Oblique Clip Technique via Anterior Temporal Approach for Blood Blister Aneurysm of Distal Portion of Internal Carotid Artery

Pritam Gurung[1], Yasushi Motoyama[2], Ichiro Nakagawa[2], Hun Soo Park[2], Yasuo Hironaka[2], Young Su Park[2], Hideyuki Ohnishi[1], Hiroyuki Nakase[2]

■ BACKGROUND: **Blood blister aneurysms (BBAs) of the internal carotid artery (ICA) are challenging vascular lesions for neurosurgeons because they are fragile and difficult to clip. They are commonly found at the dorsal wall of the ICA. Trapping is an alternative for these lesions, accompanied by vascular reconstruction. However, they are sometimes close to the posterior communicating artery and anterior choroidal artery.**

■ CASE DESCRIPTION: **A 30-year-old man presented with subarachnoid hemorrhage caused by rupture of a BBA in the right distal ICA. After construction of a high-flow bypass, the BBA was accessed via the standard pterional approach to end only in proximal clipping. Two weeks later, the remnant of the BBA showed a tendency to grow. Therefore, the anterior temporal approach was successfully used to obliterate the BBA using an oblique clip technique under direct inspection of patency of the perforators.**

■ CONCLUSIONS: **The anterior temporal approach to a BBA in the distal ICA is amenable to application of the oblique clip technique, which can provide direct inspection of the perforators emanating from the posteromedial wall of the ICA as well as obliteration of the pathologic wall. Furthermore, less retraction of the frontal lobe is also reasonable for avoidance of premature rupture of a fragile BBA.**

INTRODUCTION

Blood blister aneurysms (BBAs) of the internal carotid artery (ICA) arise at a nonbranching site of the dorsal wall of the supraclinoid portion of the ICA.[1-7] These types of aneurysms are rare and their management remains difficult. A variety of treatment modalities have been reported for this kind of aneurysm, such as direct clipping over an intact wall,[8] wrapping and clipping,[3] encircling clip graft,[9] and endovascular treatment.[10] Radial artery (RA) graft bypass and parent vessel sacrifice during the acute phase of subarachnoid hemorrhage (SAH) have been successfully performed.[11] BBAs are sometimes within or close to the level of the posterior communicating artery (PcoA).[11] In such situations, if we trapped the part of the ICA with the blister aneurysm, perforators, including the PcoA and anterior choroidal artery (AchoA), would likely be sacrificed. Oblique clipping at the distal side of the ICA can avoid occlusion of the PcoA and AchoA emanating from the posteromedial wall of the ICA.[12] However, with the standard pterional approach, the patency of perforators could not be visualized directly because those perforators would be behind the ICA. We describe herein a case of BBA in the distal portion of the right ICA, close to the PcoA and AchoA. In this case, after construction of a high-flow bypass using an RA graft, the oblique clip technique was used for trapping of the diseased portion via an anterior temporal approach under direct visualization, which was useful for avoidance of perforator occlusion.

CASE DESCRIPTION

A 30-year-old man with a history of hypertension and obesity presented with sudden onset of severe headache followed by

Key words
- Anterior temporal approach
- Blood blister aneurysm
- Oblique clip technique

Abbreviations and Acronyms
AchoA: Anterior choroidal artery
BBA: Blood blister aneurysm
CT: Computed tomography
ICA: Internal carotid artery
ICG: Indocyanine green
PcoA: Posterior communicating artery
RA: Radial artery
SAH: Subarachnoid hemorrhage

From the [1]Department of Neurosurgery, Ohnishi Neurological Center, Akashi, Hyogo; and [2]Department of Neurosurgery, Nara Medical University, Kashihara, Nara, Japan

To whom correspondence should be addressed: Yasushi Motoyama, M.D. [E-mail: myasushi@naramed-u.ac.jp]

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consciousness disturbance. He was immediately taken to a nearby hospital, where computed tomography (CT) of the head showed diffuse SAH (Figure 1A); the patient was then transferred to our institution for further treatment. On arrival, he was drowsy but without any focal neurologic deficits. Three-dimensional CT angiography and digital subtraction angiography showed a small bulge with a concave shape along the dorsal wall of the distal part of the right ICA (Figure 1B). The patient was diagnosed with a ruptured BBA of the right ICA and surgical treatment was chosen to prevent rerupture of the aneurysm. According to neuroradiologic findings, trapping of the BBA with high-flow bypass using an RA graft was chosen as the surgical intervention in consideration of the dissecting nature of the BBA.

While the right frontotemporal craniotomy was created, the bifurcation of the cervical carotid artery was exposed in the neck. An 18-cm length of the RA was simultaneously harvested from the right forearm as an arterial graft. First, the proximal end of the RA graft was anastomosed with the proximal side of the external carotid artery, then the distal end was anastomosed with the M2 segment of the middle cerebral artery, after dissection of the distal sylvian fissure. After confirmation of patency of the high-flow bypass, gentle retraction of the frontal lobe and opening of the opticocarotid cistern showed thick hematoma covering the intracranial part of the right ICA. Meticulous aspiration of the subarachnoid clot showed dark reddish discoloration of the dorsal wall of the distal portion with hemispheric bulging. At first, trapping of the pathologic wall of the ICA was attempted but could not be accomplished because the PcoA and AchoA were involved at the opposite side of the segment of the ICA with the aneurysm (Figure 1C). Therefore, the portion of the ICA with a normal wall proximal to the BBA was obliterated by application of a straight clip, preserving the PcoA and AchoA. We confirmed the obliteration of the ICA and collateral flow into the middle cerebral artery and anterior cerebral artery

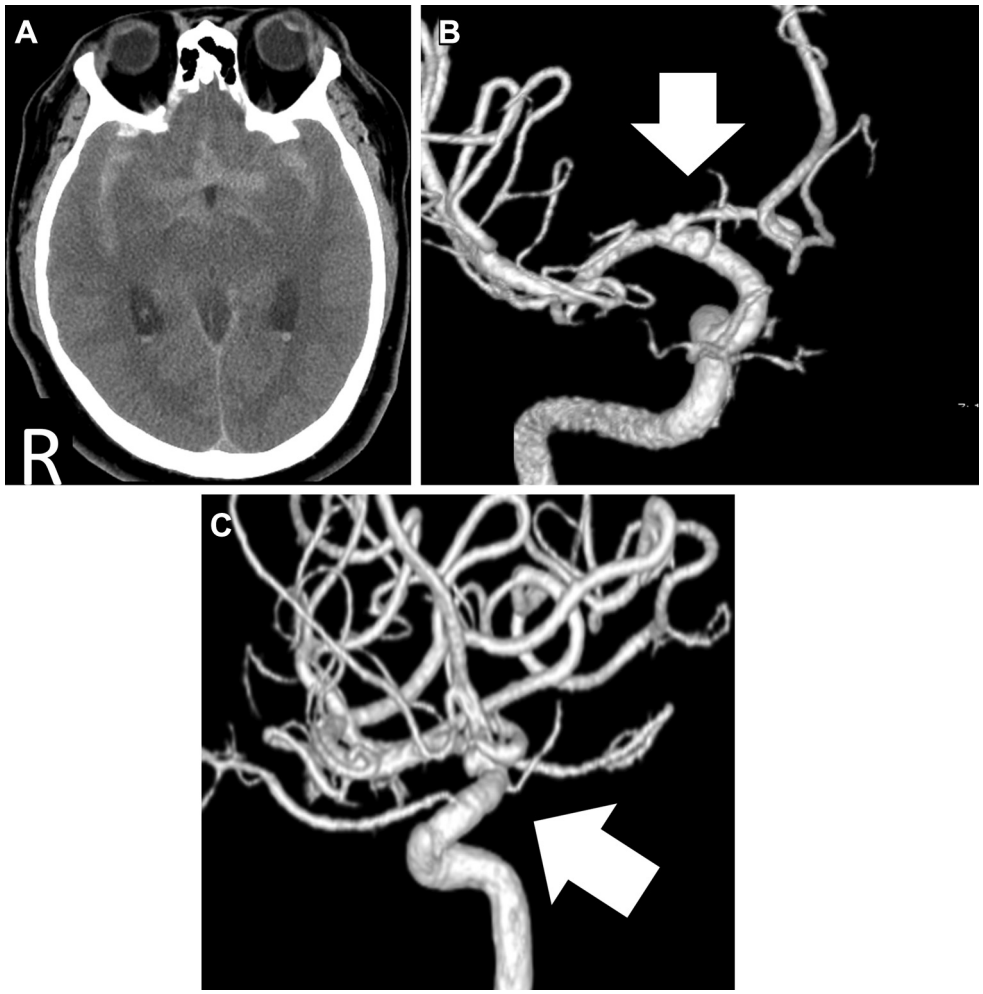

Figure 1. (**A**) Computed tomography of the head shows diffuse subarachnoid hemorrhage. R, right. (**B**) Right three-dimensional carotid angiography shows a small aneurysm with a concave shape in the nonbranching site of the dorsal part of the internal carotid artery (*white arrow*). (**C**) A right three-dimensional carotid angiography image from the medial side shows that the origin of the posterior communicating artery is proximal to the internal carotid artery dorsal aneurysm (*white arrow*).

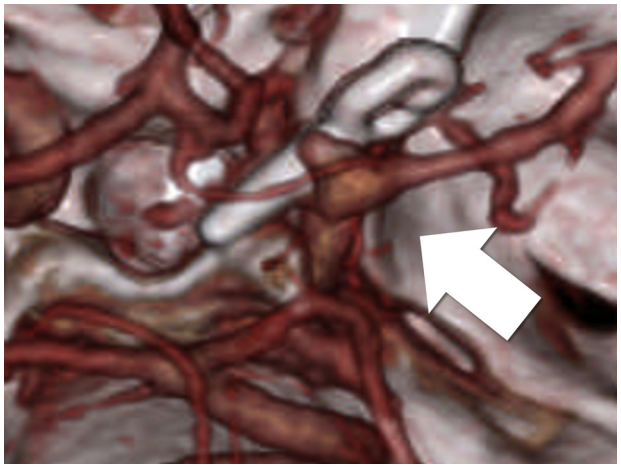

Figure 2. Three-dimensional computed tomography angiography 2 weeks after the first operation shows the growing tendency of the remnant of the aneurysm (*white arrow*).

through the high-flow bypass by indocyanine green (ICG) videoangiography. Brain swelling related to the acute stage of SAH was so severe that external decompression was also performed.

The postoperative course was uneventful, and the patient improved with no neurologic deficits.

Two weeks after the operation, follow-up three-dimensional CT angiography showed good patency of the high-flow bypass and obliteration of the proximal right ICA. However, growth of the size of the remnant aneurysm fed by the PcoA was also noticed (**Figure 2**). For prevention of rerupture of the aneurysm, we decided to perform additional treatment.

At the second operation, after opening of the proximal sylvian fissure, an anterior temporal artery was detached from the medial surface of the temporal lobe. Next, the arachnoid membrane of the deep part of the medial temporal lobe was dissected to make the temporal lobe more easily mobile. The temporal lobe was then retracted laterally to provide an optimal view of the pathologic portion of the ICA from the lateral side. An irregularly shaped aneurysm without any clear neck was observed to arise from the dorsal wall with no branching site in the distal right ICA, which projected in the anterior medial direction (**Figure 3A**). Further sharp dissection of the arachnoid membrane and retraction of the temporal lobe created enough space to expose the lateral surface of the ICA for observation of the origin of the PcoA and AchoA. ICG videoangiography showed turbulent flow inside the aneurysm fed by retrograde flow through the PcoA. Then the clip was applied in an oblique fashion, covering the pathologic wall of the ICA and preserving the perforators (**Figure 3B**). After clip application, flow through

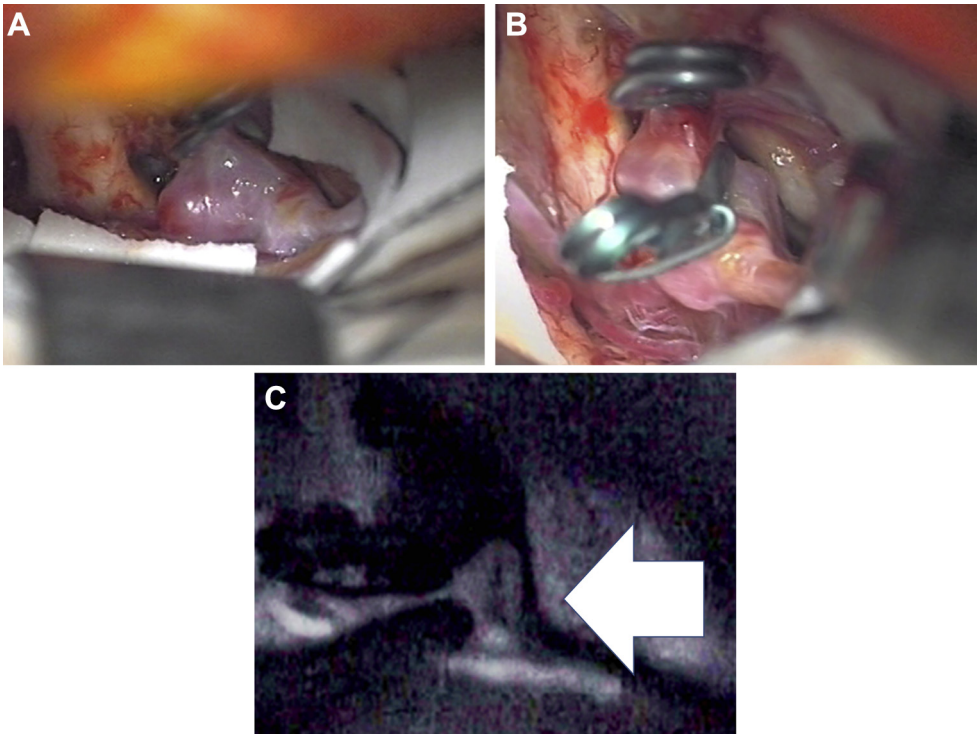

Figure 3. (**A**) Frontal lobe retraction showing an irregularly shaped aneurysm arising from the dorsal wall with no branching site in the distal right internal carotid artery, which projects in the anterior medial direction. (**B**) Temporal lobe retraction and lateral viewing show the relationship between the aneurysm and perforators, which makes it possible to obliterate the aneurysm by oblique clip application. (**C**) The tip of the clip blade was just proximal to the origin of the posterior communicating artery, and flow through the posterior communicating artery was confirmed by indocyanine green videoangiography (*white arrow*).

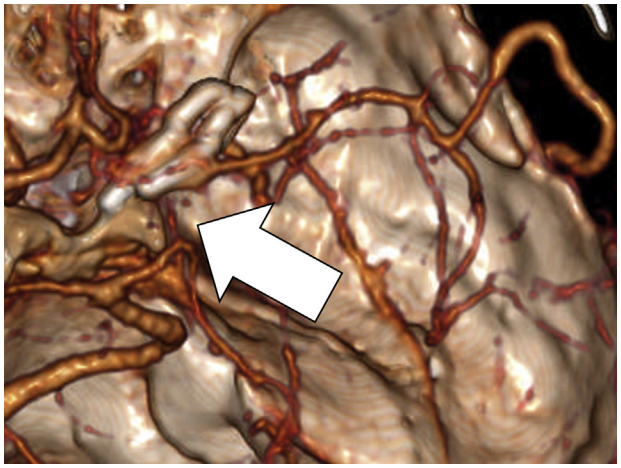

Figure 4. Three-dimensional computed tomography angiography after the second operation shows disappearance of the aneurysm and patency of the posterior communicating artery (*white arrow*).

the PcoA was again confirmed by ultrasound Doppler sonography and ICG videoangiography (**Figure 3C**). The patient's postoperative recovery was uneventful with no neurologic deficits. The patient was discharged and was able to resume normal activities (**Figure 4**).

DISCUSSION

Aneurysms located at the anterior aspect of nonbranching sites in the supraclinoid ICA were described first by Sundt and Murphey.[13] Ogawa et al.[6] reported that 10 of 40 BBAs showed angiographic characteristics of dissection such as a double lumen, narrowing and dilation, pooling or slow filling along the vessel wall, an intimal flap, or a filling defect.

The histologic characteristics of BBAs include focal defects of the vessel wall covered with clot, normal adventitia, and fibrous tissue, which may be the result of laceration of the ICA wall caused by ulceration and penetration into the internal elastic lamina, resulting from arteriosclerosis.[1,14] This is the reason why so-called BBAs are believed to have a dissecting nature. Regarding the incidence of this aneurysm, many studies have shown that it is more common in women, with a preponderance occurring in the right ICA.[12] A high incidence of rerupture in the early period after the ictus is characteristic of intracranial arterial dissection. Likewise, the incidence of intraoperative or postoperative bleeding among patients with BBAs has been reported to be significantly higher than that among patients with saccular-type aneurysms.[6]

Because of the dissecting nature of BBAs, standard neck clipping is not appropriate to prevent future rerupture. Many investigators have reported that treatment failure would occur as rebleeding or regrowth of the aneurysm just after surgery with this method. Instead of neck clipping, many treatment modalities have been described for BBAs, including clipping,[8] wrapping and clipping,[9] encircling clip,[15] endovascular treatment,[10] and ICA sacrifice followed by high-flow bypass using a radial graft.[11]

In consideration of the dissecting nature of BBAs, trapping of the pathologic portion of the ICA is the most reasonable method for complete elimination of blood flow inside the affected ICA, even although vascular reconstruction for the sacrificed ICA would be needed. BBAs are sometimes in or close to the level of the PcoA.[11] Kazumata et al.[11] have described several scenarios of hemodynamic alterations caused by ICA trapping in the treatment of distal BBAs: ICA trapping proximal to the origin of the PcoA potentially induces bidirectional flow through the thick PcoA; in a hypoplastic PcoA, retrograde flow through the distal ICA develops and potentially induces retrograde thrombosis; when trapping between the origin of the PcoA and AchoA is performed, retrograde thrombosis is also expected at the origin of the AchoA. Our patient had a fetal-type PcoA. The point just proximal to the PcoA was believed to be the best location for application of the distal clip to prevent extension of thrombosis into the AchoA. In addition to preservation of perforators, obliteration of the pathologic wall of the ICA requires oblique clip application.[11,12]

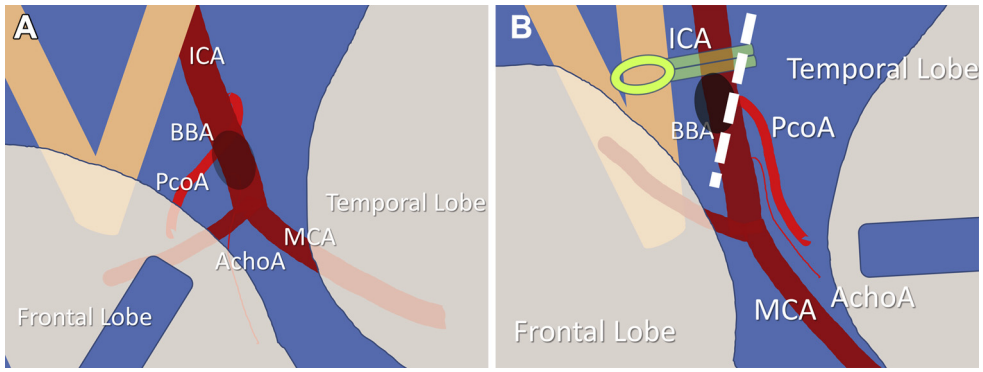

Figure 5. (**A**) Illustrative drawing showing the intraoperative view through the standard pterional approach; the courses of the posterior communicating artery (PcoA) and anterior choroidal artery (AchoA) are not visualized behind the internal carotid artery (ICA). (**B**) The anterior temporal approach provides good visualization of the posterolateral surface of the ICA to expose the PcoA and AchoA under direct inspection. An oblique clip can be applied appropriately with less retraction of the frontal lobe (*dotted white line*). BBA, blood blister aneurysm; MCA, middle cerebral artery.

The PcoA and AchoA arise from the posteromedial surface, midway between the origin of the ophthalmic artery and the terminal bifurcation. They sweep backward and medially under the ICA. The origin of the PcoA and AchoA can be observed via the standard pterional approach. However, in this case, the distal part of the PcoA was confirmed to be medial to the ICA or opticocarotid space. The middle part of the PcoA was behind the ICA. The course of the AchoA would have also been blocked by the ICA with the pterional approach (**Figure 5A**). An anterior temporal approach can provide a view from the lateral side, which allows visualization of the course of those perforators in the retrocarotid space (**Figure 5B**), which has been described as a useful approach for the treatment of basilar apex aneurysms or lesions in the posterior cerebral artery.[16-19]

An anterior temporal approach requires dissection of the distal sylvian fissure, anterior temporal artery from the medial surface of the temporal lobe, and arachnoid connection between the medial temporal lobe and oculomotor nerve to make the temporal lobe mobile. For prevention of postoperative contusion of the temporal lobe as a result of retraction, it is important to ensure a wide dissection of the arachnoid membrane, with preservation of as many sylvian veins as possible; occasional extension of the craniotomy, including orbitozygomatic osteotomy, is sometimes necessary.[20] BBAs have been reported to have fragile domes and easily bleed during surgery.[1,14,21] Inadvertent retraction of the frontal lobe should be avoided because of premature rupture caused by destruction of the fragile dome adherent to the base of the frontal lobe. An anterior temporal approach can avoid premature rupture caused by robust retraction of the frontal lobe. In those situations, the anterior temporal approach to BBAs is a reasonable method.

CONCLUSIONS

The oblique clip technique for BBAs in the distal ICA is useful to obliterate the pathologic walls of the ICA and preserve the perforators, including the PcoA and AchoA. During this technique, the anterior temporal approach can provide direct inspection of the perforators of the ICA emanating from the posteromedial wall. Moreover, less retraction of the frontal lobe is also helpful in avoidance of premature rupture of the fragile dome of a BBA adherent to the base of the frontal lobe.

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