

Case Report

A case report of Y stent assisted coiling of a basilar tip aneurysm combined with top of the basilar syndrome and a literature review

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Abstract: Objective: To report a rare case of Y stent assisted coiling of a basilar tip aneurysm combined with post-operative top of the basilar syndrome (TBOS) to improve the understanding of technical complications of Y stent use. Case report: A female patient, 55 years old, exhibited a subarachnoid hemorrhage. Computed tomography angiography (CTA) and digital subtraction angiography (DSA) findings suggested a basilar tip aneurysm. The patient underwent interventional Y stent assisted aneurysm coiling embolization. The operation was successful. After the operation, the patient exhibited clear consciousness, fluent expression, and flexible limbs and was returned to the ward safely. Approximately 20 h after the operation, the patient suddenly developed TBOS and was administered low-molecular-weight heparin anticoagulation, anti-vasospasm treatment and underwent therapy to improve circulation and prevent ion disorders. The patient's symptoms gradually stabilized. The imaging results confirmed a rare case of TBOS. Results: The patient recovered well and was followed up for 20 months without recurrence of the aneurysm or development of new infarction symptoms. Conclusion: The application of a Y stent is a high-risk factor for TBOS; therefore, the Y stents should be carefully applied to the basal artery.

Keywords: Y stent, top of the basilar syndrome (TBOS), vasospasm

Introduction

Treatment of intracranial complex wide-necked bifurcation aneurysms, particularly basilar tip aneurysm, is a challenge for neurosurgeons. The emergence of double-stent assisted coiling provides a safe and effective clinical solution for such aneurysms, and the Y stent is the most important type [1-4]. Y stent assisted coiling was first proposed by Chow et al. in 2004. The Y stent includes two stents; the first stent is placed into the branch vessel of one side, and the second stent is passed through the mesh of the first stent. Two stents form a Y connection that relatively decreases the neck of the aneurysm and protects the parent artery [5]. The Y stent procedure has become increasingly popular in recent years, but relatively few studies have examined the surgical complications, and even fewer research studies have examined the related risks of this technology when applied to the basal artery. Top of the basilar syndrome (TBOS), which was first reported by

Caplan [6], is a specific type of posterior circulation infarction, that refers to the clinical syndrome of two or more cerebral infarction lesions in the basilar artery blood supply zone induced by obstructed blood circulation of the basilar artery apex due to various causes. Due to its special infarction area, the mortality of this syndrome is approximately 25% and prognosis is poor [7]. Although the Y stent itself may cause complications, it is very rarely complicated by TBOS. Thus, this paper is intended to report a rare case while reviewing the literature to improve the understanding of the complications associated with Y stent use.

Case report

A female patient, 55 years old, experienced a severe headache without an obvious cause at 6 pm on October 21, 2014, which was accompanied by several incidences of nausea and vomiting. A head CT examination at the local hospital suggested a subarachnoid hemorrhage, and

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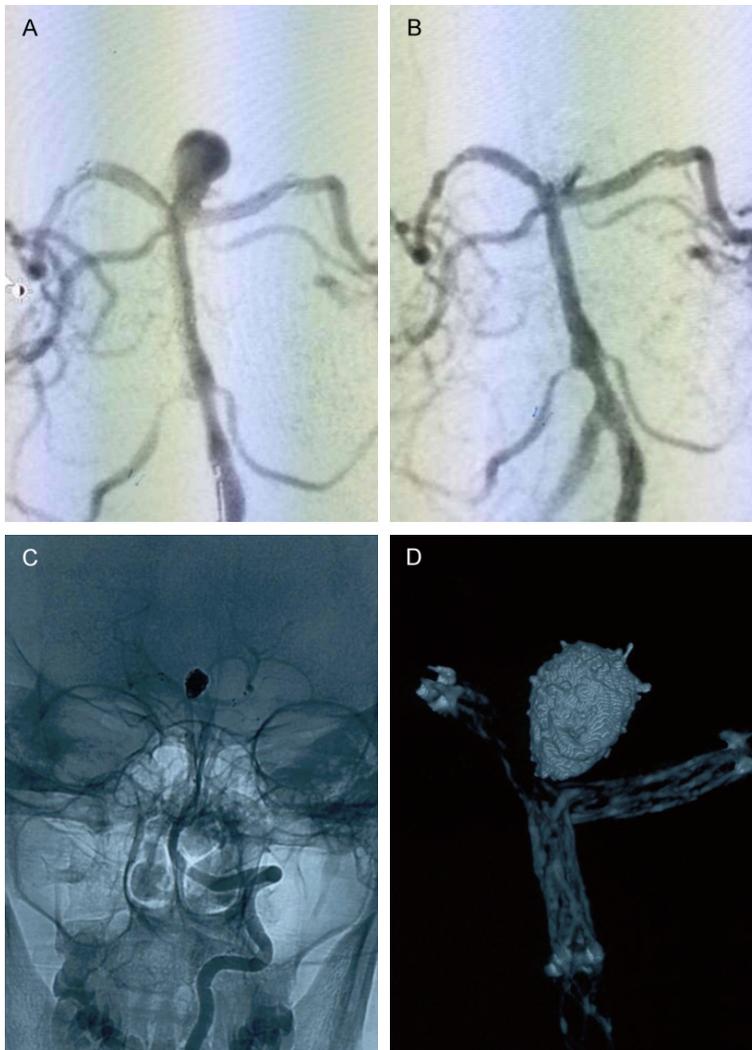


Figure 1. Intraoperative angiography. A. Angiography shows an aneurysm at the top of basal artery. B. Postoperative angiography of Y stent assisted coiling. The aneurysm is barely visible; the blood flow of the bilateral posterior cerebral artery and basal artery is not blocked, and no thrombosis is present. C. Postoperative imaging without subtraction. D. Postoperative Vaso CT shows the relationship between the Y stent and coil. Both stents were in good position.

head CTA indicated basilar artery aneurysm. The patient was transferred to our hospital for further diagnosis and treatment. The physical examination results were as follows: the Kernig sign was positive. The neck was stiff with two horizontal fingers, and no obvious positive nervous system signs were observed. The patient had an one-year history of hypertension without regular treatment. The patient denied a history of cerebral infarction, cardiac disease, diabetes, hyperlipidemia, and smoking. A routine blood test showed no obvious abnormalities. The patient was given symptomatic treatments

including hemostasis, reduction of intracranial pressure, and nerve nutrition after admission. The patient underwent Y stent assisted coiling for the aneurysm under general anesthesia on October 24, 2014. The patient was orally administered aspirin (300 mg) and clopidogrel (300 mg) 4 h before the operation for antiplatelet therapy, and 4000 U of heparin was used during the operation. Intraoperative angiography suggested an aneurysm of the basilar artery apex. The aneurysm was approximately 6.8 mm × 8.8 mm, with a wide (approximately 4.6 mm). Subsequently, a Nero Renegade stent catheter was passed through the left posterior cerebral artery across the aneurysm neck guided by a Synchro guide wire. A NEUROFORM EZ 3.5 mm × 20 mm stent was placed and released to cover part of the aneurysm neck. Imaging showed good positioning of the stent. A Rebar18 stent catheter was passed through the right posterior cerebral artery through the NEUROFORM EZ stent guided by a Transend guide wire. A Solitaire SAB-4-20 stent was placed and released to cover part of the aneurysm neck. Imaging showed good positioning of the stent. An Echelon 10 micro-catheter was carefully

passed through the aneurysm cavity guided by a Synchro 14 micro guide wire, and the aneurysm was filled with Target 360 6 mm × 20 cm; Target 360 5 mm × 15 cm; Helix ev3 Axiom, 4 mm × 1 cm; Target 3 mm × 6 cm; and Helix ev3 Axiom 2 mm × 6 cm in turn. Five coils were used to embolize the aneurysm. The aneurysm was not visible on images, which showed an unobstructed parent artery and good stent positioning (Figure 1). The operation was then completed. The patient exhibited clear consciousness, fluent expression, and no paralysis of the limbs. The patient was safely returned to

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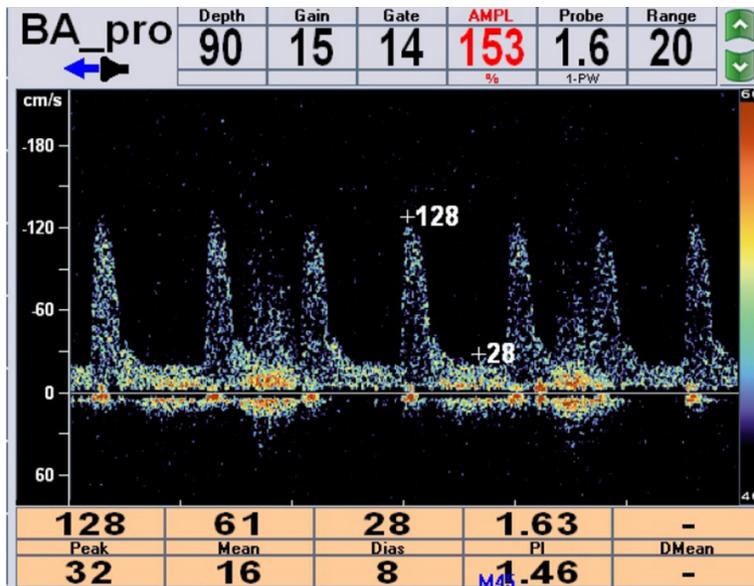


Figure 2. An intracranial ultrasound examination suggested abnormal blood flow in the basilar artery, which showed an uncommon high-resistance low-velocity waveform and images that differed from those of vascular stenosis, vascular spasm, or high cranial pressure.

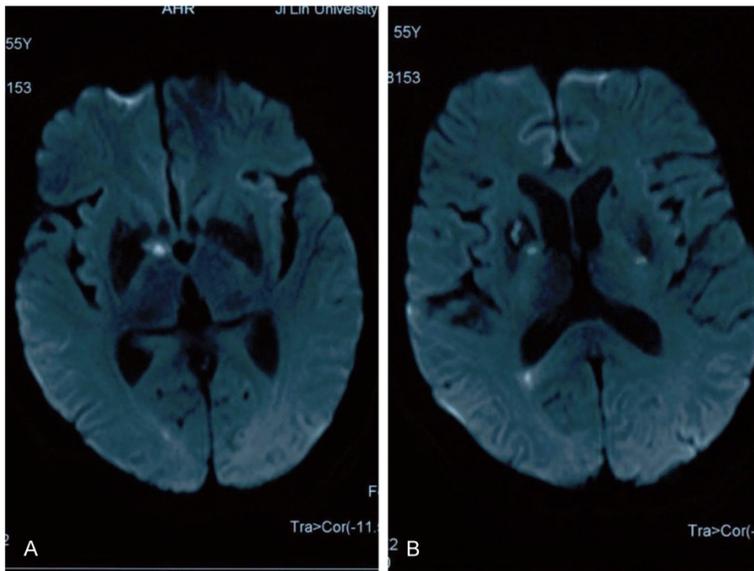


Figure 3. MRI images. (A and B) DWI images showed multiple infarcts at different times in the bilateral thalamus.

the ward and given symptomatic and supportive treatment, including anti-hypertensive therapy, antiplatelet therapy, volume expansion therapy, and medication for the prevention of vasospasm.

The patient exhibited intermittent unconsciousness beginning at 13:00 on October 25, 2014.

At first, the symptoms lasted approximately 10 min; later, the duration of unconsciousness gradually extended. Bilateral pupils exhibited changes in size, with a maximum diameter of 5.0 mm and a minimum diameter of 2.0 mm. The response to light disappeared, and the pathological reflex was not induced. The patient exhibited clear consciousness and fluent expression during the lucid intervals and had flexible limbs; her body temperature was slightly increased (approximately 37.5°C). A review of the head CT found that the results conformed to the postoperative changes caused by aneurysm embolization and showed no abnormal findings in the remaining area. Her vital signs were stable. A bedside intracranial ultrasound examination suggested abnormal blood flow of the basilar artery, which showed an uncommon high-resistance low-velocity waveform, and the images were different from those caused by vascular stenosis, vascular spasm, or high cranial pressure (**Figure 2**). TBOS was considered based on the clinical symptoms, and the patient was given low-molecular-weight heparin anticoagulation and anti-spasm treatment, in addition to therapy for the improvement of circulation and prevention of ion disorders. The patient's consciousness had gradually improved, but she was still in a somnolent state.

The patient's condition had improved sufficiently on November 02, 2014 to allow a head MRI scan, which suggested multiple acute-stage and subacute-stage infarcts in the bilateral thalamus (**Figure 3**). In addition, the patient's symptoms and signs objectively confirmed the diagnosis of TBOS. The patient was discharged on November 7, 2014 and exhibited

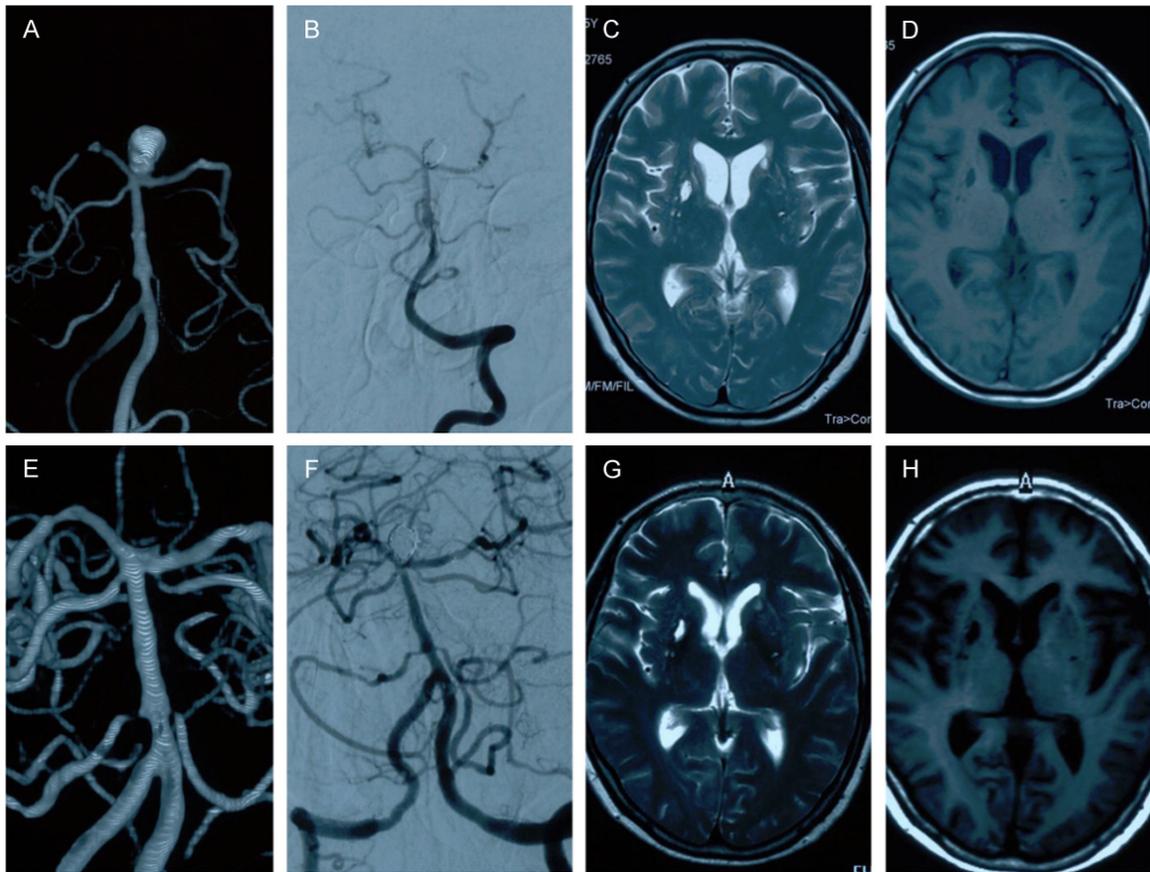


Figure 4. Follow up images. Aneurysm recurrence and parent artery stenosis were not observed at 3 months post-operative. NMI showed multiple obsolete infarcts of the bilateral thalamus (A. 3D without subtraction; B. 2D with subtraction; C. T2 image; D. T1 image); A 20-month postoperative review did not detect aneurysm recurrence or parent artery stenosis; MRI showed multiple obsolete infarcts of the bilateral thalamus (E. 3D with subtraction; F. 2D with subtraction; G. T2 image; H. T1 image).

clear consciousness and fluent expression during lucid intervals, along with a normal body temperature and flexible limbs. Her pupils were sensitive to light. A physical examination did not find any positive nervous system signs.

The patient was followed up in January 2015 and August 2016, at which time head CT, head MRI, and whole brain angiography examinations were performed. The examination results showed that the patient had recovered well, without recurrence of the aneurysm or parent artery stenosis. NMR showed multiple obsolete infarcts in the bilateral thalamus and an absence of new ischemic lesions (**Figure 4**).

Discussion

Basilar tip aneurysm is most commonly associated with posterior circulation aneurysms [8]. Due to the extremely high mortality and morbid-

ity of surgical clipping for aneurysm on the top of basilar artery, intravascular interventional therapy is typically used for the vast majority of clinical situations [9]. Interventional therapy for wide-necked basilar tip aneurysm is challenging for neurosurgeons. The emergence of double stent assisted coiling has provided a safe and effective clinical solution for this type of complex wide-necked bifurcation aneurysm, and a Y stent is the most common type of treatment [3]. Y stent assisted coiling was first proposed by Chow et al. in 2004 [5]. The Y stent can effectively decrease the aneurysm neck, protect the parent artery, and change the angle of blood vessels at the bifurcation. This technology provides a good clinical prognosis for the treatment of basilar tip aneurysm [1-4]. Three major combinations of stents are used for the Y stent, including two open-cell stents, two closed-cell stents, or a combination of

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Table 1. This table summary similar reports in which TBOS is not induced by thrombotic events due to the basal artery itself

Author	Journal	Lssuing time	Gender	Age	Associated disease	First Symptom	Therapy	Prognosis
Zoya Voronovich [18]	Surg Neurol Int	2014	Male	48	Persistent primitive hypoglossal artery	Unresponsive with flaccid extremities	Manual aspiration thrombectomy	Aphasia
Koushun Matsuo [23]	Internal Medicine	2011	Male	23	Seizure	Loss of consciousness and a generalized convulsive seizure.	Conservative treatment	Cure
Yuji Kato [24]	J Neurol	2009	Female	70	Takotsubo cardiomyopathy	Disturbed consciousness	Conservative treatment	Consciousness improved
Isaac E	Clinical Neurology and Neurosurgery	1998	Female	60	Absence of necessary anastomosis	Gait ataxia	Conservative treatment	Improved

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open-cell and closed-cell stents. An organizational stent has been used in recent years [10]. Application of two open-cell stents or one open-cell stent is most commonly used, while application of two closed-cell stents is very rare [11]. However, existing studies have proposed that no significant differences in postoperative complications exist among the different combinations of stents [12]. Thus, in this case, we chose a combination of open-cell and closed-cell stents. In addition, postoperative Vaso CT images suggested that both of the stents were in very good wall position and made coils stable. The patient recovered well after the operation and exhibited clear consciousness and no nerve dysfunction.

Although the Y stent has many advantages, it also has several major disadvantages, including potential thrombus generation and the need for long-term application of antiplatelet agents [13]. Currently, no large-scale multicenter study has examined the application of a Y stent for basilar tip aneurysm. The main concern of the procedure is the recanalization rate of the aneurysm [3, 10, 14, 15]. Few research studies have examined the complications associated with this procedure. According to the existing data, the probability of adverse thrombotic events is approximately 2-21.4% after placement of the Y stent [2, 11-13, 16]. Pyoung Jeon et al. independently studied its application in the basilar artery, and the incidence of thrombotic events was approximately 12% among 25 cases of basilar artery aneurysm with embolization assisted by double closed-cell stents in a single center. The study included a total of three patients with complications. For the first patient, stent thrombosis occurred within several hours after the operation and was considered to be caused by intraductal embolus detachment, but the patient also had Moyamoya disease, which is a high-risk factor for thrombosis. In the second case, thrombosis developed at the distal branch of the posterior cerebral artery after the operation, but the patient did not have any clinical symptoms, and this situation was found in the postoperative MRI scan. The third case involved intraoperative stent thrombosis, which caused an occipital lobe infarction [11]. In another 28-case study, 6 cases exhibited operation-related thrombosis complications, with an incidence rate of 21.4% [16]. But In a study of 193 cases

of aneurysms at artery bifurcations in intracranial areas treated with Y stents (including application in the basal artery in 22 cases), the overall incidence of surgical complications was only 2.7% [3]. It is obvious that the risk of complications associated with the application of a Y stent to the basal artery is much greater than the risk associated with its use in other intracranial regions.

TBOS was first reported by Caplan [6] and is mainly characterized by bilateral thalamus infarcts, which are caused by ischemia of the midbrain, thalamus, hypothalamus, temporal lobe, and occipital lobe area due to occlusion of the top of the basilar artery. Due to the deep perforators that supply the midbrain and because the thalamus is thinner than the posterior cerebral and cerebellar arteries and their branches, collateral circulation is difficult to establish, and thus it can cause disorders of consciousness, the sleep-wakefulness cycle, behavior, eye movement, and the pupils. However, limb movement and sensory disorder are relatively milder [6, 17-22], but the mortality rate is very high (approximately 25%) [7]. Among the limited studies, most concern primary TBOS, which is induced by thrombotic events due to the basal artery itself, such as stenosis, and only a handful of reports have shown that TBOS is accompanied by other vascular abnormalities or other diseases (**Table 1**) [18, 23, 24]. In addition, few reports have described the application of Y stent assisted coiling to postoperative TBOS of aneurysms on the top of the basilar artery. Approximately 24 h after the operation, the patient suddenly exhibited gradual intermittent aggravated disturbances of consciousness and pupil movement disorders, but no body movement disorders. The patient is presented with multiple infarcts of the bilateral thalamus upon imaging, which suggested TBOS based on the patient's symptoms and imaging data. However, the precise mechanism by which the use of a Y stent leads to thrombosis complications remains unclear. A commonly proposed reason is that the second stent is not sufficiently released after passing through the mesh of the first stent, and thus the blood flow produces turbulence, and the cutting effect leads to the formation of an embolus [10], or it is caused by the detachment of intraductal embolus during the operation [11]. However, in this case, the patient exhibited symptoms with-

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in 20 h after the operation, and whole brain angiography at both 3 and 22 months postoperative showed well developed stents without obvious stent thrombosis or stenosis of the basilar artery system; therefore, the above causes are unlikely. After the onset of symptoms, the patient immediately underwent bedside intracranial vascular ultrasound. It showed a high-resistance low-velocity waveform, which was different from the typical waveform observed with vascular stenosis, vascular spasm, or high cranial pressure. Due to the results and clinical symptoms, the patient was considered to have vasospasm after stent implantation. However, due to the support role of the stent itself, vasospasm signs of the area covered by the stent were not obvious, and thus the above waveform appeared. The vasospasm occurred in the perforator vessels of the top of the basilar artery, which was not covered by the stent and was not detected in the ultrasound examination, resulting in multiple infarcts of the bilateral thalamus. Thus, patients exhibited symptoms of TOBS. This case did not involve the common cause of TOBS, and the patient had a good outcome comparing to the high mortality and morbidity of TOBS.

Although the direct factor leading to complications in this case was not defined, the Y stent was the most likely cause. Although stent-assisted aneurysm coiling can reduce the probability of recurrence of an aneurysm [25], a new meta-analysis showed that compared to the pure coil embolization, stent-assisted aneurysm embolization is associated with a higher incidence of thrombotic events and complications and a higher mortality rate [26]. In this case, it is unclear whether a Y stent was necessary or whether other auxiliary methods could have been adopted to achieve dense embolization, such as the double-catheter technique and auxiliary balloon embolization technology.

This case report suggests that the application of a Y stent is a high-risk factor for TBOS; thus, the Y stent should be carefully applied for treatment of the basal artery.

Disclosure of conflict of interest

None.

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