior inferior cerebellar artery (AICA). (c) intimal flap and double-lumen sign were confirmed by 3-dimentional digital subtraction angiography (3D-DSA). (d) high-resolution CT showing perforators (arrow) originating from the dissecting artery. (e) intraoperative view: superficial temporal artery (arrow) -superior cerebellar artery (arrowhead) bypass. (f) intraoperative view: BA just proximall to origin of AICA (arrow) was almost normal (arrowhead) and there were no perforators nearby. BA distal to AICA was dissected (star).

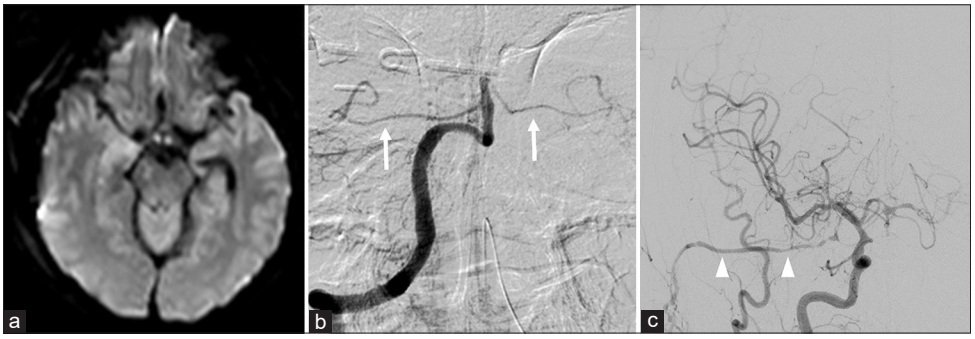

Figure 2: Postoperative imaging. (a) Postoperative MRI showed an infarction. (b, c) Postoperative angiography revealed that no new aneurysm was observed in the dissecting area with sufficient blood flow to bilateral AICA (arrows) and the patency of the bypass (arrow heads) was maintained well.

of the BA, but the most frequent site is between SCA and AICA as this case[20]. The onset pattern is mainly divided into three patterns: subarachnoid hemorrhage (46%), brainstem infarction (42%), and brainstem compression symptoms[8,20,25].

In cases of BAD without hemorrhage or infarction, conservative treatment with strict control of blood pressure is considered. On the other hand, the morbidity and mortality rate of ruptured BAD is 20% and 40%, respectively, which are much higher than those of unruptured BAD[16]. Moreover, rebleeding rate of BAD is very high[2,14], and the mortality of rebleeding from ruptured BAD is very high as 70–90%[15,25]. Therefore, treatment for prevention of rerupture is mandatory in the acute phase. However, a consensus on therapeutic options is lacking because the surgical intervention of BAD is extremely difficult.

Direct surgery for dissecting aneurysms of the posterior circulatory system is generally difficult and may have serious

consequences. There are few reports that direct surgery worked well in BAD[1,3]. One of the reasons for the difficulty of direct surgery in BAD is that the access to basilar artery trunk is hindered by multiple cranial nerves, perforating arteries, and important venous drainage system[3]. Extradural subtemporal approach to the petrosal ridge and the resection of the anterior pyramidal bone enabled the observation of the lower basilar artery with minimal retraction of temporal lobe[7].

In recent years, with the advancement of new devices, the number of cases of endovascular treatment for BAD has been increasing. In addition to coils and conventional stents[6,8,9,12,19,22], there have been reports of the treatment of ruptured BAD using flow diverters (FDs) recently[10,21,23]

However, there are several problems in endovascular treatment. First, anticoagulation and dual antiplatelet therapy induction are necessary in acute phase of rupture to prevent thromboembolic complications including occlusion. Second, flow alteration with stent or flow diverters, unlike clipping, does not completely prevent blood flow to BAD, so there is a risk of rebleeding even after treatment during the acute phase of rupture. It takes about 1 month to complete the regeneration of the vascular endothelium or intimal thickening in the part of dissection[15,18], and rebleeding may occur during this period. Third, in internal coil trapping, longer segment of artery is occluded compared with clipping. Coil occlusion of longer segment of the artery leads to perforator occlusion and infarction[4]. For the above reasons, we chose proximal ligation of BAD by direct clip just distal to AICA in this case.

The purpose of proximal occlusion for BAD is to block anterograde blood flow to the dissection. Clipping is possible for saccular type aneurysms, and only two cases have been reported in the past[1,3]. On the other hand, neck clipping is difficult in a fusiform-type aneurysm such as this case, and it is considered optimal to use proximal occlusion and bypass in the part with insufficient blood flow. In this case, the dissecting aneurysm was presented distal to the bifurcation with AICA, so proximal ligation with direct clip was performed just distal of the AICA. Fortunately, in this case, we could confirm that no perforator branching off the artery at the planned occlusion site.

The important point in proximal occlusion of the parent artery is to preserve sufficient blood flow to distal part of the artery. Although blood flow to PCA is supplied by cross flow from the anterior circulation through right PCoA in this case, we could not confirm that the flow is sufficient. To examine whether the blood flow through PCoA would replace upper BA or not, meticulous collateral evaluation by balloon occlusion test should have been performed. However, we did not perform the procedure due to patient's deteriorated consciousness and risk of thromboembolic complications. Thus, we tried to maintain blood flow by conducting STA-SCA bypass together [Figure 3].

The postoperative course was fairly good, with no apparent complications other than the right midbrain infarction.

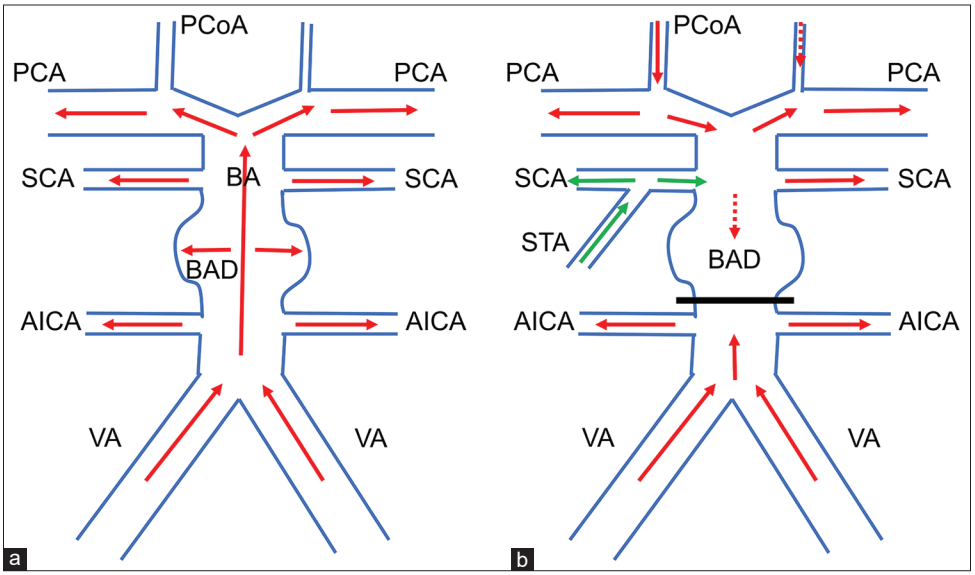

Figure 3: Schematic drawings of the surgery for the basilar artery dissection. (a,b) Preoperative and postoperative hemodynamics. Postoperatively, using superior temporal artery-superior cerebellar artery (SCA) bypass together with clipping just the distal part of anterior inferior cerebellar artery, the blood flow of SCA is covered by the bypass. The blood flow of posterior cerebral artery is supplied from the anterior circulation through posterior communicating artery. There is no blood flow in the dissection. Red arrows: normal blood flow, green arrows: blood flow by STA-SCA bypass, VA: vertebral artery.

Because the infarction occurred in the right midbrain, not in the pons, we assumed the causes as that the hemodynamic change after the operation caused insufficiency of blood flow to the perforators to midbrain and that the cisternal drain compressed the midbrain itself or small artery around[5]. Fortunately, there was no additional infarction or hemorrhage after that.

There is no standard treatment for ruptured BAD, and optimal treatment should be provided according to each patient and condition to prevent rebleeding. In addition to blocking the blood flow to the dissecting part, it is effective to use a bypass technique together to secure the blood flow to the area where ischemia may occur.

CONCLUSION

There is no standard treatment for ruptured BAD, and optimal treatment should be provided according to each patient. Proximal occlusion of the BAD combined with STA-SCA bypass was successful in preventing rerupture of BAD and ensuring blood flow in the upper BA region. Although there is controversy regarding acute treatment for ruptured BAD, direct surgery using bypass and skull base technique may be one of the optimal treatments.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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