Endovascular Treatment of Ruptured Large or Wide-Neck Basilar Tip Aneurysms Associated with Moyamoya Disease Using the Stent-Assisted Coil Technique

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Background: Endovascular coiling is preferred to surgical clipping for the treatment of basilar tip aneurysms (BTAs) associated with moyamoya disease (MMD). However, there are few reports addressing the safety of stent treatment of aneurysms located on unaffected arteries in MMD patients. We report our experiences of stent-assisted coil embolization for ruptured large or wide-neck BTAs associated with MMD. *Methods:* A retrospective review was conducted of 5 patients with ruptured BTAs associated with MMD treated by stent-assisted coil from January 2010 to December 2013 in our hospital. All presented with subarachnoid hemorrhage, and the diagnosis was confirmed by digital subtraction angiography. The procedure-related complications, immediate angiographic results, and clinical and angiographic follow-ups were analyzed. *Results:* Successful embolization was performed without procedure-related complications in all 5 patients, of whom 3 were treated by single stent-assisted coiling, and the others were treated by Y-configured stent technique. Immediate angiographic results showed complete occlusion in 2 patients, neck residual in 1, and partial occlusion in 2. Postoperative angiographic follow-ups were obtained in all 5 cases at a mean time of 17.6 ± 9.3 months (range, 6-28 months). Follow-up angiographic examinations demonstrated total occlusion without in-stent restenosis in all cases, and all the patients reported good outcomes (modified Rankin Scale score, 0-2). *Conclusions:* Endovascular embolization using stent-assisted coiling proved to be a safe and efficient treatment for ruptured large or wide-neck BTAs associated with MMD; however, the long-term safety still remains to be confirmed. **Key Words:** Ruptured basilar tip aneurysm—moyamoya disease—stent-assisted coil embolization.

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Received March 12, 2015; revision received May 15, 2015; accepted May 26, 2015.

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This work was supported by the National Natural Science Foundation of China (project no.81271271) and "1225" Discipline Construction Project of Changhai Hospital (CH125520105).

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1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2015.05.024

Moyamoya disease (MMD) is a chronic cerebrovascular disorder with slow progressive occlusions of the supraclinoid internal carotid artery (ICA) and its main branches within the circle of Willis.[1] Adult patients more commonly present with intracranial hemorrhage, and rupture of the aneurysm is one of the important reasons.[2] Maki and Nakata[3] first reported an intracranial aneurysm associated with MMD in 1965. Kawaguchi et al[4] reported that about 15% of the patients with MMD were found with intracranial aneurysms. The vertebrobasilar system plays an important role in providing collateral circulation in patients with MMD. Thus, the posterior circulation especially the basilar tip is a common location of these aneurysms due to the hemodynamic burdens as a

collateral pathway.[4-6] In light of its location, poor tolerance to ischemia, and initial poor clinical conditions, the risk of complication is high following direct clipping of BTA associated with MMD.[4,7,8] Endovascular embolization using detachable platinum coils has proved to be a suitable option.[9,10] But for wide-necked or large aneurysms, complete embolization is difficult by conventional coiling, because of the wide neck of the aneurysms. And incomplete initial occlusion is prone to recurrence of BTAs.[11,12] In light of the influences of the compensatorily increased blood flow, the recurrence rate might be higher in the BTA associated with MMD. Stent-assisted coil embolization may be a better option.[13] However, the rate of in-stent stenosis is significantly high when the stent is implanted in the progressively stenotic arteries of anterior circulation in patients with MMD.[14] However, the safety of the stent implanted in the nonstenosis posterior circulation still remains unknown. In this study, we introduced our experiences of stent-assisted embolization for large or wide-neck basilar tip aneurysms (BTAs) associated with MMD.

Materials and Methods

Patients

Institutional review board approval was obtained for this retrospective study. One hundred seventy-four patients were diagnosed with MMD through digital subtraction angiography (DSA) at Changhai Hospital, Shanghai, China, from October 2006 to December 2013. The angiographic findings of all the cases were compatible with the diagnostic guidelines for MMD proposed by the Ministry of Health and Welfare of Japan.[1] In 18 (10.3%) of the 174 cases, one or more aneurysms were found. Among these cases, 7 BTAs were diagnosed. Two were excluded because of unruptured lesion or treatment without stent assistance. The other 5 cases with ruptured aneurysms which were treated by stent-assisted coil were included in this study (Table 1). Of the 5 patients, 3 were women and 2 were men, whose ages ranged from 39 to 52 years (mean, 47.0 ± 4.8 years). All patients presented with subarachnoid hemorrhage (SAH). Three patients presented with World Federation of Neurosurgeons (WFNS) scale 1 and two with scale 3.

Aneurysms and MMD

Altogether, the 5 patients had 5 aneurysms located at the basilar artery apex. One was small (≤10 mm), and 4 were large (10 to ≤25 mm). All aneurysms were wide-necked (neck >4 mm and/or dome/neck ratio <2). We staged the MMD from stage 3 to 4 on angiography according to Suzuki staging of MMD.[15]

Endovascular Treatment Procedures

All the surgeries were performed under general endotracheal anesthesia. Three-dimensional DSA was performed before surgery. The anatomical relationship between aneurysms and peripheral vessels was evaluated by 3-dimensional reconstruction of the aneurysms. At 2 hours before stent placement, all the patients were treated with a rectal loading dose of clopidogrel and aspirin (300 mg, each). All procedures were performed via the femoral approach with full anticoagulation therapy with intravenous heparin to prolong the activated coagulation time to approximately twice the base value.

All the aneurysms (showed in Fig 1) were treated by stent-assisted coiling technique (Table 2). The unilateral stent-assisted coiling was applied to aneurysms involving the unilateral posterior cerebral artery (cases 1, 4, and 5). For the wide-neck aneurysms which involved the bilateral posterior cerebral arteries of the basilar artery bifurcation, Y-configured stent technique was adopted (cases 2 and 3).

Postoperative Management

Postoperative management such as hydration was important to avoid ischemic complications and alleviate cerebral vasospasm in these patients. For patients with SAH, lumbar cistern drainage was performed according to the severity of SAH after surgery. Nimodipine was administered to all the patients. Clopidogrel (75 mg/day) was taken orally for an additional 6 weeks, and

Table 1. *Summary of the 5 patients with BTA associated with moyamoya disease*

		Suzuki stage		Size of aneurysm (mm)		
Case	Sex/age	R	L	Maximum	Neck	Presentation (WFNS grading)
1	M/52	3	4	16.6	4.5	SAH (1)
2	F/48	3	4	10.8	4.9	SAH (3)
3	M/47	4	3	12.9	8.9	SAH (1)
4	F/49	3	4	10.2	4.5	SAH (3)
5	F/39	4	4	5.4	4.5	SAH (1)

Abbreviations: L, left carotid angiography; R, right carotid angiography; SAH, subarachnoid haemorrhage; WFNS, World Federation of Neurosurgeons.