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CASE REPORT

Successful carotid artery stenting in patients with aortic dissection

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Abstract

Background: There are no guidelines for the optimal timing of surgery (emergency *vs.* delayed) for ascending aortic dissection with acute ischemic stroke. We retrospectively compared the prognoses and radiological and clinical findings for concomitant aortic dissection and ischemic stroke in a series of case reports. **Case presentation**: Three patients presented with left hemiparesis. Patient 1 underwent surgery for acute aortic dissection without treatment for acute ischemic stroke. In Patient 2, emergency stenting could not be performed due to cardiac tamponade and hypotension. Therefore, emergency acute aortic dissection surgery was performed. Patient 3 underwent emergency right common carotid artery stenting followed by surgery for acute aortic dissection. Brain perfusion computed tomography angiography (CTA) was performed to diagnose severe stenosis of the right common carotid artery or occlusion concomitant with acute aortic dissection involving the aortic arch with a cerebral perfusion mismatch in all the patients. Patient 3 had postoperative local cerebral infarction, whereas patients 1 and 2 (without stent insertion) had extensive postoperative cerebral infarction. **Conclusion**: Patient 3 showed a better prognosis than patients without stent treatment. We suggest that perfusion CTA of the aortic arch in suspected acute ischemic stroke can facilitate early diagnosis and prompt treatment in similar patients.

Keywords

Acute stroke; Aortic arch; Aortic dissection; Common carotid artery; Stent

1. Background

Aortic dissection occurs twice as frequently in men than in women. Based on the Stanford classification [1], an ascending aortic dissection (AAD) is classified as type A, for which surgery remains the primary treatment. Patients usually present with sudden-onset chest, back, or abdominal pain [2, 3]. AAD is associated with acute ischemic stroke (AIS) in 5-10% of patients [4]. In such cases, it is often not accompanied by characteristic symptoms, such as chest pain, hypotension, and loss of peripheral pulses [5]. In patients with concomitant AAD and AIS, the guidelines for the optimal timing of surgery between delayed and emergency are remain unclear.

2. Case presentation

We evaluated three concomitant AAD (Stanford classification type A, DeBakey type I) and AIS patients with severe stenosis or occlusion of the right common carotid artery (CCA) between May and July 2018. Brain perfusion computed tomography angiography (CTA) was used to diagnose AIS and AAD. We observed prognostic heterogeneity based on whether patients underwent emergency right CCA stenting followed by AAD surgery or emergency AAD surgery without CCA stenting (Table 1).

2.1 Case 1

A 73-year-old man presented with left hemiparesis and asomatognosia, which started an hour before admission. His Glasgow Coma Scale (GCS) was 14 and National Institute of Health Stroke Scale (NIHSS) score was 9. The blood pressures in his right and left arms were 85/45 and 130/80 mmHg, respectively. The pulse rates in his right and left radial arteries were 45 and 80 beats/min, respectively. Brain perfusion CTA showed severe stenosis of the right CCA (Fig. 1 A-1) and severe right hemispheric cerebral perfusion mismatch (Fig. 1 A-2). Axial enhanced perfusion CTA images confirmed AAD involving the right aortic arch (Fig. 1 A-3). Emergency surgery was successfully performed for AAD. However, his consciousness deteriorated into a stupor (GCS 7 and NIHSS 23) postoperatively. Brain CT revealed extensive right hemispheric cerebral infarction (Fig. 1 A-4).

2.2 Case 2

A 65-year-old woman presented with left hemiparesis and dysarthria, which started 3 hours before admission. Her GCS

TABLE 1. Comparison of patients with concomitant aortic dissection and ischemic stroke.

	Stroke onset	Blood pressure	Pain	Cardiac tamponade	Perfusion CTA	CCA stent insertion
1	< 1hour	Right 85/45 mmHg Left 130/80 mmHg	-	-	Right Carotid artery stenosis	-
2	< 3hours	Right 70/40 mmHg Left 70/40 mmHg	-	+	Right Carotid artery occlusion	-
3	< 1hour	Right 100/60 mmHg Left 130/80 mmHg	-	-	Right Carotid artery occlusion	+

Note: CCA, common carotid artery; CTA, computed tomography angiography.

was 13 at that time and NIHSS was 5. Her blood pressure was 70/40 mmHg in both arms, and her pulse rate was 40 beats/min in both radial arteries. Brain perfusion CTA showed right CCA occlusion (Fig. 1 B-1) and severe right hemispheric cerebral perfusion mismatch (Fig. 1 B-2). Axial enhanced perfusion CTA images showed AAD involving the right aortic arch (Fig. 1 B-3). Stenting was planned to treat the acute right CCA occlusion and severe right hemispheric cerebral perfusion mismatch. However, it could not be performed because she developed cardiac tamponade, and her blood pressure fell to 70/40 mmHg. Therefore, she underwent emergency surgery for AAD instead of stenting. Although the surgery was successful, her consciousness deteriorated into a stupor (GCS 8 and NIHSS 24). Brain magnetic resonance imaging (MRI) revealed diffuse AIS in both the cerebral hemispheres (Fig. 1 B-4).

2.3 Case 3

A 66-year-old man presented with left hemiparesis and asomatognosia, which started an hour before admission. His GCS was 13 and NIHSS was 8. The blood pressures in his right and left arms were 100/60 and 130/80 mmHg, respectively. The pulse rates in his right and left radial arteries were 60 and 80 beats/min, respectively. Brain perfusion CTA showed right CCA occlusion (Fig. 1 C-1) and severe right hemispheric cerebral perfusion mismatch (Fig. 1 C-2). Axial enhanced perfusion CTA images showed AAD involving the right aortic arch (Fig. 1 C-3). Stenting was performed to treat the acute right CCA occlusion and severe right hemispheric cerebral perfusion mismatch. Through the right femoral artery, shuttle guiding catheter (8 French) and Fubuki guiding catheter (8 French) were introduced into the descending aorta and a HN-5 diagnostic angiocatheter was navigated into the innominate artery with intermittent contrast injection in order to confirm the true lumen. In a similar way, Fubuki guiding catheter (8 French) and Reba 18 microcatheter were introduced into the right CCA and a microcatheter was navigated into the right internal carotid artery with intermittent contrast injection. Carotid artery stenting using RX Acculink (6 mm-8 mm-40 mm) stent was performed under fluoroscopic guidance (Fig. 2). Surgery was successfully performed for AAD immediately after stenting. Neurological examination performed on postoperative day 1 showed improvement in the left hemiparesis and other symptoms observed on admission (GCS 15 and NIHSS 1). Brain MRI performed on the same day revealed reductions in the right hemispheric cerebral infarctions (Fig. 1 C-4).

2.4 Surgical procedure

All three patients were treated with the same surgical method (ascending aorta and hemi-arch replacement with Gelweave 1 branched graft and aortic valve resuspension), because they had the same type of AAD. All operations were initiated by exposing the right axillary artery with a deltopectoral groove incision. An 8-mm vascular graft (Vascutek; Terumo, Ann Arbor, Mich) was sewn end-to side to the axillary artery. The graft was attached to the cardiopulmonary bypass circuit. After the initiation of cardiopulmonary bypass and upon reaching the goal core body temperature, the innominate artery was clamped proximally and arterial inflow via the right axillary artery was lowered to 10 mL/kg/min. This provided unilateral antegrade cerebral perfusion at 18 °C via the right common carotid artery, which was adjusted to maintain cerebral perfusion pressures of 70-80 mmHg. After the initiation of the circulatory arrest period, all aortic arch pathology was resected. The open arch was routinely inspected for the presence of retrograde flow coming from the ostia of the left common carotid and subclavian arteries to verify the presence of antegrade cerebral perfusion via the right axillary artery. In all cases of hemi-arch replacement, distal aortic reconstruction was performed with an open beveled anastomosis to the undersurface of the aortic arch.

3. Discussion

All three patients in this report had Stanford classification type A aortic dissection including the ascending aorta, and in particular, they were DeBakey type I cases including entry into the common carotid artery. The diagnosis and treatment of AAD are delayed in patients with concomitant AAD and AIS with altered consciousness or aphasia because they cannot express symptoms such as pain, and prognosis is often unfavorable [2, 5]. Additionally, recombinant tissue plasminogen activator (t-PA) is contraindicated in patients with concomitant AIS and AAD [6]. Therefore, they may not receive appropriate treatment even after presenting to a clinic within the "golden time window." t-PA administration may precipitate fatal hemothorax or hemopericardium secondary to aortic dissection or result in widening of the ruptured segment [7]. Furthermore, t-PA administration can negatively affect the prognosis of patients with AAD because uncontrolled or

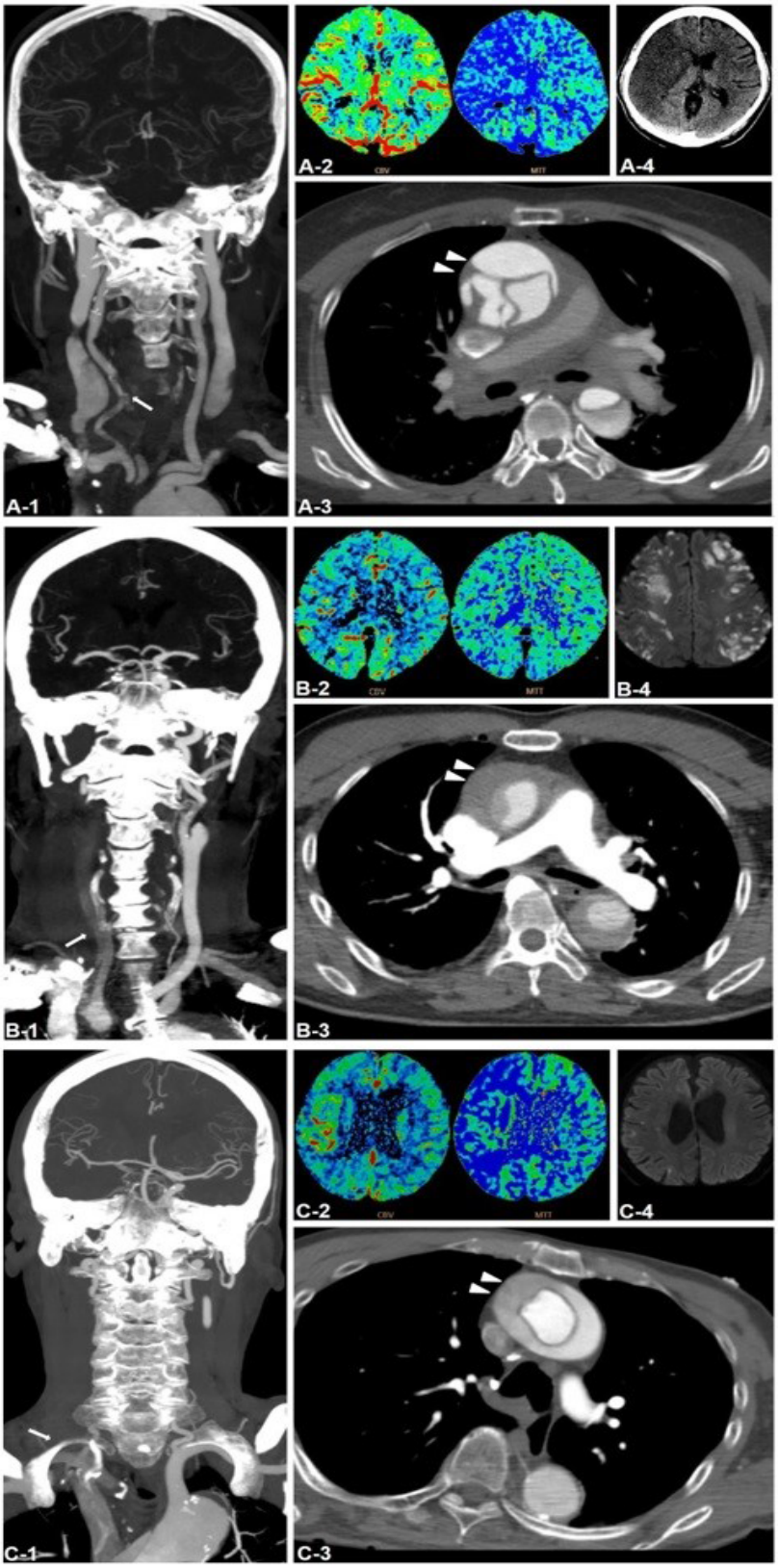

FIGURE 1. Brain perfusion computed tomography angiography and magnetic resonance imaging findings. (A-C) Brain perfusion computed tomography angiography (p-CTA) shows severe stenosis or occlusion of the right common carotid artery (arrow) (A-1, B-1, C-1). Severe cerebral perfusion mismatch is seen in the right hemisphere (A-2, B-2, C-2). Axial enhanced p-CTA shows aortic dissection involving the right wall of the ascending aorta (arrowhead) (A-3, B-3, C-3). Extensive right hemispheric cerebral infarction (A-4) and multifocal infarctions in the bilateral cerebral hemispheres (B-4) are observed after surgery for aortic dissection without stenting. After emergency stenting followed by surgery, only a small focal cerebral infarction is observed in (C-4).

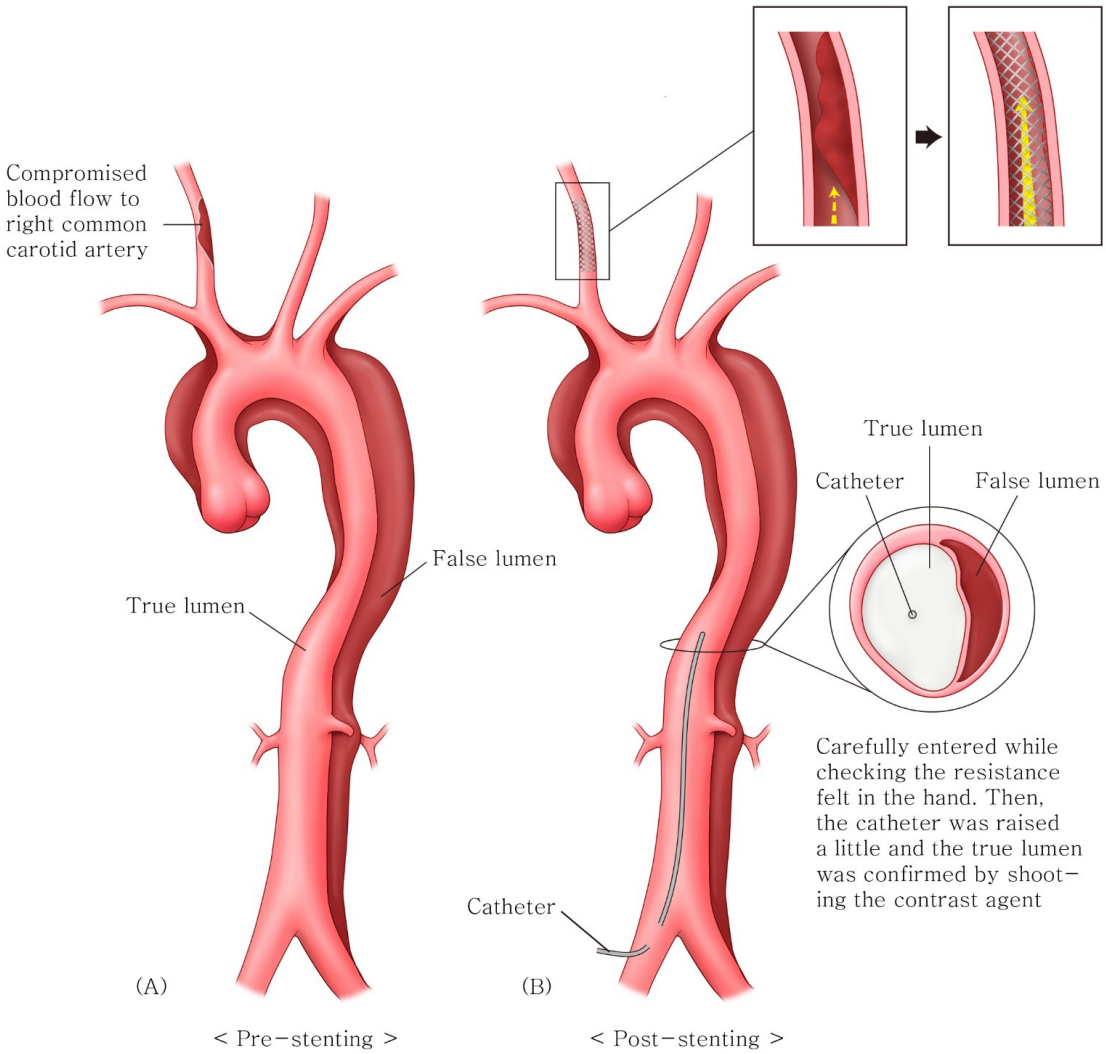

FIGURE 2. Illustrations of common carotid artery stenting. (A) Angiographic images reveal the compromised blood flow to the right common carotid artery. (B) Angiographic images after stent insertion show complete recovery of the carotid artery flow. Fig. 2 illustrations by HGK.

excessive intraoperative bleeding may prolong the duration of surgery [8, 9]. All patients in this study presented to the emergency department within 4.5 hours, and t-PA could have been administered intravenously but was contraindicated because all patients presented with AAD.

The development of AIS in patients with AAD is attributed to the following mechanisms: (1) direct expansion of aortic dissection can obstruct the carotid artery; (2) borderzone infarction may occur after hemodynamic instability or reduced cerebral perfusion pressure; and (3) thromboembolism within the area affected by aortic dissection can precipitate AIS [10]. Concomitant AIS and AAD primarily affect the right cerebral hemisphere, which is related to the pathology of AAD [11]. Intimal tears occur most commonly within the right wall of the ascending aorta [12], and AADs are twice as common as descending aortic dissections [3]. Therefore, the risk of right CCA obstruction secondary to the direct expansion of AAD is higher than that of left CCA obstruction caused by anatomical changes. All three patients in our series had right CCA occlusion, decreased right hemispheric cerebral perfusion, cerebral perfusion mismatch, and typical symptoms of right cerebral infarction.

We considered emergency right CCA stenting in Patient 1. However, emergency surgery was performed without treating AIS, given the lack of specific guidelines for this situation [13] and the risk of exacerbating the dissection. Although the AAD surgery was successful, extensive right hemispheric cerebral infarction was observed. In Patient 2, we attempted emergency CCA stenting, which was subsequently abandoned because of unstable vital signs secondary to the development of cardiac tamponade. Therefore, we only performed emergency surgery. However, this patient also showed a wide area of right hemispheric cerebral infarction and poor prognosis. Patient 3 showed relatively more stable vital signs than patients 1 and 2. Therefore, emergency AAD surgery was performed following right CCA stenting. Postoperative brain MRI showed small multifocal right hemispheric cerebral infarctions. However, the patient improved with no neurological sequelae.

4. Conclusions

Based on our experience with patients in this case series, we conclude that emergency stenting followed by AAD surgery has better outcomes than AAD surgery without stenting for right CCA stenosis or occlusion with AAD. No definitive guidelines have been established on the better option between emergency or delayed surgery for treating patients with concomitant AAD and AIS. This case study showed that emergency stenting affected the prognosis positively in patients with concomitant AAD and AIS.

Additionally, we propose that perfusion CTA, as well as the evaluation of the aortic arch, can facilitate early diagnosis of asymptomatic AAD. Moreover, the penumbra can be confirmed using perfusion mismatch to promptly determine the efficacy of emergency stenting in patients with AIS. Furthermore, fatal hemothorax or hemopericardium secondary to t-PA administration can be avoided without confirming AAD. However, large-scale prospective studies are warranted in the future because our findings are based on the evaluation of only a few cases.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethics approval is not needed for case reports in our institution as per their instructions.

CONSENT FOR PUBLICATION

Written informed consent was obtained from each patient for the publication of this case report and the accompanying images. Our patients were able to converse with others when we obtained informed consent. For ethics approval and consent to participate, we received consent from the patients and their legal guardians. Copies of the written consent are available for review by the editor of this journal.

AUTHOR CONTRIBUTIONS

PKC and HGK participated in the design of this research. PKC, SWH, BSS, and HGK collected and analyzed the raw clinical data. SWH, BSS, and HGK carried out computational studies and wrote the manuscript. SWH and HGK wrote the revised manuscript. All authors have read and approved the final manuscript.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest with respect to the research, authorship, funding, and/or publication of this article.

AVAILABILITY OF DATA AND MATERIAL

All data and material supporting our findings are contained within the manuscript.

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