

Carotid artery stenting before surgery for carotid artery occlusion associated with acute type A aortic dissection: Two case reports

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Abstract

Background: We experienced two cases of ischemic stroke resulting from carotid artery occlusion associated with acute type A aortic dissection (ATAAD), in which carotid artery stenting before the surgery for ATAAD resulted in good clinical outcomes.

Case 1 description: A 63-year-old woman was hospitalized for conscious disturbance, right hemiparesis, and total aphasia. Computed tomography of the head showed no abnormal findings. Computed tomography angiography showed ATAAD and bilateral common carotid artery occlusion. Surgery was not indicated for ATAAD because of a poor prognosis of ischemic stroke. However, carotid artery stenting of the left common carotid artery occlusion was successfully performed, and her neurological findings improved. The patient underwent hemiarch replacement for ATAAD on the day after carotid artery stenting. Her final modified Rankin Scale was 1. **Case 2 Description:** A 57-year-old woman was hospitalized for mild left hemiparesis. Magnetic resonance imaging showed right watershed infarction and right common carotid artery occlusion. Computed tomography angiography showed ATAAD. After hospitalization, conscious disturbance appeared and left hemiparesis worsened. Ischemic stroke indicated a poor prognosis for revascularization by surgery for ATAAD. Thus, carotid artery stenting of the right common carotid artery occlusion was performed. The patient's neurological findings improved and she underwent hemiarch replacement for ATAAD at 19 days after carotid artery stenting. Her final modified Rankin Scale was 1.

Conclusions: In the present cases, although ischemic stroke was serious and precluded surgical indication for ATAAD, carotid artery stenting before surgery for ATAAD resulted in good clinical outcomes. Performing carotid artery stenting before surgery for ATAAD is challenging but achievable, and is a valid treatment option depending on the individual cases.

Keywords

Carotid artery stenting, carotid artery occlusion, type A aortic dissection

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Introduction

Acute type A aortic dissection (ATAAD) involves dissection of the ascending aorta and requires emergency surgery. Without surgical treatment, the outcome is often fatal, with the mortality rate increasing by 1%–2% every hour in the early onset stage, and reaching $\geq 50\%$ in admitted patients.¹ Neurological symptoms occur because of occlusion of the carotid, vertebral, or spinal arteries, and vasa nervorum of peripheral nerves, or because of hypotension and related cerebral perfusion deficit.²

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The frequency of initial neurological symptoms ranges from 17% to 40%, and postoperatively from 22.8% to 47.5%.^{2,3} The complication of ischemic stroke is considered a predictor of a poor prognosis.⁴ We experienced two cases of ischemic stroke because of carotid artery occlusion associated with ATAAD, in which carotid artery stenting (CAS) before the surgery for ATAAD resulted in good clinical outcomes.

Case description

Case 1

Initial presentation. A 63-year-old woman was hospitalized for conscious disturbance, right hemiparesis, and total aphasia. She had a prior medical history of type B aortic dissection. The Glasgow Coma score was 8, and the National Institutes of Health Stroke Scale (NIHSS) was 24. Computed tomography (CT) of the head showed no abnormal findings, and the Alberta Stroke Program Early CT Score was 10 (Figure 1(a) and (b)). CT angiography of the chest showed ATAAD (Figure 1(c)), and CT angiography of the head and neck showed occlusion of the bilateral common carotid artery (CCA) and left vertebral artery (Figure 1(e)). The anterior circulation was supplied with perfusion from the posterior circulation via the right posterior communicating artery (Figure 1(d)).

Although there was a high possibility of bleeding and death without surgery for ATAAD, surgery was not indicated for ATAAD because of the likelihood of ischemic stroke. Surgery for ATAAD was possible if neurological findings improved. Thus, treatment for ischemic stroke was performed.

Endovascular procedure. CAS for the left CCA occlusion was performed under local anesthesia because the clinical symptoms were caused by ischemia of the left cerebral hemisphere. Heparinization was performed to maintain an increased activated clotting time at ≥ 250 s during the procedure. Left CCA angiography showed an irregular vessel wall and occlusion of the left CCA (Figure 2(a)). A 4 French SY4 (Cathex) was advanced into the occluded part of the left CCA, and the true lumen of the distal portion of the left CCA was confirmed because the left external carotid artery was identified (Figure 2(b)). Although an 8 French guiding catheter (Britetip; Johnson & Johnson) was then inserted into the CCA lumen, the left internal carotid artery (ICA) was also occluded. A guide wire was advanced into the occluded part of the left ICA, and a 5 French OK2M (Cathex) was inserted into the petrous portion of the left ICA. The true lumen of the petrous portion of the left ICA was confirmed because a distal portion of the left ICA was

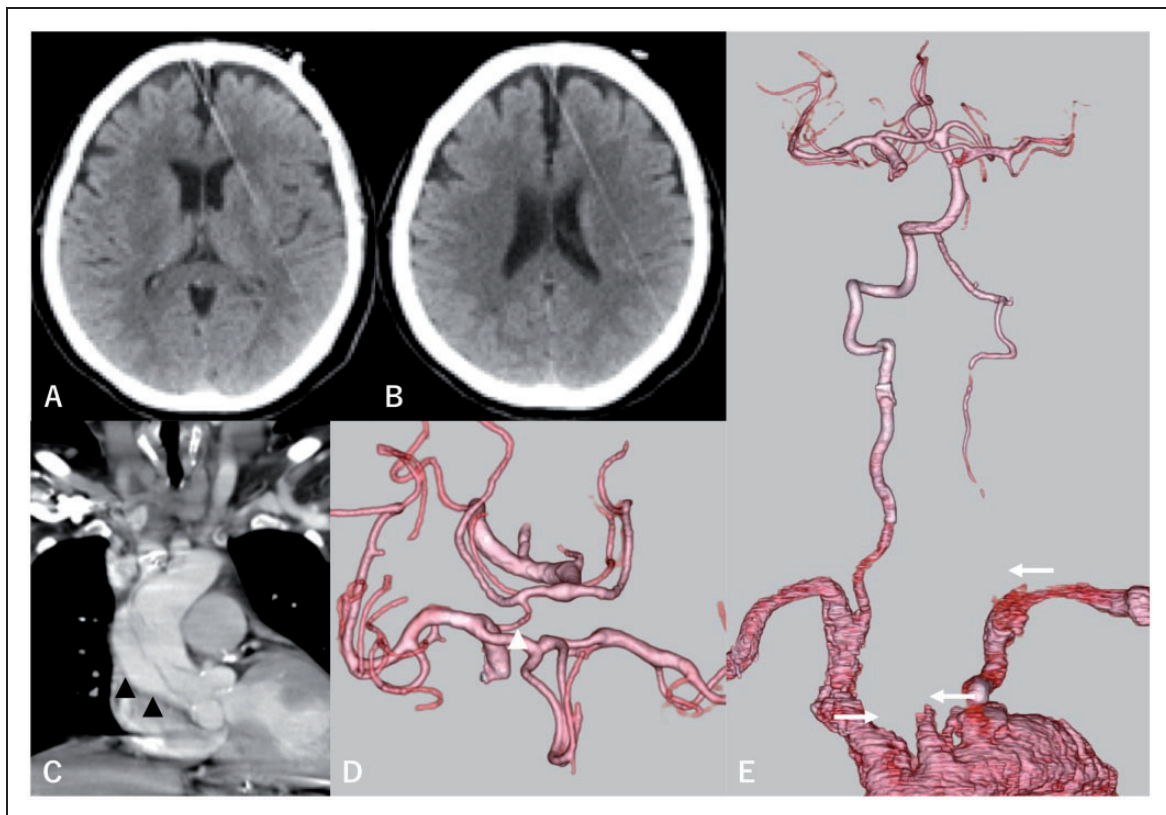


Figure 1. (a,b) Computed tomography (CT) on admission shows no abnormal findings, and the Alberta Stroke Program Early CT Score was 10. (c) Coronal view of CT angiography of the chest shows acute type A aortic dissection (black arrowheads). (d,e) Three-dimensional CT angiography of the head and neck shows occlusion of the bilateral common carotid artery (CCA) and left vertebral artery (white arrows). The anterior circulation is supplied by the posterior circulation via the right posterior communicating artery (white arrowhead).

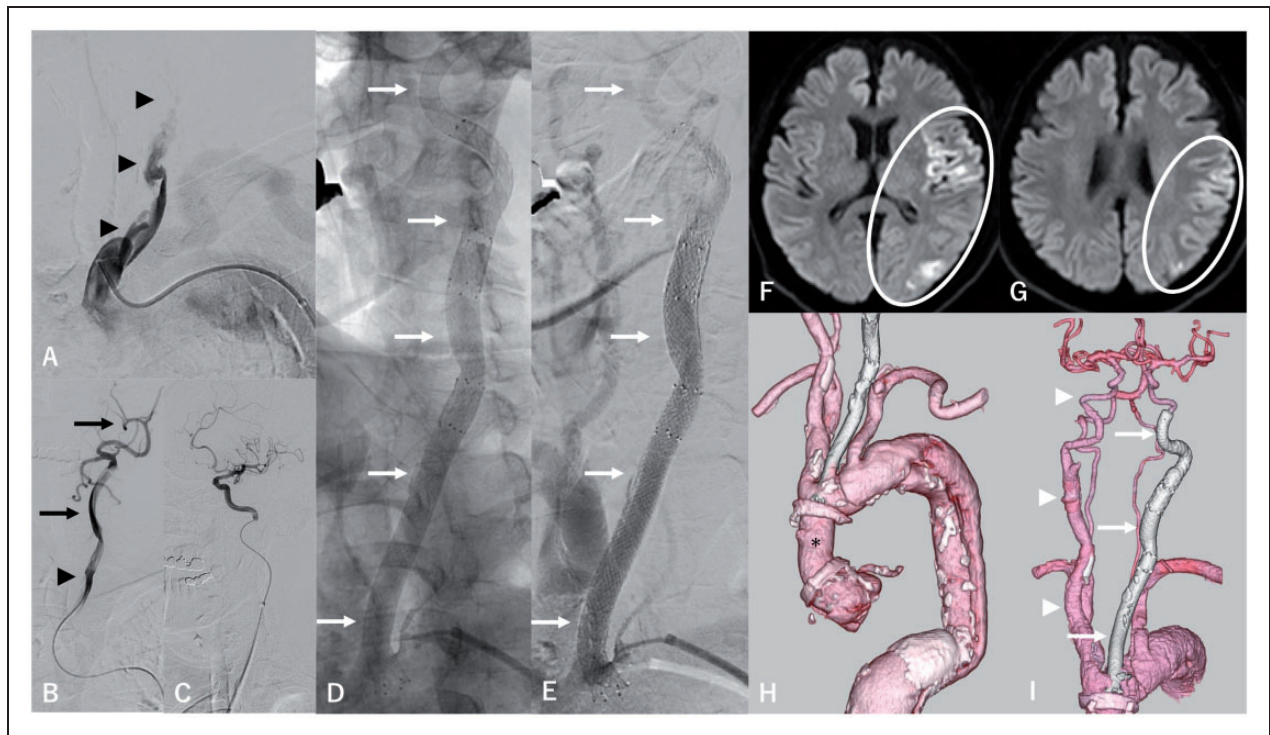


Figure 2. (a) Left CCA angiography shows irregular vessel wall and occlusion of the left CCA (black arrowheads). (b) Left CCA angiography shows the true lumen of the left CCA (black arrowhead) and external carotid artery (black arrows). The left internal carotid artery (ICA) is occluded. (c) Left ICA angiography after lesion crossing shows that the true lumen of the left ICA is maintained. (d,e) From the petrous portion of the left ICA to the origin of the left CCA, four stents were deployed (white arrows) and antegrade blood flow of the left CCA was confirmed. (f,g) Diffusion-weighted imaging (DWI) shows small signal hyperintensity areas in the left cerebral cortex (white circle). (h,i) CT angiography shows successful replacement of the ascending aorta (*), deployment of the stents from the left ICA to the CCA (white arrows), and recanalization of the right CCA (white arrowheads).

identified (Figure 2(c)). PRECISE 10 × 40 mm (Cordis), Protégé 10 × 60 mm (eV3 Covidien), SMART control 10 × 60 mm (Cordis), and SMART control 8 × 100 mm (Cordis) stents were deployed from the petrous portion of the left ICA to the origin of the left CCA to cover the entry tear (Figure 2(d)), and antegrade blood flow of the left CCA was confirmed (Figure 2(e)).

Postprocedural course. Argatroban, which has a short half-life, was administered after the procedure rather than dual antiplatelet therapy (DAPT). At 24 h after the procedure, the Glasgow Coma score improved from 6 to 14, and right hemiparesis also improved. Post-procedural magnetic resonance imaging (MRI) showed small signal hyperintensity areas in the left cerebral cortex on diffusion-weighted imaging (DWI) (Figure 2(f) and (g)). On that day, because her neurological findings improved, argatroban treatment was discontinued, and she underwent hemiarch replacement for ATAAD. Postoperative CT angiography showed successful replacement of the ascending aorta, deployment of the stents from the left ICA to the CCA, and recanalization of the right CCA (Figure 2(h) and (i)). The patient experienced no post-operative complications and was discharged. At one

year after the procedures, her modified Rankin Scale was 1.

Case 2

Initial presentation. A 57-year-old woman, who had no medical history and no episode of chest pain, was hospitalized for mild left hemiparesis (NIHSS 4). MRI showed signal hyperintensity spots in the right watershed area on DWI (Figure 3(a) and (b)) and right CCA occlusion on MR angiography (Figure 3 (c) and (d)). CT angiography of the chest showed ATAAD and the false lumen was thrombotic (Figure 3(e) and (f)). ATAAD was not considered to be in the super-acute phase. Therefore, elective surgery was planned after stabilization of ischemic stroke. However, on the day after hospitalization, a conscious disturbance appeared and left hemiparesis had worsened (NIHSS 18). Although MRI and CT angiography showed no progression of infarction or ATAAD, clinical symptoms indicated hypoperfusion of the right cerebral hemisphere. Ischemic stroke indicated a poor prognosis for ATAAD surgery and the risk of worse infarction because of intraoperative hypoperfusion of the cerebrum. Thus, CAS of the right CCA occlusion was performed.

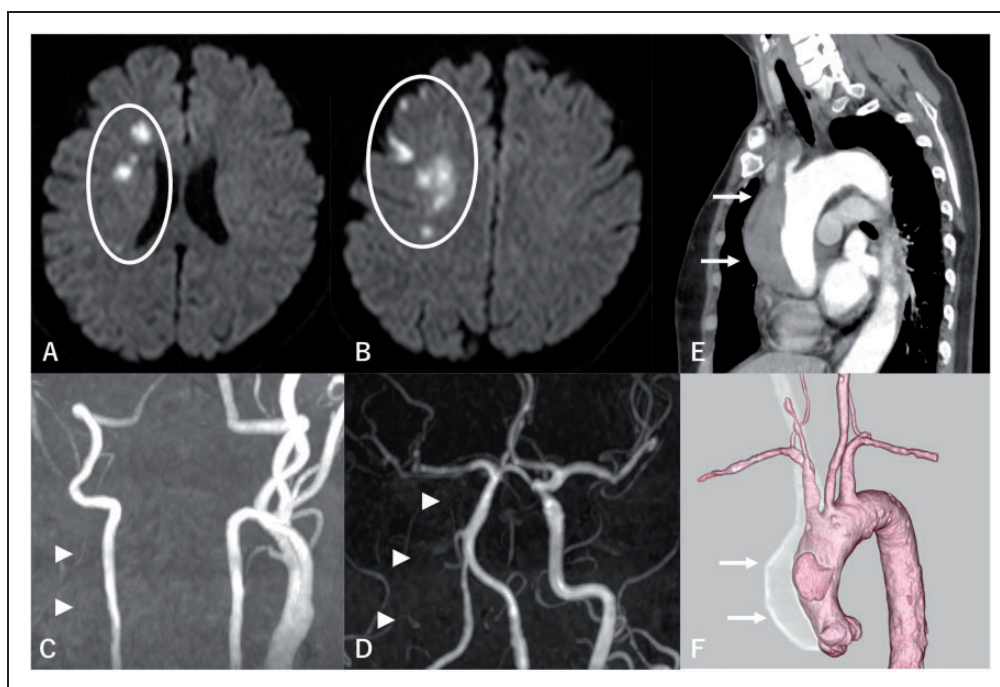


Figure 3. (a,b) DWI shows signal hyperintensity spots in the right watershed area (white circle). (c,d) Magnetic resonance angiography of the head and neck shows the right CCA occlusion (white arrowheads). (e,f) Sagittal view and three-dimensional imaging of CT angiography of the chest shows an acute type A aortic dissection and a thrombotic false lumen (white arrows).

Endovascular procedure. CAS of the right CCA occlusion was performed under local anesthesia. Heparinization was performed to maintain an increased activated clotting time at ≥ 250 s during the procedure. Innominate artery angiography showed occlusion of the right CCA (Figure 4(a)). A guide wire was advanced into the occluded part of the right CCA, and the true lumen of the distal portion of the right CCA was confirmed because the right external carotid artery was identified (Figure 4(b)). Although a 9 French balloon guiding catheter (Optimo; Tokai Medical Products) was placed at the right CCA, the right ICA was also occluded. A micro-guide wire (CHIKAI 18 black; Asahi Intecc) was advanced into the occluded part of the right ICA, and a microcatheter (Transit; Codman & Shurtleff, Inc.) was inserted into the petrous portion of the right ICA. The true lumen of the petrous portion of the right ICA was confirmed because a distal portion of the right ICA was identified (Figure 4(c)). PRECISE 7×40 mm (Cordis), PRECISE 8×40 mm (Cordis), PRECISE 9×40 mm (Cordis), PRECISE 10×40 mm (Cordis), Protégé 10×60 mm (eV3 Covidien), and PRECISE 10×40 mm (Cordis) stents were deployed from the petrous portion of the right ICA to the origin of the innominate artery to cover the entry tear (Figure 4(d)), and antegrade blood flow of the right CCA was confirmed (Figure 4(e)).

Postprocedural course. DAPT was administered after the procedure. At 24 h after the procedure, left hemiparesis improved and the NIHSS improved from

18 to 4. Post-procedural MRI showed no expansion of the signal hyperintense area on DWI (Figure 4(f) and (g)). At 12 days after the procedure, CT angiography of the chest showed an increase in the diameter of the ascending aorta from 54 to 57 mm. Because a risk of rupture was considered, the patient underwent hemiarch replacement for ATAAD under single antiplatelet therapy (SAPT). Postoperative CT angiography showed successful replacement of the ascending aorta, and deployment of the stents was performed from the right ICA to the CCA (Figure 4(h) and (i)). The patient experienced no postoperative complications and was discharged. At three months after the procedures, her modified Rankin Scale was 1.

Discussion

ATAAD is an inherently lethal surgical emergency and remains a challenging condition associated with high mortality and morbidity.³ Postoperative stroke associated with ATAAD is an independent predictor of late mortality, and the best management for this complication is still controversial.⁵ Aortic arch and carotid replacement, and CAS during open surgery for extended dissection of the carotid arteries were reported to prevent postoperative stroke.^{6,7} Additionally, CAS for extended dissection of the carotid arteries after surgery for ATAAD was also reported.⁵ However, in the present cases, ischemic stroke caused by CCA dissection occurred at the same time as ATAAD rather than postoperatively. Case 1 has already published in the Japanese literature from our institute.⁸ Although surgery was not

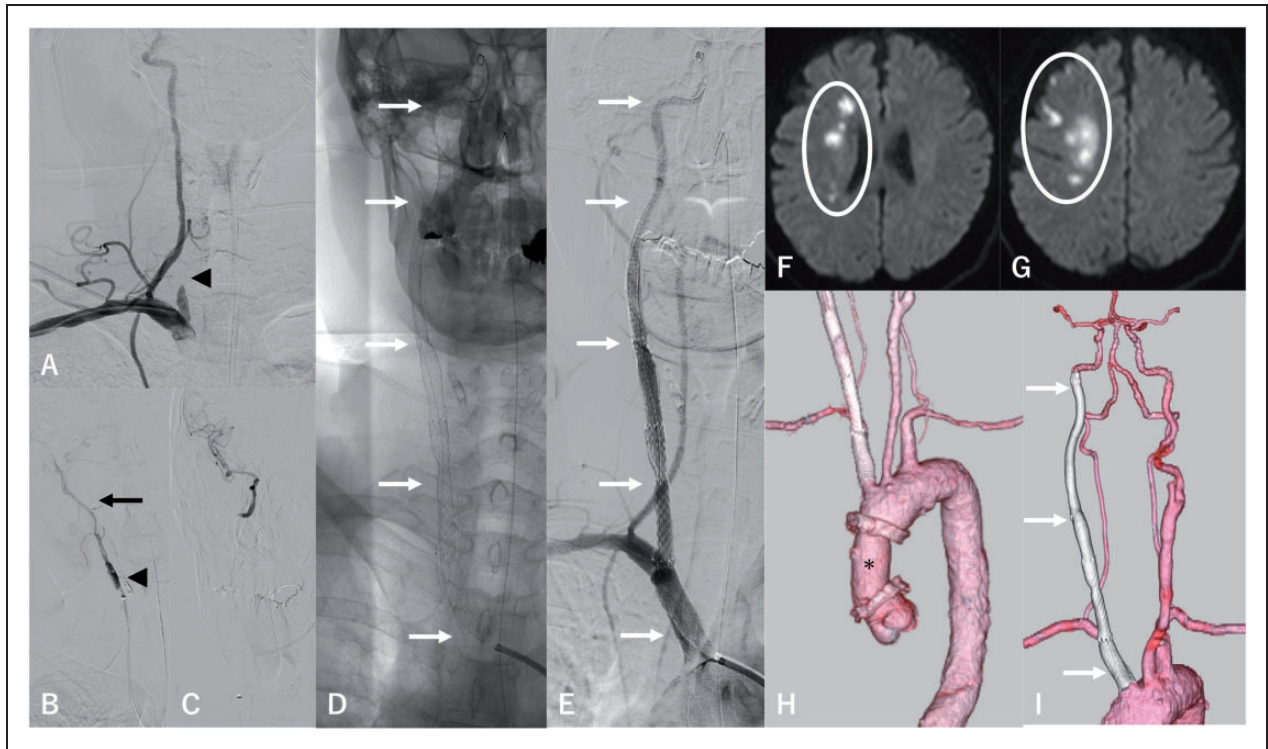


Figure 4. (a) Innominate artery angiography shows occlusion of the right CCA (black arrowhead). (b) Right CCA angiography shows the true lumen of the right CCA (black arrowhead) and external carotid artery (black arrow). The right ICA is occluded. (c) Right ICA angiography after lesion crossing shows that the true lumen of the right ICA is maintained. (d,e) Six stents were deployed from the petrous portion of the left ICA to the origin of the innominate artery (white arrows), and antegrade blood flow of the right CCA was confirmed. (f,g) DWI shows no expansion of the signal hyperintensity spots (white circle). (h,i) CT angiography shows successful replacement of the ascending aorta (*), and deployment of the stents from the left ICA to the CCA (white arrows).

indicated for poor prognostic ischemic stroke associated with ATAAD, prior CAS for carotid artery occlusion before surgery for ATAAD provided a good clinical course. Recently, high-quality studies have resulted in major changes in the evidence-based treatment of patients with acute ischemic stroke,⁹ and good outcomes of thrombectomy for patients with a clinical deficit that was disproportionately severe relative to the imaging of infarction have been reported.^{10,11} Even if ischemic stroke is serious and precludes surgical indication for ATAAD, such as in the present cases, neurological findings can be improved to enable surgical indication by emergency revascularization for ischemic stroke. Performing CAS before surgery for ATAAD should be considered as a treatment option depending on the individual cases.

Although CAS before surgery for ATAAD is considered reasonable depending on each case, it remains a challenging treatment. For ATAAD with a risk of fatality, surgery cannot be performed until CAS is completed, and heparinization during CAS can increase the risk of bleeding caused by ATAAD. In addition, there are some technical difficulties with CAS. First, selective catheterization of the true lumen of the artery is often difficult.¹² Heran et al.¹³ reported a similar case of right CCA occlusion associated with ATAAD. In that case, ultrasound-guided

puncture into the true lumen and retrograde access to the lesion were possible because only the proximal portion of the right CCA was occluded. In the present cases, it was difficult to secure the true lumen of the long lesion at the occluded CCA and ICA. Once the lesion was successfully crossed, several stents were deployed from sites distal to the lesion to the origin of the occluded artery. At this time, it was technically difficult to cover the origin of the vessels that branched from the aortic arch to cover the entry tear. In addition, there is a risk of distal embolization during the procedure, and it is difficult to navigate embolic protection devices through the lesions.¹² However, distal embolization rarely occurs in the treatment of dissecting lesions, unlike for atherosclerotic lesions, and the requirement for embolic protection devices is controversial.¹² Additionally, there is also a risk of hyper-perfusion after CAS for carotid artery occlusion. Cerebral blood flow evaluation such as CT/MRI perfusion or single photon emission computed tomography is required to evaluate the risk of hyper-perfusion. However, in the present cases, cerebral blood flow evaluation was skipped because revascularization was essential for these cases, whose ischemic stroke was severe with high NIHSS scores and caused by acute occlusion.

Although ATAAD is a potentially fatal emergency that can present with a wide variety of clinical

scenarios, advances in the surgical management of this complex disease are improving outcomes.¹⁴ A tailored approach, including total arch or hemiarch replacement, is performed based on surgeon and center experience, and patient presentation.¹⁵ However, performing CAS before surgery for ATAAD has some problems. For example, CAS limits the cardiovascular surgery options for ATAAD. In CAS for carotid artery occlusion associated with ATAAD, stents should be deployed over the origin of the branches of the aortic arch to cover the entry tear. However, if a stent is located near the origin of the branches of the aortic arch, aortic arch replacement is impossible. In the present cases, hemiarch replacement was performed for this reason. Another problem is perioperative antiplatelet therapy. Only aspirin and clopidogrel are approved antiplatelet drugs for ischemic stroke in our country, and DAPT with aspirin and clopidogrel is generally performed for CAS in our institute. If CAS is performed before ATAAD surgery, DAPT should be continued after the procedure. Although DAPT can be reduced to SAPT after a certain period, the invasive surgery for ATAAD is required to be under SAPT, which causes hemostasis difficulties. In case 1, argatroban was administered perioperatively rather than DAPT before surgery for ATAAD. In case 2, the elective surgery for ATAAD was not in the super-acute phase. Thus, DAPT was used after CAS as usual.

The treatment of patients with acute ischemic stroke has changed markedly in recent years. Performing CAS before surgery for ATAAD is challenging but achievable, and is a valid treatment option depending on the individual case.

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Contributorship

All authors meet the ICMJE authorship criteria. Yusuke Funakoshi designed this study and wrote the initial draft of the manuscript. All other authors critically reviewed the manuscript and assisted in the preparation of the manuscript. All authors approved the final version of the manuscript, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

This study is exempt from ethical approval in our institution. The patient has provided permission to publish the

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