Characteristics of Blood Blister-Like Aneurysms with a Saccular-Shape Appearance

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BACKGROUND: **Blood blister-like aneurysms (BBAs) are a subgroup of aneurysms located on nonbranching sites of the internal carotid artery (ICA) and characterized by small size, a fragile wall, and a poorly defined broad-based neck. Both direct surgery and endovascular treatment for BBAs are often challenging. Some of the BBAs have been reported to look like true saccular aneurysms, and the misdiagnosis of BBA might result in catastrophic outcomes. The purpose of this study is to clarify the clinical and intraoperative findings of saccular BBAs.**

METHODS: **We analyzed clinical and intraoperative findings in consecutive 11 patients with subarachnoid hemorrhage caused by ruptured BBA. BBAs were divided into typical BBAs, which were defined as typical tiny, broad-based, blister-like aneurysms, and saccular BBAs, which seemingly looked like true saccular aneurysms but were demonstrated to be BBAs by the intraoperative findings of the laceration of the ICA. The characteristics of saccular BBAs were analyzed.**

RESULTS: **There were 4 patients with saccular BBAs in which the admission day was diverse from the onset day to several days after the onset. The origin of saccular BBAs was the medial (n = 2) or anterior (n = 2) walls of the ICA. Three of the 4 saccular BBAs pointed toward the optic nerve, whereas none of the typical BBAs pointed toward the optic nerve.**

CONCLUSIONS: **Saccular BBAs may not merely develop secondarily from typical BBAs, but also form by the surrounding structures-dependent mechanisms when an aneurysm points toward the optic nerve. The findings in this study suggest that saccular-shaped aneurysms at nonbranching sites of the ICA toward the optic nerve should be considered as saccular BBAs.**

INTRODUCTION

Blood blister-like aneurysms (BBAs) are a subgroup of aneurysms located on nonbranching sites of the internal carotid artery (ICA) and characterized by small size, a fragile wall, and a poorly defined broad-based neck.[1-4] Therefore, ruptured BBAs require a careful interpretation of angiography for diagnosis because they are difficult to be managed both surgically and endovascularly.[5-10] BBAs generally have a tiny, broad-based neck, whereas some of them show rapid configurational changes and/or saccular-shaped appearances. Although there are true saccular aneurysms at nonbranching sites of the ICA, misdiagnosis of saccular-shaped BBA as true saccular aneurysm may cause a devastating result. Many previous reports have focused on the surgical or endovascular treatment strategies, but only a few reports examined the morphologic aspects of BBAs.[7,8,11] This study investigates the clinical and intraoperative features of BBAs with a saccular shape.

Key words
- Blood blister-like aneurysm
- Carotid trunk aneurysm
- Optic nerve
- Saccular aneurysm

Abbreviations and Acronyms
BBA: Blood blister-like aneurysm
CT: Computed tomography
ICA: Internal carotid artery
mRS: modified Rankin Scale
Pcom: Posterior communicating
SAH: Subarachnoid hemorrhage
WFNS: World Federation of Neurosurgical Surgeons

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MATERIALS AND METHODS

This study was approved by the Institutional Review Board of Ise Red Cross Hospital. All persons or their relatives gave their informed consent using the written treatment contract, which was signed on admission to our institution. We retrospectively reviewed all subarachnoid hemorrhage (SAH) patients by ruptured ICA BBAs who were treated in the Ise Red Cross Hospital between August 2010 and February 2017. We collected data including each patient's age, sex, location of the ruptured BBA, history of hypertension, admission and operation day after onset, admission and resuscitated World Federation of Neurosurgical Surgeons (WFNS) SAH scale grade, modified Fisher computed tomography (CT) scale score, and preoperative rerupture. Ruptured BBAs were defined as tiny, broad-based aneurysms arising from nonbranching sites of the supraclinoid ICA, or saccular-shape aneurysms arising from nonbranching sites of the ICA, in which the laceration of the ICA was confirmed during an operation. Outcome was evaluated using the modified Rankin Scale (mRS), and good outcome was defined as mRS score of 0–2 at 3 months.

BBA Classifications and Intraoperative Findings

BBAs were classified as follows. First, regarding the morphologic aspects, BBAs were classified into typical BBAs, which showed tiny, broad-based, and typical blister-like aneurysms, and saccular BBAs, which also had a fragile neck and looked like true saccular aneurysms. Second, the origin of BBAs was evaluated in relation to the circumference of the ICA wall and classified as anterior, medial, or lateral wall angiographically and intraoperatively. Third, BBAs were classified as proximal, opposite, or distal based on the location in relation to the origin of the posterior communicating (Pcom) artery. Sizes of the neck and height were measured in all BBAs, and sizes of width were assessed in saccular BBAs.

Our surgical strategy for BBAs is ICA trapping combined with high- or low-flow bypass to prevent rerupture completely. After trapping, we removed blood clots around the ICA wall and confirmed whether BBAs had ill and fragile wall or normal wall of necks. The selection of either high- or low-flow bypass depended on collateral blood flow and operation day after onset. We carefully observed surrounding structures of BBAs during an operation, which were adhered to BBAs with firm clots, in other words, which were considered to contribute to hemostasis of ruptured BBAs.

The characteristics of saccular BBAs were analyzed and compared with typical BBAs based on clinical and intraoperative findings.

RESULTS

Eleven patients were included in this study, and there were 4 patients with saccular BBAs (36%). Table 1 shows the clinical findings in all 11 patients. Mean age ± SD was 52.8 ± 9.7 years, and 7 of the 11 patients were women. Only 1 patient had a history of hypertension. Preoperative rerupture of BBAs occurred in 3 patients (27%). Six patients (55%) had severe SAH, defined as resuscitated WFNS grades IV and V. Cases 2, 4, and 11 were difficult to be diagnosed as BBAs initially because of their too small sizes, and repeated angiography revealed enlargement of the size, leading to the diagnosis of BBAs. Case 6 presented with transient hemiparesis secondary to cerebral vasospasm 5 days after onset; therefore, we selected intensive medical therapy against cerebral vasospasm as the initial treatment. Repeated angiography showed enlargement of the BBA, and trapping with low-flow bypass was performed after cerebral vasospasm was improved.

Table 2 shows angiographic and intraoperative findings of saccular BBAs. Two saccular BBAs arose from the anterior wall of the ICA, whereas the other 2 cases originated from the medial wall of the ICA (Figure 1). Three of 4 saccular BBAs were located on the proximal ICA to the origin of the Pcom artery: all of them were confirmed to exist under the optic nerve by operative findings. On the other hand, there were 5 typical BBAs arising from the anterior wall of the ICA, but no typical BBA was located under the optic nerve on intraoperative inspections (Table 3). The mean size of the neck and height was 3.7 ± 1.4 and 4.9 ± 2.9 mm, respectively, in saccular BBAs, whereas those of typical BBAs were 4.2 ± 1.9 and 2.0 ± 0.8 mm, respectively.

ILLUSTRATIVE CASES

Case 1

A 59-year-old woman was admitted to our hospital with a sudden loss of consciousness, and classified as WFNS grade V on admission. CT scan revealed modified Fisher grade 4 of SAH, and cerebral angiography revealed an aneurysm arising from the anterior wall of the left ICA with a saccular appearance (Figure 1A). With a diagnosis of BBA, to perform trapping with high-flow bypass on the day after onset, the carotid artery was exposed in the neck, and the anterior clinoid process was extradurally removed. After high-flow bypass, the left ICA was dissected along the lateral side. The BBA was exposed and found to point toward the optic nerve. There was a firm clot between the optic nerve and BBA (Figure 2A). After trapping of the left ICA, the laceration of the ICA and a diseased neck of the aneurysm were confirmed (Figure 2B). Patency of the Pcom and anterior choroidal arteries was confirmed by indocyanine-green videoangiography, but postoperative CT scan revealed cerebral infarction in the anterior choroidal artery territory. The patient further had extensive delayed cerebral infarction and died at 7 days post-SAH. In a postoperative reevaluation, the preoperative coronal contrast-enhanced CT reconstructed images revealed that the aneurysm pointed toward the optic nerve, and that the optic nerve was displaced superomedially (Figure 3).

Case 10

A 36-year-old woman was admitted to our hospital with a sudden loss of consciousness, after headache that had lasted for 3 days, and classified as WFNS grade III on admission. CT scan revealed modified Fisher grade 3 of SAH. Cerebral angiography showed an aneurysm arising from a nonbranching site of the left ICA with a saccular appearance (Figure 1D). The aneurysm was located at the proximal ICA to the Pcom artery, and originated from the medial wall of the ICA. Rich collateral blood flow via the Pcom and anterior communicating arteries was found on cerebral