

Case Report

Embolization of complex cerebral aneurysm at the middle cerebral artery bifurcation using WovenEndoBridge combined with stent (two case reports)

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Abstract: In recent years, the WovenEndoBridge (WEB), as a representative of emerging intratumoral flow disturbance devices, has been increasingly used in clinical practice. However, there are few reports on how to utilize it correctly when the release position is unsatisfactory or the parent artery is affected during WEB embolization of cerebral aneurysms. We report the treatment process of two female patients who underwent intracranial aneurysm flow diversion therapy for saccular aneurysms at the bifurcation of the middle cerebral artery and benefited from the procedure. The aneurysm embolization was satisfactory during the operation, but the embolization system partially interfered with the parent artery. In order to protect the parent artery and prevent embolism of the Middle Cerebral Artery (MCA) branch, an Atlas stent was introduced to assist in embolization. The angiography was repeated: the parent artery was unobstructed. This article describes in detail the preoperative evaluation of the patient's condition, the surgical plan, and the postoperative treatment. The results of this case confirm the feasibility of stent-assisted WEB embolization of complex aneurysms at the bifurcation of the middle cerebral artery.

Keywords: Intracranial aneurysms, middle cerebral artery, WovenEndoBridge, coil embolization, Neuroform Atlas stent

Introduction

An intracranial aneurysm (IAs) is a bulge in a blood vessel in the brain that can lead to serious health complications [1, 2]. MCA aneurysms represent approximately 30% of all IAs, 80% of which are located at the bifurcation [3]. Since the bifurcation has many cerebral blood vessels, it is prone to variation and is the likely site of hematoma formation after rupture, causing surgical treatment to be difficult [4]. Owing to the development of interventional materials and technologies in recent years, interventional embolization has been increasingly performed for IAs. The WEB is a recently introduced intratumoral flow disturbance device [5] that can be placed in the tumor body to self-expand and thus block the aneurysm neck, disturb the blood flow to close the bifurcation aneurysm,

and strengthen the aneurysm wall, overcoming the shortcomings of traditional flow diverters and reducing the rates of long-term recurrence and branch vessel stenosis or occlusion [5-8]. However, there are still questions about what needs be done when the release position of the WEB is not satisfactory or it affects the parent artery? Stent-assisted WEB embolization of MCA bifurcation aneurysms is described in this report, with the aim of providing clinical treatment experience.

Materials and methods

A retrospective analysis was conducted on the treatment process of one patient with a middle cerebral artery bifurcation aneurysm from each of two centers: the Third People's Hospital of Henan Province and the First Affiliated Hos-

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pital of Zhengzhou University. The treatment involved stent placement to modulate the morphology of the parent artery affected by WEB deployment.

Case presentation

Chief complaints

Patient 1 experienced dizziness accompanied by nausea and vomiting for more than a month. However, these symptoms had worsened for more than 7 hours.

Patient 2 was admitted to the hospital due to a 10-day history of headache.

History of present illness

Patient 1, a 66-year-old female, was admitted to the hospital on July 9, 2024, due to dizziness, nausea, and vomiting that had lasted for more than a month and had worsened for more than 7 hours. The patient experienced dizziness without an obvious cause more than a month prior, accompanied by nausea and non-jet vomiting of the gastric contents. The patient underwent brain Magnetic resonance imaging (MRI) and magnetic resonance angiography at a local hospital, and the findings were as follows: 1. Three-branch variation of the anterior cerebral artery; 2. Possible aneurysm at the right MCA M1 bifurcation. After oral medication (unspecified), dizziness, nausea, and vomiting were relieved, but the aneurysm was not further treated. Dizziness, which recurred more than 7 hours prior and was worse than before, was accompanied by frequent nausea and vomiting. The patient was admitted to the hospital via the emergency department due to dizziness and was screened for a cerebral aneurysm. Following clinical presentation, the patient was in poor spirits, did not eat and had poor sleep quality but had normal urination and defecation. Whole-brain angiography on July 10, 2024 revealed the following: 1. An aneurysm at the M1 bifurcation of the right MCA (**Figure 1A**) measuring approximately 5.2 mm × 5.4 mm × 4.8 mm in size; 2. An aneurysm of the ophthalmic segment of the right internal carotid artery measuring approximately 1.8 mm × 2.0 mm × 1.8 mm in size. After surgical contraindications were excluded, “whole-brain angiography + flow diverter placement” was performed on July 12, 2024.

Patient 2, a 55-year-old female, was admitted to the hospital on June 11, 2024, due to a 10-day history of headache. Ten days prior, she experienced a sudden severe headache without any obvious precipitating factors. Magnetic resonance angiography (MRA) performed at an external hospital revealed a saccular protrusion at the bifurcation of the left middle cerebral artery. Subsequent cerebral angiography at a local hospital suggested multiple intracranial aneurysms. On June 12, 2024, a full-brain angiography was performed, which demonstrated an aneurysm at the origin of the left middle cerebral artery with a relatively wide neck, measuring approximately 2.4 mm × 1.8 mm in size and with an irregular shape. Another aneurysm was identified at the bifurcation of the left middle cerebral artery, also with a relatively wide neck, measuring approximately 5 mm × 7 mm in size and with an irregular shape (see **Figure 2A** and **2B**). After excluding contraindications related to surgery and following a multidisciplinary consultation, it was unanimously decided to perform a “full-brain angiography with flow diverter (dense mesh stent) placement + endovascular coiling with or without stent assistance + coil embolization” on June 12, 2024.

History of past illness

Patient 1 had hypertension for more than 10 years, with the highest blood pressure reaching 200/98 mmHg. She took amlodipine besylate tablets (5 mg qd) and candesartan cilexetil tablets (8 mg qd) orally, and her blood pressure was controlled at approximately 130/70 mmHg. She reported no adverse habits, including tobacco, alcohol, or drug use. There were no additional contributing factors in her personal or family history.

Patient 2 had a 15-year history of hypertension, with the highest blood pressure reaching 145/90 mmHg. She took antihypertensive medications orally (details unspecified), and her blood pressure was controlled at approximately 125/85 mmHg. She reported no adverse habits, including smoking, alcohol consumption, or drug use. There were no other relevant risk factors in her personal or family history.

Physical examination

Patient 1's temperature (T) was 36.6°C, her heart rate (HR) was 79 beats/min, and blood

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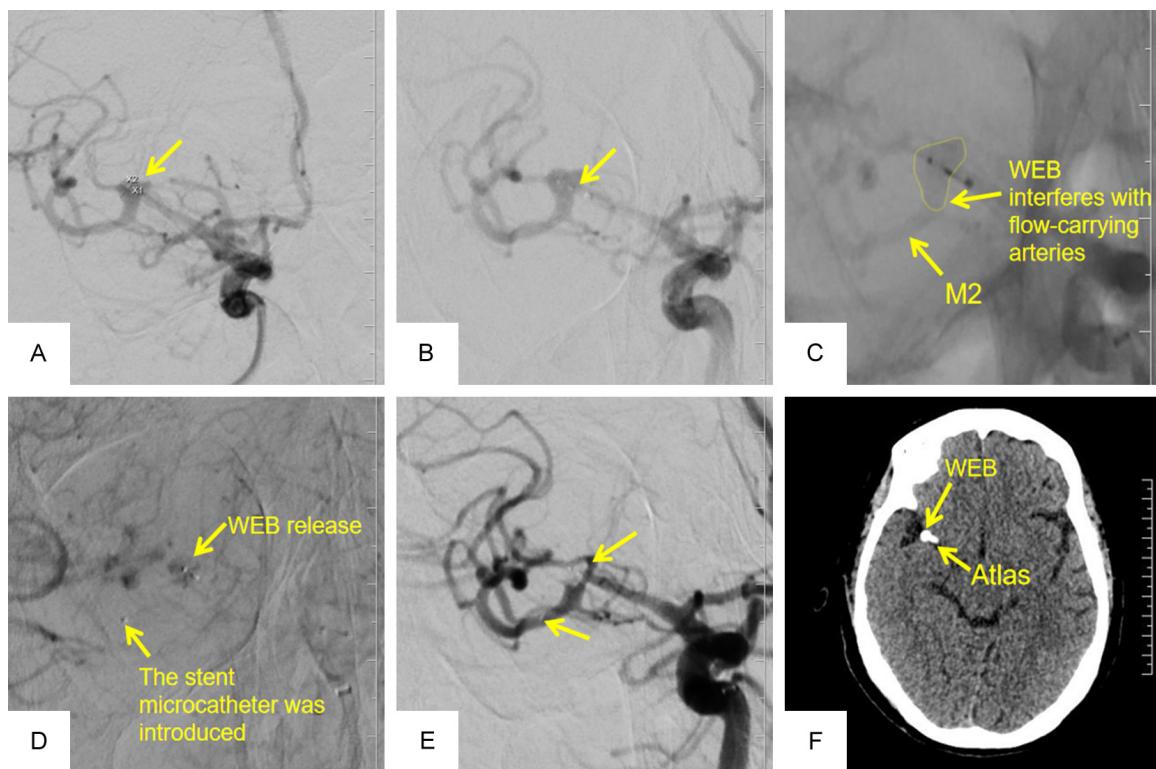


Figure 1. Note: (A) Preoperative angiography showed an aneurysm at the right MCA M1 bifurcation; (B) WEB was successfully released into the aneurysm at the right middle cerebral artery M1 bifurcation; (C) The WEB system partially interfered with the parent artery; (D) The stent microcatheter was introduced and the WEB was released; (E) After the WEB and stent were placed, the aneurysm was embolized satisfactorily and the parent artery was unobstructed; (F) Postoperative follow-up CT: WEB and Atlas stent were stable, the aneurysm was completely embolized, and the parent artery was unobstructed.

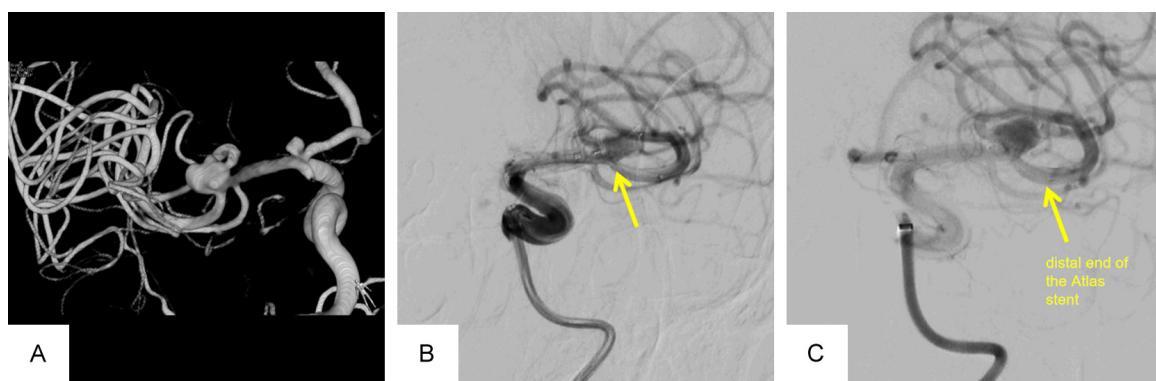


Figure 2. Note: (A) Preoperative angiography confirmed the location of the aneurysm. (B) Intraoperatively, the WEB device was deployed properly but partially protruded into the distal segment of the parent artery, affecting blood flow. (C) After introduction of the Atlas stent, blood flow in the parent artery was patent, and contrast agent residue was noted within the WEB.

pressure (BP) was 138/76 mmHg. Physiological reflexes were present, pathological reflexes were not elicited, and the muscle strength and tension of the limbs were normal.

Preoperative physical examination: T 36.8°C, HR 77 beats/min, BP 128/72mmHg. Physiolo-

gical reflexes exist, pathological reflexes are not elicited, and the muscle strength and muscle tone of the limbs are normal.

Patient 2's T was 36.2°C, HR was 80 beats/min, and BP was 124/78 mmHg. Physiological reflexes were present, pathological reflexes

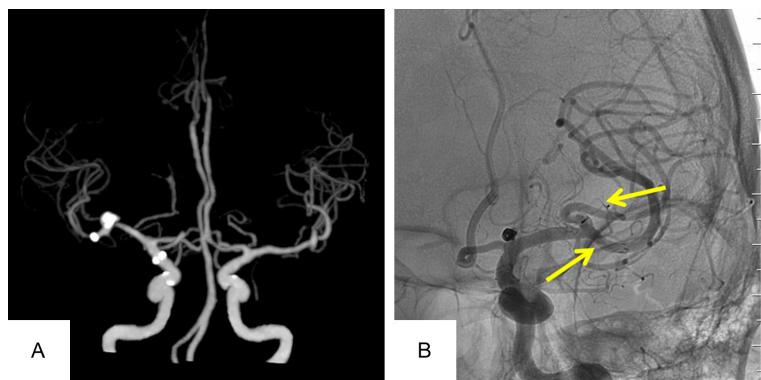


Figure 3. Note: (A) Postoperative changes in M2 segment of right middle cerebral artery; (B) The aneurysm at the bifurcation of the left middle cerebral artery has achieved satisfactory healing, and the aneurysm of the left anterior cerebral artery has similarly achieved satisfactory healing.

were not elicited, and the muscle strength and tone of the limbs were normal.

Preoperative physical examination: T 36.4°C, HR 78 beats/min, BP 126/72 mmHg. Physiological reflexes were present, pathological reflexes were not elicited, and the muscle strength and tone of the limbs were normal.

Laboratory examinations

Patient 1: MRI and MRA of the head revealed the following: 1. Three-vessel variation of the anterior cerebral artery; 2. Possible aneurysm at the right MCA M1 bifurcation.

Patient 2: MRA performed at an external hospital revealed a saccular protrusion at the bifurcation of the left middle cerebral artery. Digital subtraction angiography (DSA) suggested multiple intracranial aneurysms.

Their re-operative complete blood count, liver and renal function tests, coagulation profile, blood lipid and glucose levels, infectious disease screening, and electrocardiograms showed no significant abnormalities.

Imaging examinations

Patient 1's whole-brain angiography revealed the following: 1. An aneurysm at the right MCA M1 bifurcation (Figure 1A) measuring approximately 5.2 mm × 5.4 mm × 4.8 mm; 2. An aneurysm of the ophthalmic segment of the right internal carotid artery measuring approximately 1.8 mm × 2.0 mm × 1.8 mm in size.

Patient 2's whole-brain angiography revealed the following: An aneurysm is visible at the origin of the left middle cerebral artery, with a relatively wide neck, measuring approximately 2 mm × 2 mm. Another aneurysm is visible at the bifurcation of the left middle cerebral artery, with a vessel arising from the aneurysmal sac, measuring approximately 5 mm × 7 mm and with an irregular shape. An aneurysm is also visible at the bifurcation of the right middle cerebral artery, measuring approximately 4 mm × 4 mm and with a regular appearance.

Final diagnosis

Patient 1: The diagnosis on the basis of physical and auxiliary examinations was as follows: (1) Aneurysm of the right MCA; (2) Extremely high risk of hypertension grade 3.

Patient 2: The diagnosis on the basis of physical and auxiliary examinations was as follows: (1) Intracranial aneurysm; (2) Grade 2 hypertension with very high risk.

Multidisciplinary expert consultation

After consultation with experts from the Department of Neurology, Department of Neurosurgery, Department of Interventional Radiology, and Department of Emergency, they unanimously decided to perform "whole-brain angiography + flow diverter placement".

Treatment

The patient was positioned supine, with general anesthesia administered. The inguinal region was routinely disinfected and draped with sterile towels. Right femoral artery puncture was performed. A guidewire was used in conjunction with a pigtail catheter, vertebral artery catheter, and Simons catheter for aortic arch and whole-brain angiography to identify the location and size of the aneurysm. A microguidewire and microcatheter were used for super-selective navigation into the aneurysm, and a

flow diverter (WEB) was introduced into the aneurysm. The WEB was slowly deployed under multiple angles (**Figure 1B**). Follow-up angiography showed satisfactory aneurysm embolization, but partial interference with the parent artery by the WEB system (**Figure 1C**). An intracranial stent system (Atlas) was introduced and slowly deployed to protect the parent artery and cover the aneurysm neck (**Figure 1D**). Follow-up angiography showed patency of the parent artery and satisfactory aneurysm embolization (**Figures 1E, 2C**). The guidewire and catheter were removed, and the sheath was left in place. The surgical process was smooth. After awakening, the patient had normal speech and limb movement, and there was no bleeding at the puncture site.

Results

Patient 1: After the operation, oxygen inhalation was performed, as was electrocardiogram (ECG) monitoring, and the right lower limb was immobilized for 24 hours. Aspirin Enteric-coated Tablets 100 mg/d + Clopidogrel Hydrogen Sulfate Tablets 75 mg/d dual antiplatelet, Atorvastatin Calcium Tablets for lowering lipid and stabilizing vascular plaque, Nitroglycerin Injection micropump for lowering blood pressure, and continuous monitoring of blood pressure for symptomatic and supportive treatment. Physical examination: Body temperature is 36.7°C, heart rate is 82 beats per minute, blood pressure is 135/71 mmHg. Head Computed Tomography (CT) performed on the third day after the operation revealed a high-density shadow in the right MCA, possibly causing changes in the patient's condition after surgery (**Figure 1F**). The patient reported that she was no longer dizzy and that her headache had disappeared. Her BP was stable, and she was discharged from the hospital. Three months after the operation, the patient recovered well without postoperative complications. Computed tomography angiography (CTA) 6 months after operation showed postoperative changes in M2 segment of right middle cerebral artery (see **Figure 3A**).

Patient 2: Postoperative physical examination: Temperature 36.20°C, pulse rate 80 beats/min, respiratory rate 20 breaths/min, blood pressure 124/78 mmHg, and the patient was alert. Medications prescribed included Rosuvastatin Calcium Tablets 10 mg P.O. once night-

ly; Ticagrelor Tablets 60 mg P.O. twice daily; and Indobufen Tablets 0.10 g P.O. twice daily. Follow-up cerebral angiography at 6 months post-operatively revealed satisfactory healing of the aneurysm at the bifurcation of the left middle cerebral artery and satisfactory healing of the aneurysm of the left anterior cerebral artery (**Figure 3B**).

Discussion

Common treatments for IAs include surgical clipping and endovascular embolization [1, 9]. Currently, the interventional treatments commonly used in clinical practice can be divided into occlusive and reconstructive types [10, 11]. Occlusive types include aneurysm embolization and/or proximal occlusion of the parent artery; reconstructive types include stent-assisted coil embolization, simple stent placement, and flow diverter placement. To date, reports of WEB combined with stent embolization of aneurysms at the bifurcation of the MCA are very rare. Nordmann [12] reported an example of the excellent effect of using stents to assist in the treatment of basal apical aneurysms due to insufficient WEB occlusion; Sahnoun, M [13] found that the incidence of additional stent placement after WEB embolization aneurysms is relatively low (11.2%), but the embolization success rate is 100%. Srinivasan VM [14] reported two cases of LVIS stents and one case of using Atlas stents to assist WEB intracranial aneurysm in 13 diagnosis and treatment centers over 7 years. Escalante, R [15] reported two cases of WEB misplaced or displaced causing iatrogenic tumor-borne vascular occlusion and rescued placement treatment with an Atlas stent.

Compared with conventional surgical options such as stent placement and simple coil embolization, WEB embolization is advantageous in that (1) it overcomes the shortcomings of traditional blood flow diversion devices, such as long-term recurrence and branch vessel stenosis or occlusion [16-18]; (2) placement is simple; (3) no dual antiplatelet therapy is required during the perioperative period, and it can effectively treat IAs [6]; and (4) it is suitable on the basis of the position of the aneurysm neck and protects the blood flow of the bilateral cerebral arteries, with good safety and effectiveness [19-21].

In this case, owing to the irregular shape of the aneurysm, although the size of the selected WEB model did not exceed the size of the aneurysm, part of the embolization system still interfered with the blood flow of the parent artery. Owing to the increased risk of thromboembolism, the protrusion of the WEB should be minimized, and the effect on aneurysm occlusion should be limited [22]. Therefore, the patient in this case still needed to undergo stent implantation to adjust the shape of the WEB after release. AISF [23] suggested that factors for incomplete IA occlusion using a WEB include a large aneurysm, an aneurysm with a wide neck, partial intrasaccular thrombosis, and an irregular-shaped aneurysm. The indications for WEB embolization should be more stringent, including the evaluation of aneurysm morphology. Gajera J [24] reported that aneurysms with a neck width of 3-10 mm and a height of 3-10.5 mm are suitable for WEB embolization; because the WEB system is spherical or cylindrical, aneurysms with spherical, cylindrical or oval shapes are very suitable for WEB embolization.

The authors consulted relevant domestic and foreign literature and reported that with respect to treatment methods when the WEB release position is unsatisfactory or affects the parent artery. Salem MM [25-27] reported that during the WEB embolization process, lesions with a complex anatomy present greater technical challenges, and 5.4% of cases require balloon assistance. There are few reports on stent-assisted treatment. We further confirmed through actual clinical cases that a WEB has good conformability, can be used in combination with an Atlas stent, is easy to place, and results in satisfactory embolization.

In summary, this study revealed that a WEB has good conformability and is safe to use. Even if the WEB release position is unsatisfactory or affects the parent artery, stents can be added to protect the parent artery in the treatment of MCA bifurcation aneurysms. This case provides a clinical solution for when the WEB release position is unsatisfactory or affects the parent artery.

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Disclosure of conflict of interest

None.

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