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Opinion paper

Acute ischemic dissection of an "S"-shaped carotid artery: The "one-stop" value of using a detachable Solitaire AB stent

Hongchao Shi [a], Jiankang Hou [a], Wanyin Shi [b,*], Jianping Gu [b,*]

[a] Department of Neurology, Nanjing First Hospital, Nanjing Medical University, No. 68 Changle Road, Nanjing 210006, China
[b] Department of Interventional and Vascular Radiology, Nanjing First Hospital, Nanjing Medical University, No. 68, Changle Road, Nanjing 210006, China

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ABSTRACT

This study aimed to evaluate the efficacy and safety of endovascular repair using detachable Solitaire AB stents for acute ischemic dissection of "S"-shaped carotid arteries. From May 2015 to December 2016, a total of 127 patients with acute ischemic stroke (AIS) underwent endovascular treatment in our center. Among them, five AISs were due to acute dissection of an "S"-shaped carotid artery. Coexisting carotid embolism was identified in all five patients, who first underwent successful Solitaire AB stent-based retrieval of the embolism. All patients then underwent Solitaire AB stenting to reopen the occluded carotid arteries, all of which were successfully recanalized. There were no procedure-related complications, except for minor hemorrhage transformation in one patient. The mean NIHSS scores were 12 ± 3.7 and 3.8 ± 3.4 at admission and 90 days after stenting, respectively (P = 0.018). The median modified Rankin Scale score at 90 days was 2.0 ± 1.4. Follow-up computed tomography angiography demonstrated in-stent patency in four of the five patients. Dissection of an "S"-shaped carotid artery infrequently leads to AIS. Such dissected arteries can be safely and reliably repaired by this stenting, ensuring successful reconstruction of the carotid arterial circulation.

1. Introduction

Acute ischemic stroke (AIS) is the most common type of stroke, accounting for approximately 80% of the total number of strokes. It is the third leading cause of death in the United States [1,2]. The high morbidity and mortality and the limited time window require accurate, timely diagnosis and treatment.

Carotid arterial dissection is a less frequent contributor to AIS than cardiogenic thromboembolism. Carotid arterial dissection, however, is increasingly implicated in strokes in young populations [3–5], who seem to have worse clinical prognoses even when thrombolysis is applied [6–8]. The main cause of cerebral infarction is thromboembolism originating from dissection. That is, brain hypoperfusion resulting from acute occlusion of a dissected artery might well lead to a cerebral infarct. The complexity of dissection-related AIS may in part explain some patients being refractory to thrombolytic therapy.

The presence of an acutely obstructed carotid artery due to dissection necessitates timely reconstruction of the carotid blood flow to improve cerebral perfusion. Consequently, stent-based endovascular repair of the dissected artery has been increasingly regarded as a feasible, safe treatment option [6]. However, no consensus has been attained on the choice of stent (i.e., self- or balloon-expandable), which is largely clinically empirical. It is essential, however, that the stent be individually tailored to the lesion's anatomy [9]. We report our limited experience on the use of stents to treat AIS secondary to carotid arterial dissection with an "S"-shaped carotid artery.

2. Materials and methods

The study protocol was approved by the institutional review board. Informed consent was obtained from all patients or their immediate family members prior to endovascular interventions.

3. Population

From May 2015 to December 2016, a total of 125 patients with AIS underwent endovascular interventions in our center. The patients were aged 31–92 years (mean 69.54 ± 11.73 years), with a significant male predominance (n = 75/125, 60%). All patients experienced acute onset of symptoms lasting no >6 h. Among them, five were diagnosed by angiography to have carotid arterial dissection, which was considered the underlying lesion resulting in

* Corresponding authors.
E-mail addresses: shwy110@163.com (W. Shi), gjp_nj@163.com (J. Gu).

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acute onset of cerebral ischemia. Demographic data of these patients are shown in Table 1.

4. Clinical evaluation

The National Institutes of Health Stroke Scale (NIHSS) was used at admission to assess the severity of the individual's neurologic deficit. One patient with an NIHSS score > 25 was considered ineligible for endovascular treatment or intravenous thrombolysis.

5. Imaging evaluation

Plain computed tomography (CT) was performed on each of the five patients to rule out contraindications to endovascular treatment or recombinant tissue plasminogen activator (r-tPA)-based intravenous thrombolysis, including cerebral hemorrhage. The CT revealed signs of early infarction in more than one-third of the territory of the middle cerebral artery (MCA). The Alberta Stroke Program Early CT Score [10] was also used to indicate the regions of ischemia. With a range of 1–10, a score of 10 points indicated a normal CT scan, and a score of 0 indicated diffuse ischemia throughout the MCA territory. Patients suspected of having acute large-vessel occlusion then underwent a multi-modal magnetic resonance (MR) examination: three-dimensional time-of-flight MR angiography to confirm large-vessel occlusion; perfusion-weighted imaging to assess ischemic penumbra; and fluid-attenuated inversion recovery to evaluate collateral network conditions.

6. Treatment

Four of the five patients were admitted within 3.5 h after symptom onset and had no contraindications to intravenous (IV) thrombolysis. Hence, they were emergently given r-tPA (0.9 mg/kg IV) for thrombolysis, according to National Institute of Neurological Disorders and Stroke guidelines. During the IV thrombolysis, they were monitored by MR examinations. Clinical status was also reassessed immediately after each MR examination. The results of the MR and clinical assessment indicated large-vessel occlusion. Consequently, they were immediately transferred to the digital subtraction angiography (DSA) room to undergo endovascular treatment. Because the symptom duration had been >4 h in one patient, IV thrombolysis was not applied and the patient was transferred to the DSA room immediately after the MR evaluation confirmed AIS and large-vessel occlusion.

Each of the five patients was safely placed on the DSA table and immobilized by tying wrists and knees to the table with home-made soft belts. They were sedated with dexmedetomidine HCl (0.5 μg/kg IV per hour). The injection rate was mediated based on the patient's sedation status, heart rate, and respiratory response. The right femoral artery was conventionally used for catheterization access. A 6F sheath (Terumo, Tokyo, Japan) was inserted, through which a 4F pig-tail catheter (Cook, Spencer, IN, USA) was navigated over a 0.035-inch guidewire (Terumo) into the ascending aorta. Aortography was then performed to visualize the aortic arch to confirm the diseased artery that had been previously identified on MRA. Selective catheterization was conducted using a 4F Headhunter catheter with its tip placed proximal to the diseased artery. Selective angiography was then performed to attain detailed information about the acutely obstructed artery.

Following diagnostic angiography, a 6F guide-catheter (Chaperon; MicroVention, Columbia, Aliso Viejo, California) was placed in the common carotid artery proximal to the lesion, providing guide sheath support. A micro-catheter (Headway 27; MicroVention) was then navigated over a 0.014-inch micro-guidewire (Traxcess; MicroVention) into the internal carotid artery. Micro-catheter/micro-guidewire access was obtained through the dissection flaps with contrast injections confirming true lumen catheterization and opacification of the distal intracranial vasculature. It is relatively common and easy to navigate a micro-guidewire through a dissected occlusion. It should be noted that a micro-guidewire may be in the false lumen when its top gets twisted or entangled. Finally, the micro-catheter was distally placed in the true lumen of the carotid artery, providing a channel for the next stent-based manipulations. For the five patients with thrombosis in the dissected segment of the carotid artery, the clot was removed using a 6×30 mm Solitaire AB stent (MicroVention). After successful clot removal, repeat angiography demonstrated dissection-induced occlusion in the C1-C2 segments of the carotid artery. To reopen the occluded dissection, the Solitaire AB stent was inserted via a micro-catheter (Headway 27; MicroVention) that had been previously placed in a normal segment distal to the area of dissection. We then retracted the micro-catheter until the whole stent came into the open field, making sure that the stent had fully covered the dissected segments. Angiography was then repeated via the guide catheter to visualize the patency of the stent and distal circulation. Finally, the stent was detached

Table 1
Baseline demographic and clinical data.

		Patient No.				
		1	2	3	4	5
Age (Y)		50	69	55	43	66
Gender		M	M	M	M	M
Clinical risk factors						
	Tobacco use	N	N	N	N	N
	Arial fibrillation	N	N	N	N	N
	Hypertension	Y	Y	N	N	Y
	Hyperglycemia	N	Y	N	N	N
	Hyperlipidemia	N	N	N	N	N
	Malignancy	N	N	N	N	N
SPECTS		7	8	10	10	7
Intravenous t-PA		Y	Y	N	Y	Y
NIHSS score at presentation		12	10	15	7	16
Hemorrhage transformation		N	N	N	N	Y
NIHSS score at 90 days		1	8	1	2	7
mRS at 90 days		1	4	1	1	3

SPECTS, Alberta Stroke Program Early CT Score; L, left; mRS, modified Rank in Scale; NIHSS, National Institutes of Health Stroke Scale; R, right; TTR, time to recanalization, from symptom onset to recanalization ; TTT, time to therapy, from symptom onset to puncture.

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