

Original Article

The clinical management experience in treating special, ruptured, blood blister-like aneurysms: a case report and literature review

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Abstract: Blood blister-like aneurysms (BBAs) are a rare type of ruptured intracranial aneurysm accounting for 0.5-2.0% of all aneurysms and are fragile and arise from non-branching vessels. BBAs remain the most difficult cerebrovascular lesions to diagnose and treat, especially BBAs combined with other intracranial aneurysms. The management of BBAs is a huge challenge for neurointerventionalists and neurosurgeons because their diagnosis and treatment are difficult. There are high morbidity and mortality rates in surgical clipping and a high complication rate in endovascular embolization. We report a special case who presented with a sudden headache and vomiting for two hours. Acute subarachnoid hemorrhage (SAH) was diagnosed after a computerized tomography (CT) scan, and the severity and distribution of the SAH and hematoma were similar on both sides. Only a left carotid-ophthalmic aneurysm was found on the first digital subtraction angiography (DSA) and CTA scan. The second DSA confirmed a right carotid BBA (ruptured) after one week. The patient successfully underwent a double stent-assisted coil embolization without ischemia or neurological dysfunction. Additionally, the aneurysm was completely occluded after a re-examination. Based on the literature review, the diagnosis of BBAs is difficult due to their tiny size, especially when combined with other intracranial aneurysms. The double stent-assisted coil embolization technique might be a good choice for BBAs, especially those not suitable for clipping or embolization.

Keywords: Blood blister-like aneurysms, diagnosis, endovascular embolization

Introduction

Cerebral aneurysms are an abnormal enlargement of the cerebral artery with very serious consequences and a poor outcome if the aneurysm ruptures [1]. Blood blister-like aneurysms (BBAs) are a fragile and rare type of aneurysm that occur in the non-branching main artery. They often originated from the anterior wall of the internal carotid artery (ICA). BBAs account for only 1% of all intracranial aneurysms [2] and just 0.5%-2% of all ruptured intracranial aneurysms are BBAs [3, 4]. Because of the rarity of BBAs, the pathophysiology, treatment, and outcomes of BBAs are unclear. The most typical clinical and radiologic characteristics are subarachnoid hemorrhage or

intracranial hematoma. BBAs are often missed or misdiagnosed due to their tiny size and are indistinguishable after bleeding occurs [5]. BBAs combined with other intracranial aneurysms have a high misdiagnosis rate. It is difficult to confirm which is the ruptured aneurysm. Misdiagnosis also leads to incorrect management and very poor outcomes. Meckel [6] reported that the typical diagnostic characteristics of BBAs are an increased size after several days. The treatment of BBAs is a challenging task for neurovascular surgeons and neurosurgeons. The morbidity and mortality rates are high [2-6] because BBAs do not have a normal aneurysm structure [7]. In recent years, there have been many treatments, including microsurgical clipping, coiling, bypass,

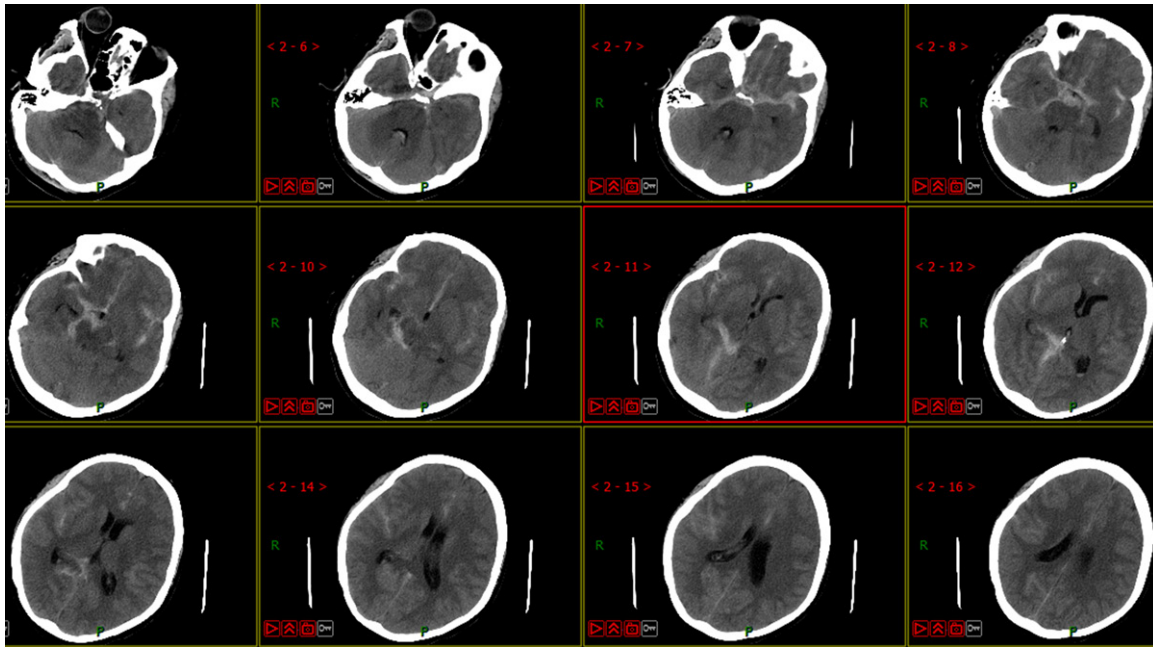


Figure 1. The CT scan showed a subarachnoid hemorrhage, and the severity and distribution of the SAH and hematoma on the two sides were similar.

suturing, and flow-diverting stents [2-9]. However, many researchers have found that simple clipping or coiling lead to a poor prognosis and more complications for BBAs [8, 10]. Therefore, the optimal treatment is still unclear. In the present report, a special BBA combined with a contralateral ICA aneurysm made the diagnosis very difficult, and finally, the second digital subtraction angiography (DSA) confirmed the contralateral side was responsible for the BBA rupture. Subsequently, the patient successfully underwent a double stent-assisted coil embolization, and the aneurysm was completely occluded after 6 years of follow-up. Therefore, we reviewed our case and analyzed the diagnosis, treatment, and clinical outcomes.

Case report

A 66-year-old female presented to a regional hospital with a sudden headache and vomiting for two hours, and she had no previous history of trauma. Her past medical history included hypertension. A physical examination showed drowsiness, and her Glasgow Coma Scale (GCS) score was 14. Her Brudzinski and Kernig's signs were positive, but the other signs were negative. An Emergency CT (**Figure 1**) showed an intracranial subarachnoid hemorrhage, and the severity and distribution of

the SAH and hematoma on the two sides were similar. The hospital considered that the operation was too risky as they could not confirm which was the ruptured aneurysm. Then, two hours later, the patient was admitted to our hospital. A neurological examination revealed no other abnormalities, with positive Brudzinski and Kernig's signs and a GCS of 15. Next, the patient underwent a CT angiography (CTA) examination, which showed an aneurysm located in a segment of the left carotid-ophthalmic artery with a size of approximately 3.5 mm*1.6 mm. The morphology of the aneurysm was regular (**Figure 2**). To further evaluate the aneurysm and the intracranial arterial collateral blood flow pathways and the changes in hemodynamics, a DSA examination was considered (**Figure 3**). The results indicated a left carotid-ophthalmic artery aneurysm with a size of 2.1 mm*2.5 mm that was a regular and a saccular aneurysm (**Figure 3A**). A right carotid artery angiography showed no other aneurysms, but a three-dimensional scan showed a minor bulge at the carotid-ophthalmic artery segment (**Figure 3B**). After discussing the case with the neurosurgeon and the neurointerventionalist in our department, we highly suspected that this aneurysm was a BBA and was ruptured, but we needed a DSA re-examination after one week for confirmation.

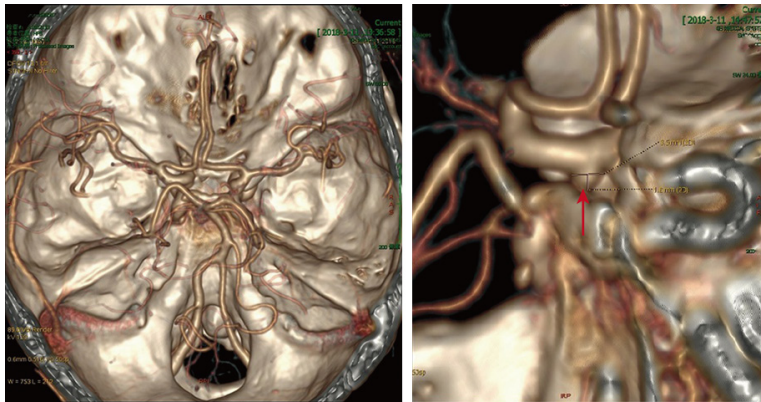


Figure 2. The CTA scan showed an aneurysm located in a segment of the left carotid-ophthalmic artery with a size of approximately 3.5 mm*1.6 mm (indicated by the red arrow).

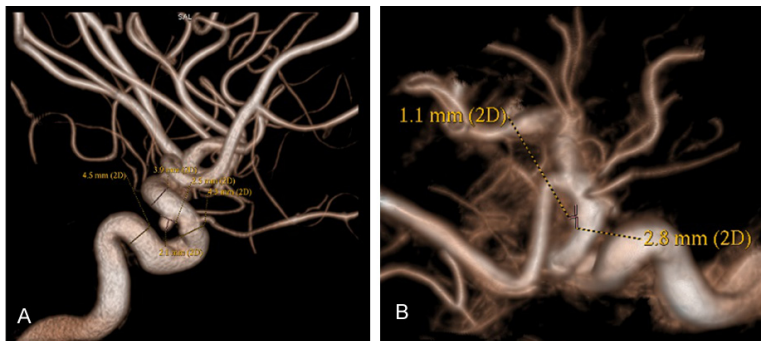


Figure 3. DSA scan. A. A left carotid-ophthalmic artery aneurysm with a size of 2.1 mm*2.5 mm that appeared regular and a saccular aneurysm. B. A right carotid artery angiography showed no other aneurysms, but a three-dimensional scan showed a minor bulge at the carotid-ophthalmic artery segment.

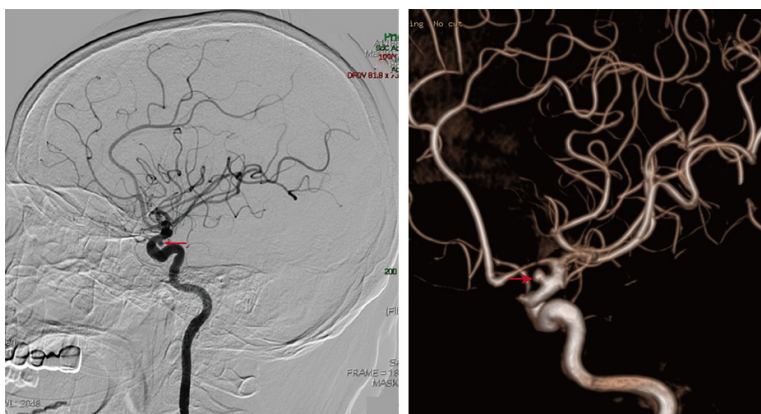


Figure 4. The minor bulge in the right carotid-ophthalmic artery progressively enlarged to a size of 3.2 mm*2.7 mm (indicated by the red arrow), and the morphology became irregular after one week.

After one week, the patient underwent a second DSA examination, and this DSA scan showed that the morphology of the left carotid-

ophthalmic artery aneurysm was the same as the first DSA. However, we found that the minor right carotid-ophthalmic artery bulge had progressively enlarged to a size of 3.2 mm*2.7 mm, and the morphology became irregular (**Figure 4**). Therefore, we confirmed that this aneurysm was responsible for the aneurysm rupture and caused the SAH.

Microsurgically clipping the aneurysm would be very difficult as it was thin-walled and could rupture with minimal manipulation. Stent-assisted coiling is feasible and safe for BBAs. This method was a good choice and provides a relatively safe and reliable method, and the neurologist, neurosurgeon, and interventional radiologist agreed after a discussion.

The preoperative preparation is very important. Both blood pressure and blood glucose were adjusted to the peak physiology state. Two hours before the operation, 300 mg aspirin and 300 mg clopidogrel were administered orally to prevent thrombosis, then systemic intravenous heparin was needed to achieve an activated clotting time between 250 and 300 seconds during the procedure.

As BBAs can easily re-rupture, the procedures required us to finish the operation right after the initial diagnosis, so the patient received general anesthesia. The first enterprise stent crossed the aneurysm neck and was inserted into the distal branch of the parent artery, and then a second microcatheter was inserted into the aneurysm sac for the coil deployment. Next, we performed a coil embolization of the aneurysm as

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compactly as possible, including the aneurysm neck. The second stent was placed through the lesion with sufficient overlap on each side of the target to secure the stent. After the operation, establishing blood pressure control was very important, and the blood pressure was maintained below the typical range by approximately 10~20 mmHg. The patient was prescribed clopidogrel (75 mg) for six weeks and long-term aspirin (100-300 mg). She left the ICU after 2 days with a GCS of 15/15. No nerve dysfunction was found. A repeat DSA (**Figure 5A**) was performed, and it indicated that the operation was successful, as the BBA was completely occluded; there were no complications. The postoperative repeat CT (**Figure 5B**) showed no re-bleeding.

Six months after the operation, the patient had a good outcome, with a GOS (Glasgow Outcome Scale) score of 5. The patient also underwent an imaging and cognitive psychological function evaluation. A DSA re-examination was considered. The DSA scan showed a stent with no stenosis or occlusion, and the aneurysm was completely occluded (**Figure 6**). The cognitive psychological function evaluation showed no neurological dysfunction.

Discussion

BBAs are very rare lesions, making up a very small proportion of ruptured intracranial aneurysms [3, 4] and accounting for 1% of all intracranial aneurysms [2]. As these aneurysms can easily rupture and cause SAH, the mortality and morbidity rates are high, and the outcomes are usually poor, especially if untreated. Early detection and surgery can improve the survival rate and prognosis. BBAs mainly originate from the trunk of the artery and are commonly located in the ICA, especially in the supraclinoid segment. Interestingly, some researchers consider that BBAs are not real intracranial aneurysms because they lack the structure of an aneurysm and include a fragile fibrin layer in the focal wall defect, without an internal elastic lamina or the media of normal arteries [11, 12]. Ogawa [13] reported that the prominent traits of blister-like aneurysms included younger age, arterial hypertension, ICA dissection, atherosclerosis, and female gender. As BBAs are very rare, the mechanism and epidemiology of BBA occurrence remain unclear.

Diagnosis of BBAs

As BBAs are tiny in size and unusual, most are not easy to detect at first by CTA or DSA. BBAs are easily misdiagnosed because their low degree of bulging may not be recognized on an MRA or CTA. In general, most patients first receive noninvasive examinations, such as CTA or MRA, after developing a SAH. Conventional DSA is mandatory in patients with negative MRA or CTA findings. However, we found a left carotid-ophthalmic aneurysm in this case, and the morphology of the aneurysm was regular; the aneurysm did not look like it was responsible for an aneurysm rupture. Then, the first DSA confirmed a left carotid-ophthalmic artery aneurysm with a size of 2.1 mm*2.5 mm that was regular and a saccular aneurysm. The right carotid artery angiography showed no other aneurysms, but a three-dimensional scan showed a minor bulge at the carotid-ophthalmic artery segment. Ishikawa [14] reported that rapid growth BBAs will more visible after several days, and the BBA will tend to re-bleed. Therefore, we performed a second DSA examination and confirmed the right carotid BBA (ruptured) after one week. Although DSA remains the gold standard for diagnosis, Peschillo [15] reported that the typical morphology of a BBA on DSA is a tiny hemispherical dome with a wide neck, so it makes any method or treatment quite dangerous, and it increases the operative complexity and technical difficulty. This case was more prone to misdiagnosis because of the presence of multiple intracranial aneurysms, and the small BBA was easily ignored. Disastrous consequences would have occurred if we did not carefully evaluate the CTA/CT or DSA findings and only clipped or directly performed endovascular embolization for the aneurysm. Shigeta [2] reported that approximately 30% of patients with BBAs had negative results from the first angiograms. Therefore, when or if a BBA is suspected after CTA or DSA, we recommend the following measures to avoid misdiagnosis: (1) A 30-degree oblique and rotational 3D angiogram may be the most effective method for visualizing these aneurysms [16, 17]; (2) CTA or DSA should be repeated within one week because of rapid BBA enlargement and morphologic changes [1, 6, 18]; and (3) High-resolution MR imaging can provide more additional radio data for the diagnosis of BBA or a dissecting aneurysm as this method can see the intramural hemorrhage in a cross-sectional view [19, 20].

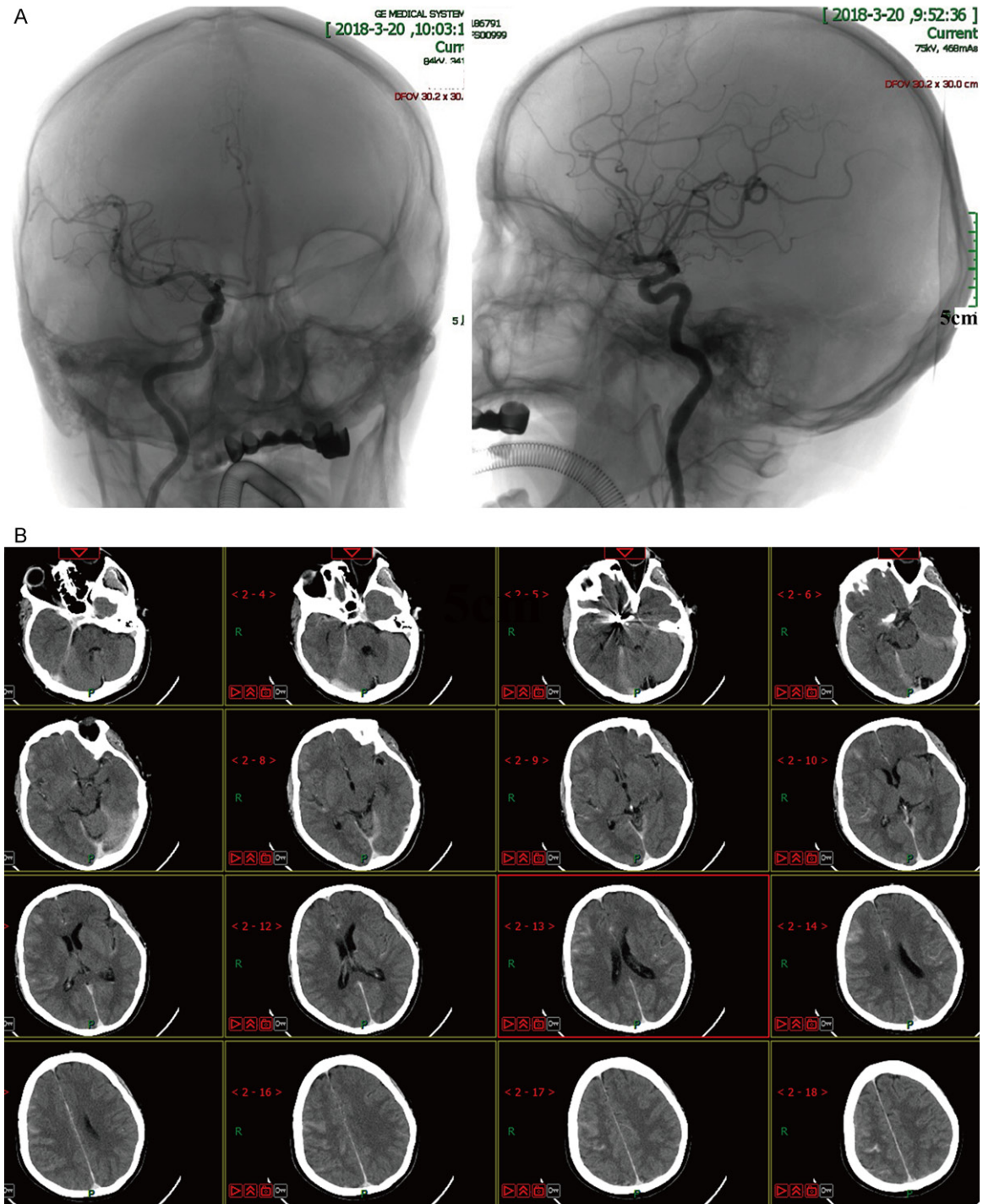


Figure 5. Postoperative examination. A. The postoperative DSA showed indicated that the operation was successful, as the BBA was occluded completely, and there were no complications. B. The postoperative CT re-examination showed no re-bleeding.

Management strategies for BBA

There are many management strategies, such as surgical clipping, bypass, parent artery sacrifice (surgical or endovascular) and endo-

vascular aneurysm exclusion. However, different strategies have different pros and cons. Recently, no standard or first-choice strategies to effectively manage BBAs have been established. McLaughlin [21] reported that the su-

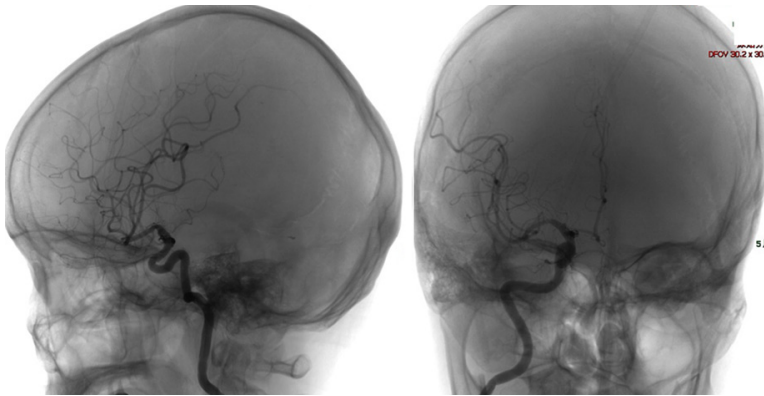


Figure 6. At the six-month follow-up after the operation, the DSA scan showed a stent but no stenosis or occlusion, and the aneurysm was completely occluded.

turing technique was a very important and useful treatment for ruptured BBAs, and all of 5 ruptured BBAs in the ICA had favorable prognoses without recurrence or rebleeding. Liu [22] reported on a study about the effectiveness of microsurgical clipping on BBAs. It enrolled 22 BBA patients, and the results showed that he successfully and completed clipped cases just on ten patients, and nine patients had a favorable prognosis, one patient recovered with a slight disability, one patient had a severe disability, 9 patients died, one patient died even though bypass surgery was performed, and one patient was in a persistent vegetative state. Even ICA trapping with bypass can prevent rebleeding, but it will face the enormous risk of ischemic complications [22, 23]. Szmuda [24] conducted a systematic review, which enrolled 311 ruptured BBAs cases, and the results demonstrated that interventional therapy was the best choice for treatment and suggested individual patient-based management. Currently, there are no large randomized, controlled trials of microsurgery and endovascular treatment for BBAs.

The advantages of surgical clipping are the ability to expose the aneurysm directly and remove the hematoma if the aneurysm ruptures to maintain parent vessel patency. However, the disadvantages are that the technique is complex and has a long learning curve, and direct surgical clipping may be associated with rebleeding, neurological dysfunction, and infarction [21-24]. As BBAs lack an identifiable aneurysm neck and the wall is very thick, the microsurgical clipping is very

difficult. Direct microsurgical clipping may lead to sacrificing the ICA wall, and ICA stenosis might increase the risk of cerebral ischemia [9]. Another very important microsurgical method is direct suturing, which has been reported by some authors [9, 25]. These authors all recommend that suturing may be better than direct clipping as it results in a lower incidence of artery stenosis. Other authors also reported that trapping/EC-IC bypass is an important and definitive

treatment strategy for intracranial complex aneurysms, including ruptured BBAs, and some cases have fully demonstrated the advantages of this new technology [26, 27]. However, this high-flow EC-IC bypass technique requires a high degree of skill and needs more time to perform and evaluate. In summary, microsurgical treatment has the advantage of exposing the aneurysm and enabling the direct observation of the BBA, but the risk for intraoperative rupture is relatively high, and this operation may cause stenosis of the parent artery or injure the branching vessels [28].

Endovascular aneurysm exclusion is very important and is the most common management strategy for BBA. The endovascular technology and intervention materials are perfect for BBAs, and the various endovascular methods that have been described for the treatment of CCAs include flow-diverter stents, endovascular patch embolization, covered-stent techniques, and multiple overlapping stents (≥ 3) with a coiling of the aneurysm [3, 5, 18, 29]. However, BBAs with wide aneurysm necks and thin aneurysm walls are challenging to treat with this endovascular method, as there is a high risk of parent artery embolization, aneurysm rupture, neurologic deficits, or residual aneurysms. In this case report, the patient underwent aneurysm coiling with the double stent-assisted technique during the endovascular coiling. This patient had a good outcome and no neurological deficits at the 6-month follow-up. The DSA reexamination scan showed a stent and no stenosis or occlusion, and the aneurysm was completely occluded.

Follow-up and future directions

The use of double or multiple overlapping stents (≥ 3) to coil BBAs is a very important management approach that can help neurosurgeons achieve excellent results. However, a long-term follow-up for the related complications is also urgently needed. Hao [3] reported on 8 patients who underwent endovascular patch embolization. No acute operation-related complications occurred in any of the patients, and most (6/8) patients had a good outcome. Most studies report that endovascular treatment is a good management approach for BBAs and has a low cerebral infarction rate during the follow-up, but the long-term follow-up data and multicenter data are lacking [3, 5, 15, 18, 29, 30]. Therefore, further follow-up studies are needed to confirm the long-term prognosis and to evaluate the risks of restenosis and cerebral infarction or ischemia. In the future, the development of new materials and endovascular techniques may enable some complex BBAs to be treated with coil embolization. An increasing number of authors and neurosurgeons are interested in flow diverters and multiple overlapping stent therapies [5, 29, 30].

Conclusion

BBAs are challenging lesions for neurosurgeons and vascular interventional physicians to treat. Ascertaining the diagnosis is the key and the most important aspect. Misdiagnosis may lead to disastrous consequences. Endovascular treatment is an important option for BBAs. Placing flow diverters and multiple overlapping stents are technically challenging, but experienced neurosurgeons can achieve excellent results. This approach can decrease the rate of cerebral infarction, aneurysm rupture and related complications. More accurate conclusions are needed from more studies with longer-term follow-ups and accurate evaluation methods.

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We obtained a written informed consent from the patient. The patient provided consent for the publication of her data and images.

Disclosure of conflict of interest

None.

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