Management of Blood Blister–Like Aneurysms of the Internal Carotid Artery: Lessons Learned from Direct Clipping in 22 Cases

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■ OBJECTIVE: **To present a case series of blood blister–like aneurysms (BBAs) of the internal carotid artery (ICA) and an assessment of diagnosis and treatment options, attempting to identify surgical or endovascular management of BBAs with a low complication rate and a functional outcome.**

■ METHODS: **A retrospective analysis including diagnosis and treatment options of BBAs of the ICA was performed of patients treated for BBAs at Fuzhou General Hospital from January 2008 to September 2016.**

■ RESULTS: **The case series includes 22 patients (14 women and 8 men) treated by direct clipping. Of all cases, 10 patients were successfully clipped; among them, 9 patients were cured with a favorable outcome, and 1 patient recovered but with slight disability. Among the other 12 cases with tear or avulsion of the BBA after clipping, the aneurysm and its parent artery had to be trapped in 9 cases. Complications in these 12 cases 3–14 days after surgery had led to ICA system occlusion on the BBA side, resulting in patient death in 9 cases, severe disability in 1 patient, persistent vegetative state in 1 patient, and 1 patient died 4 days later after bypass resurgery.**

■ CONCLUSIONS: **Preoperative diagnosis of BBAs is essential for proper management. Once the BBA has ruptured, the emergency clipping operation should be performed with caution. Moreover, based on lessons learned from direct clipping and a literature review, interventional therapy appears to be a more physiologic and more definitive treatment option for BBAs of the ICA, with a more favorable patient outcome.**

INTRODUCTION

Blood blister–like aneurysms (BBAs) refer to those aneurysms originated at the nonbranching sites in the supraclinoid portion of the internal carotid artery (ICA), accounting for 0.3%–1% of intracranial aneurysms and 0.9%–6.5% of ICA aneurysms,[1-5] and were first described by Sundt and Murphey.[6] Patients typically present with acute subarachnoid hemorrhage (SAH), and the affected population is younger than patients with regular saccular aneurysms; there is a female predominance as well as a right-sided predominance, and an association with hypertension and arteriosclerosis.[5,7,8] Although advanced endovascular techniques have revolutionized the treatment of aneurysms in general, these BBAs remain enormous challenges for doctors, because of their small size with a fragile wall and a poorly defined wider neck. The preoperative angiographic diagnosis of BBAs may be difficult because they often represent small brain lesions that can be overlooked, mistaken for artifacts or focal atheromatous irregularity, or missed completely because of overlap with vessel curvature.[9] Different management strategies have been attempted by doctors from different institutions across the world; however, no consensus has been reached on the safe treatment options because clinical outcome has generally remained poor[3,5] and resulted in significant disability and mortality from surgical management.[9] We report a single-center experience with a neurosurgical approach to BBAs,

Key words
- Aneurysm clipping
- Blister-like aneurysm
- Internal carotid artery
- Neurosurgical management

Abbreviations and Acronyms
BBA: Blood blister–like aneurysm
CT: Computed tomography
CTA: Computed tomographic angiography
DSA: Digital subtraction angiography
ICA: Internal carotid artery
SAH: Subarachnoid hemorrhage

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focused on an assessment of their diagnosis and treatment options, attempting to identify proper surgical or endovascular management of BBAs with a low complication rate and a functional outcome.

METHODS

Patient Details

This study was approved by Fuzhou General Hospital institutional review board, which waived the need for written informed consent from the patients because the data were analyzed anonymously. Patients with an aneurysmal SAH treated between January 2008 and September 2016 were retrospectively analyzed and cases of BBAs were identified from a clinical database of all aneurysms treated surgically. The case series includes 22 patients (14 women and 8 men) with a mean age of 56.5 years (range, 42–69 years). Seven cases had a past medical history of hypertension. All patients had had severe headache abruptly before admission and 14 cases appeared unconsciousness when admitted to the hospital. Hunt and Hess grading scale results were 2 in 4 patients, 3 in 7 patients, 4 in 10 patients, and 5 in 1 patient.

Methods

Neuroimaging examinations including regular CT, CT angiography (CTA), and digital subtraction angiography (DSA) were performed on patient admission. All 22 cases in this series were treated by direct clipping. A pterional craniotomy was performed with conventional incision. Laser-assisted near-infrared angiography was used to perform vascular angiography. A retrospective analysis including diagnosis and treatment options of BBAs of the ICA was performed of patients treated for a BBA and outcomes were assessed.

RESULTS

All 22 patients in this series were treated by direct clipping. One patient, who was originally scheduled for selective surgical operation or interventional therapy, had to have emergency surgery because of rebleeding 6 hours after hospitalization, and the blood broke into the ventricles (Figure 1, case 1). CT in all 22 cases showed varying degrees of SAH in the ICA. Patient demographics, aneurysm size and location, and functional outcome are summarized in Table 1.

In addition, the BBA was assessed preoperatively according to CTA imaging data to examine its position and to check whether the anterior clinoid process would block the proximal portion of the ICA and the BBA. The presence of the proximal space of the ICA should allow passing of temporary clips, therefore determining the site of the cervical incision.

Pterional craniotomy was performed with conventional incision and the bone flap was removed by a milling cutter. SAH was severe and brain swelling was in varying degrees after the dura was opened in all cases. To create a satisfactory treatment of brain collapse and reduce the risk of BBA rupture, the following steps were taken: 1) if hydrocephalus was found in preoperative CTA and severe brain swelling was visualized intraoperatively, cerebrospinal fluid was immediately released to relieve the brain swelling by means of frontal puncture of the lateral ventricle, a method that was used in 16 cases; 2) if the brain swelling was not severe, the distal lateral arachnoid membrane was dissected gradually toward the proximal

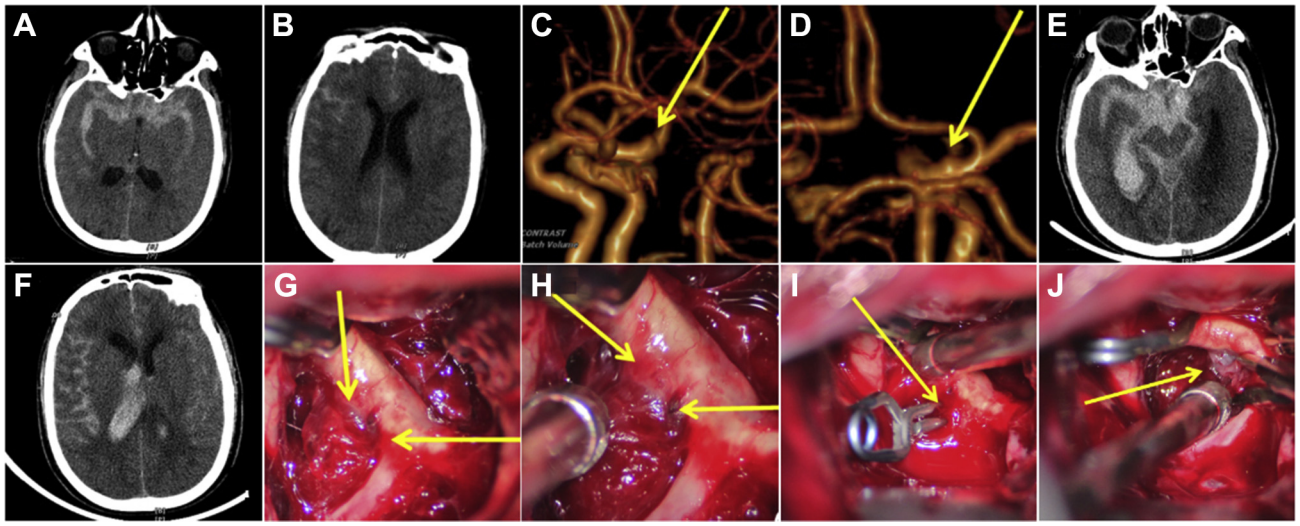

Figure 1. Illustrative case 1. (**A**, **B**) Preoperative regular computed tomography (CT) scan showing a blood blister–like aneurysm (BBA) (**A**) and its lesion (**B**). (**C**, **D**) Emergency CT angiography imaging confirming the BBA location (*arrows*). (**E**, **F**) The second CT scan showing the patient with rebleeding 6 hours after hospitalization (**E**), and the bleeding breaking into the ventricles (**F**). (**G**, **H**) Emergency craniotomy showing the BBA of the internal carotid artery under microscopy and showing the high-risk BBA with color and texture changes at the junction (*arrows*). (**I**, **J**) Intraoperative microscopy showing the BBA neck and body tear and bleeding (**I**, *arrow*) with incomplete lacerations around the arterial wall and visible arterial lumen and inner membrane (**J**, *arrow*).