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Case Report

Basilar artery occlusion due to vertebral artery injury treated with thrombectomy and distal vertebral artery embolization through the unaffected side

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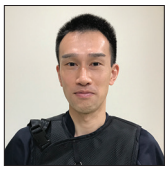

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ABSTRACT

Background: There is no established opinion regarding embolization of asymptomatic traumatic vertebral artery injuries that do not require cervical spine repair and fixation.

Case Description: A 78-year-old man fell backward from a height of about 1 m and was rushed to his previous hospital. He had a fracture of the left transverse process of the 6th cervical vertebra. Six hours after the trauma, he became unconscious; magnetic resonance *angiography* showed occlusion of the left vertebral and basilar arteries, and he was transferred to our hospital. The basilar artery was completely recanalized 430 min after the onset of unconsciousness. Due to the presence of thrombi in the distal vertebral artery at the level of the 6th cervical vertebra and collateral blood flow from the deep cervical artery, the distal vertebral artery was occluded to prevent embolism. Postoperative diffusion-weighted imaging showed extensive infarction in the posterior circulation, and the patient died two days after surgery.

Conclusion: In the case of vertebral artery injury, preparation for early occlusion of the basilar artery is necessary. If a thrombus and collateral blood flow are present distal to the vertebral artery injury, distal vertebral artery embolization may be necessary to prevent embolism.

Keywords: Basilar artery occlusion, Parent artery embolization, Thrombectomy, Vertebral artery injury

INTRODUCTION

Vertebral artery injuries associated with blunt cervical spine trauma are relatively common, ranging from 19% to 39%.[3,7,11,12] The complication rate of cerebral infarction from such injuries ranges from 9% to 54%,[6,13] and the mortality rate, particularly from basilar artery occlusion, is significantly high at 75–86%.[1] Reports on mechanical thrombectomy for basilar artery occlusion associated with vertebral artery injuries due to cervical spine trauma are limited.[16,19]

There is a potential risk of fatal cerebral embolism due to recanalization of the vertebral artery after cervical spine realignment and fixation surgery in patients with traumatic vertebral artery occlusion.[9,18] Therefore, it has been reported that preoperative vertebral artery embolization

for traumatic vertebral artery occlusion before cervical spine fixation surgery is effective in preventing the onset of cerebral infarctions.[9] On the other hand, there is no established consensus regarding the use of embolization for asymptomatic traumatic vertebral artery occlusions that do not require cervical spine repair and fixation surgery.

Here, we present a case of mechanical thrombectomy through the unaffected vertebral artery and simultaneous distal vertebral artery embolization for basilar artery occlusion that occurred during follow-up of vertebral artery injury caused by a blunt cervical spine fracture.

CASE REPORT

History and examination

A 78-year-old man fell backward from a height of about 1 m at his workplace, injuring the back of his head, neck, and back, and was rushed to the previous hospital. At the time of initial examination, he was conscious with no neurological abnormalities but had neck pain. He had diabetes, hypertension, hyperlipidemia, and a history of laminoplasty for ossification of the posterior longitudinal ligament of the cervical spine. Still, no significant family history and was not taking any antithrombotic agents. Cervical spine computed tomography (CT) showed vertebral body fractures at the 6th and 7th cervical vertebrae, a fracture of the left transverse process of the 6th cervical vertebra, and ossification of the posterior longitudinal ligament at the 4th–7th cervical spine levels [Figure 1a and b]. A slightly high-density area was noted within the foramen transversarium of the 6th cervical vertebra [Figure 1c]. Cervical spine T2-weighted magnetic resonance imaging showed no evidence of compression of the cervical spinal cord. Still, a high signal area was noted in the cervical cord at the intervertebral level between the 4th and 5th cervical vertebrae [Figure 1d]. Since there were no findings of spinal cord compression or cervical spine misalignment requiring cervical spine repair and fixation and no neurological abnormalities, the patient was admitted to the hospital for observational management. Altered consciousness, respiratory depression, and anisocoria occurred six hours after the trauma. A slightly high-intensity area in the left cerebellum (posterior circulation acute stroke prognosis early CT score [pc-ASPECTS] 9 points) was observed on diffusion-weighted imaging 70 min after the onset of altered consciousness, and occlusion of the left vertebral and basilar arteries was observed on magnetic resonance *angiography* (MRA) [Figure 1e and f]. The patient was transferred to our hospital 270 min after the onset of altered consciousness for thrombectomy.

On arrival at our hospital, the Glasgow coma scale score was E1V1M4, and there was paralysis of the right upper and lower limbs. The National Institutes of Health Stroke Scale score was 32. At 310 min after the onset of altered consciousness, a head CT showed a hyperdense sign at the tip of the basilar artery and low-density areas in the left cerebellum and midbrain (pc-ASPECTS 7 points) [Figure 2a]. After CT, the patient stopped breathing and was intubated and mechanically ventilated. Because ischemic changes on CT were localized and there was a possibility of symptom improvement, thrombectomy was performed 387 min after the onset of altered consciousness.

Endovascular surgery

Under general anesthesia, a 6-Fr Fubuki dilator kit (Asahi Intecc, Seto, Japan) was inserted through the right femoral artery, and systemic heparinization was performed. To restore basilar artery blood flow as quickly as possible, the 6-Fr Fubuki dilator kit was guided into the open and unaffected right vertebral artery. Right vertebral artery angiography showed occlusion at the tip of the basilar artery [Figure 2b]. Using a React 71 (Medtronic, Minneapolis, MN, USA) and Solitaire X 4 × 40 mm (Medtronic) in two passes, complete recanalization was achieved 43 min after femoral artery puncture and 430 min after the onset of altered consciousness [Figure 2c]. A 4-Fr catheter was then placed through the left femoral artery into the left subclavian artery to evaluate the left vertebral artery. Left subclavian artery angiography showed occlusion at the origin of the left vertebral artery and abundant collateral blood flow from the left deep cervical artery to the left vertebral artery. The left vertebral artery had anterograde blood flow distal to the 6th cervical vertebra level and thrombi at the 4th–6th cervical vertebra levels [Figure 2d and e]. Embolization of the distal left vertebral artery was planned to prevent further embolism due to the thrombus in the left vertebral artery. A 3.2/3.4-Fr Guidepost (Tokai Medical Products, Kasugai, Japan) and Phenom17 (Medtronic) were guided from the 6-Fr Fubuki dilator kit in the right vertebral artery to the left vertebral artery through the vertebral artery confluence. Coil embolization was performed from the level of the 3rd/4th cervical vertebrae, the distal end of the thrombus in the left vertebral artery V2 segment, to the left vertebral artery V3 segment [Figure 2f]. The disappearance of collateral blood flow to the left vertebral artery was confirmed by left subclavian artery angiography. Perfusion in the left posterior inferior cerebellar artery region through the left vertebral artery was confirmed, which was visualized in reverse on the right vertebral artery angiography, with no interruption of the peripheral vessels in the basilar artery region [Figure 2g].

The retrieved thrombus was macroscopically a red thrombus with a partial mixture of white thrombus [Figure 3a]. Hematoxylin-eosin staining revealed that the surface of the thrombus consisted mainly of platelets and fibrin with a

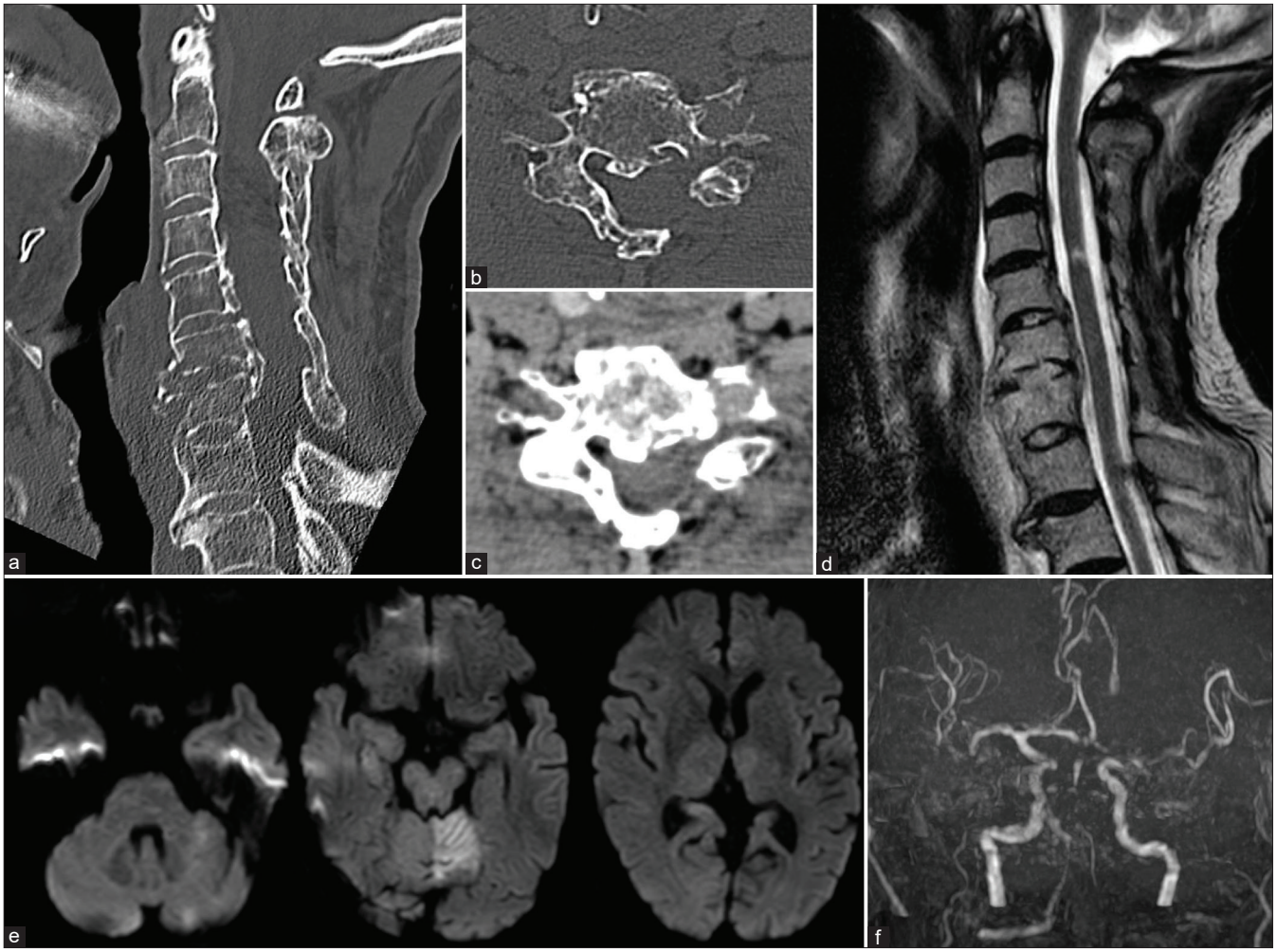

Figure 1: Images taken at the previous hospital: (a) the sagittal section of cervical computed tomography (CT) shows vertebral fractures of the 6th and 7th cervical vertebrae and ossification of the posterior longitudinal ligament at the level of the 4th–7th cervical vertebrae. (b and c) The axial section of cervical CT at the level of the 6th cervical vertebra shows a fracture of the left transverse process and a slightly high-density area within the left transverse foramen. (d) Cervical spine T2-weighted magnetic resonance imaging shows no signs of compression of the spinal cord and a hyperintense area at the level of the 4th/5th cervical vertebrae. (e) Diffusion-weighted imaging at the time of loss of consciousness shows a slightly high-intensity area in the left cerebellum (posterior circulation acute stroke prognosis early CT score 9 points). (f) Magnetic resonance angiography at the time of loss of consciousness shows occlusion of the left vertebral and basilar arteries.

mixture of neutrophils and red blood cells mixed within the thrombus [Figure 3b-d].

Postoperative course

No improvement in neurological symptoms was observed after the surgery. Diffusion-weighted imaging performed 13 h after the onset of altered consciousness showed infarction in the midbrain, pons, both occipital lobes, both cerebellar hemispheres, and the left thalamus [Figure 4a]. Patency of the right vertebral and basilar arteries and occlusion of the left vertebral artery were confirmed by MRA [Figure 4b]. Given the extent of the brain infarction, a poor neurological and life prognosis was anticipated. The patient died two days after surgery due to hypotension and cardiac arrest.

DISCUSSION

In this case, vertebral artery injury was suspected due to a transverse foramen fracture of the 6th cervical vertebra following blunt force trauma. However, because cervical spine repair and fixation were not required, the vertebral artery was not evaluated at the initial visit. During follow-up, a basilar artery occlusion occurred relatively early (6 h after the trauma), and mechanical thrombectomy and embolization of the injured vertebral artery at the source of the embolism failed to save the patient's life. To the best of our knowledge, this is the first report of a case in which thrombus retrieval from the unaffected vertebral artery and embolization of the distal vertebral artery were performed simultaneously for basilar artery occlusion

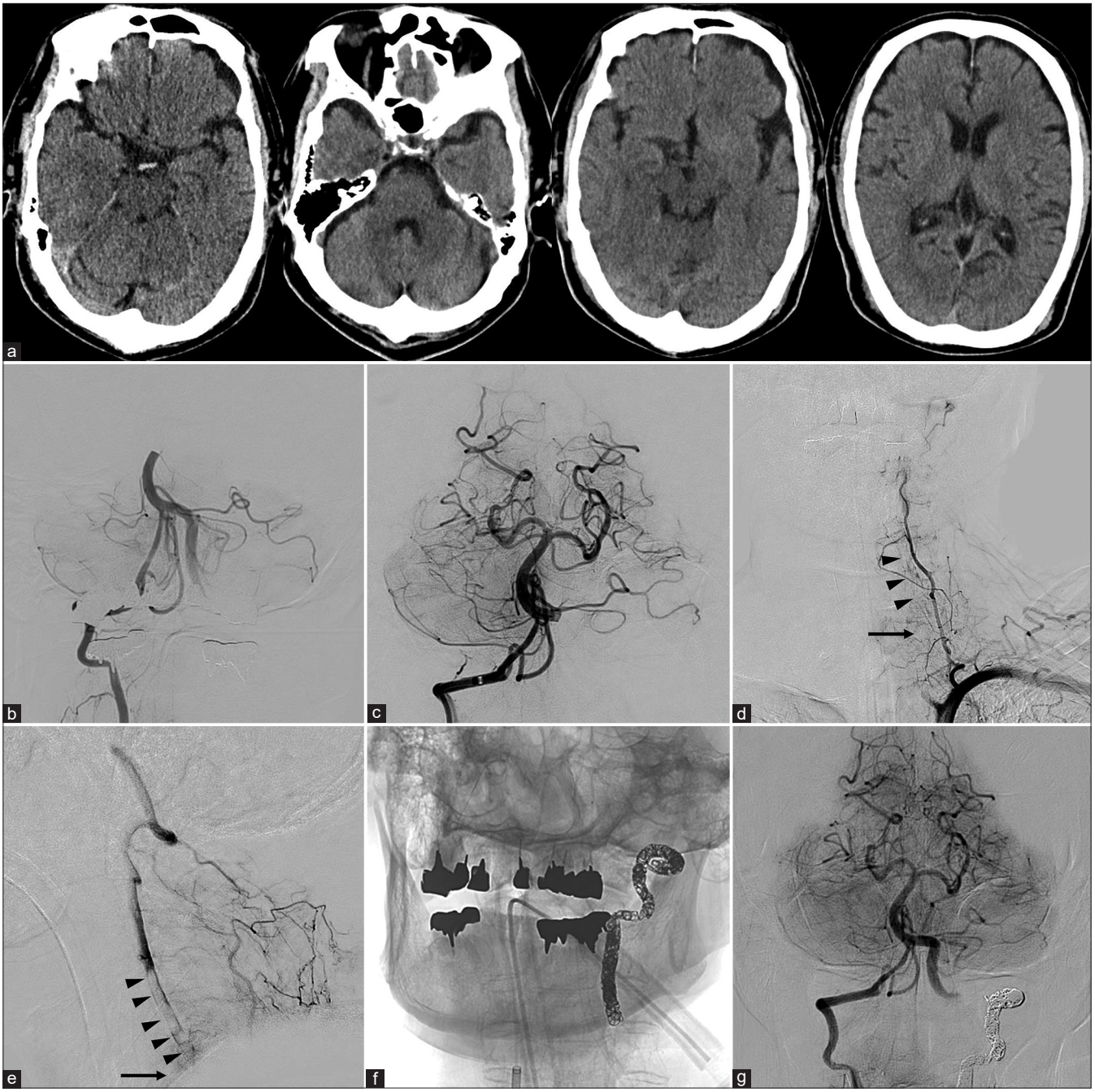

Figure 2: Preoperative and intraoperative images at our hospital: (a) preoperative head computed tomography (CT) shows a hyperdense sign at the tip of the basilar artery and hypodense areas in the left cerebellum and midbrain (posterior circulation acute stroke prognosis early CT score 7 points). (b) Before thrombectomy, right vertebral artery angiography shows occlusion at the tip of the basilar artery. (c) After thrombectomy, right vertebral artery angiography shows complete recanalization of the tip of the basilar artery. (d and e) Left subclavian artery angiography shows occlusion at the origin of the left vertebral artery. Collateral blood flow from the left deep cervical artery to the left vertebral artery is observed, with anterograde flow beyond the level of the 6th cervical vertebra (arrow). Thrombi (arrowheads) are seen within the left vertebral artery at the level of the 4th–6th cervical vertebrae. (f) Coil embolization was performed in the distal part of the left vertebral artery from the level of the 3rd/4th cervical vertebra to the V3 segment. (g) After coil embolization, right vertebral artery angiography shows retrograde blood flow of the left posterior inferior cerebellar artery through the left vertebral artery.

caused by vertebral artery injury after blunt cervical spine trauma.

In this case, the transverse process fracture of the left 6th cervical vertebra and the high-density area in the

foramen transversarium on cervical spine CT suggested that the left vertebral artery had been occluded at the level of the 6th cervical vertebra before the basilar artery occlusion occurred. Because left subclavian angiography did not show the left vertebral artery distal to the origin, the left vertebral artery was considered to be occluded at the level of the 6th cervical vertebra. There was a thrombus in the vertebral artery distal to the occluded area, and the left vertebral artery had antegrade blood flow distal to the level of the 6th cervical vertebra due to abundant collateral blood flow. Therefore, we speculated that the thrombus formation associated with the occlusion and the presence of collateral blood flow led to the basilar artery occlusion, although the vertebral artery was occluded at the site of the transverse process fracture.

To prevent embolism in traumatic vertebral artery occlusion, embolization of the proximal vertebral artery is usually the treatment of choice.[9] However, a case has been reported in which a thrombus in the distal vertebral artery caused basilar artery occlusion due to collateral blood flow after proximal embolization of the vertebral artery.[19] This suggests that proximal embolization is not sufficient to prevent embolism in patients with a thrombus and collateral blood flow on the distal side of occlusion. In the present case, the left vertebral artery was completely occluded at the site of injury, but a thrombus and collateral blood flow were present in the distal vertebral artery distal to the occlusion, suggesting that embolization of the distal vertebral artery is necessary to prevent embolism.

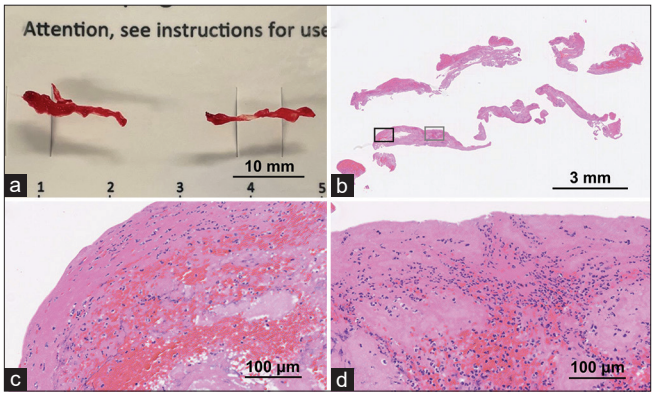

Figure 3: Photograph and histopathological findings with hematoxylin-eosin staining of the retrieved thrombi: (a) the photograph shows a predominantly red thrombus with interspersed white thrombus. (b-d) b shows the entire thrombus under hematoxylin-eosin staining. c is a magnified view of the black rectangle in b, while d is a magnified view of the gray rectangle in b. The thrombus surface is dominated by platelets and fibrin, with neutrophils interspersed. Red blood cells are mixed in the thrombus.

In thrombectomy for basilar artery occlusion with vertebral artery lesions, there are reports of approaches from both the affected vertebral artery and the opposite unaffected vertebral artery.[4,14,15] If the vessel diameter from the unaffected side is feasible, it is believed that approaching the unaffected vertebral artery may result in earlier recanalization. However, if the unaffected vertebral artery is underdeveloped or narrow, an approach from the affected vertebral artery is required. Risks associated with this approach include distal embolization of the thrombi formed at the lesion and potential misdirection of the wire and catheter into the dissection space.[15] Moreover, in vertebral artery injuries due to neck trauma, the vertebral artery may be occluded or narrowed due to mechanical compression by the cervical vertebrae, so an approach from the affected side is not always possible. In this case, both vertebral arteries were similar in diameter, so the unaffected vertebral artery was chosen for the earliest possible recanalization of the basilar artery.

Among cervical spine injuries, dislocations with intervertebral joint injury, transverse foramen fractures, and fractures of the 1st–3rd cervical vertebrae have been reported to carry a high risk of vertebral artery injury.[2,5] In this case, there was a transverse foramen fracture, and there were changes in the high-density area within the foramen, so it was considered highly probable that there was vertebral artery injury. Therefore, the vertebral artery injury should have been confirmed by computed tomography angiography (CTA)

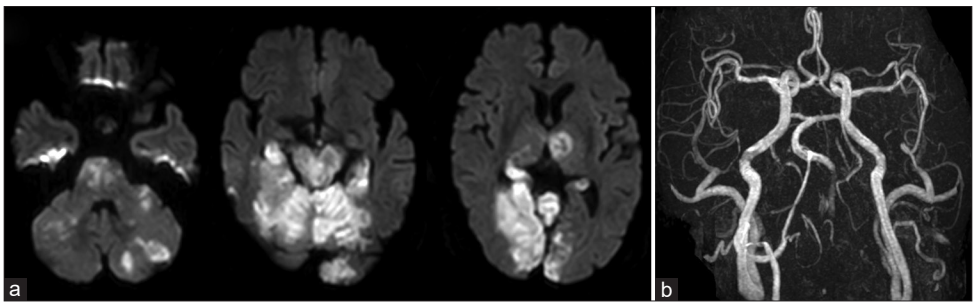

Figure 4: Magnetic resonance imaging findings 13 h after the onset of altered consciousness disturbance: (a) diffusion-weighted imaging shows hyperintense areas in the midbrain, pons, bilateral cerebellum, bilateral occipital lobes, and left thalamus. (b) Magnetic resonance angiography shows patency of the right vertebral and basilar arteries and occlusion of the left vertebral artery.

or MRA. However, because there were no neurological symptoms and no need for cervical spine repair and fixation, observational management would have been chosen even if there had been a vertebral artery injury. It has been reported that angiography should be performed for definitive diagnosis, as there are many false-positive cases with CTA.[8] Furthermore, even when CTA diagnoses vertebral artery occlusion, it is considered difficult to visualize thrombi and collateral blood flow distal to the occlusion, and it may not lead to the selection of cases at risk of distal embolism.

In recent years, randomized controlled trials have reported that thrombectomy for basilar artery occlusion yields better outcomes than medical treatment alone.[10,17] Therefore, it is believed that the opportunities to perform thrombectomy for basilar artery occlusion will increase in the future. In this case, the patient developed altered consciousness six hours after the trauma and had a relatively early onset of basilar artery occlusion. In cases of vertebral artery injury, it is crucial to carefully monitor symptom changes from the acute phase and be prepared to perform thrombectomy immediately after the onset of altered consciousness. In this case, the patient was transferred to our hospital from a relatively distant hospital because the medical staff there was unable to perform a thrombectomy. Furthermore, the need for airway management under general anesthesia resulted in a significant delay from the onset of altered consciousness to recanalization, leading to a poor outcome. Therefore, even in asymptomatic cases of vertebral artery injury, hospitalization in a facility capable of performing thrombectomy may lead to earlier recanalization.

CONCLUSION

In cases of vertebral artery injury, there is a possibility of early onset of basilar artery occlusion, necessitating preparation for early recanalization. Even in traumatic vertebral artery occlusion, there is a possibility of embolism due to a thrombus and collateral blood flow on the distal side of the occlusion. Thrombectomy from the unaffected side of the vertebral artery for basilar artery occlusion associated with vertebral artery injury may reduce the time to recanalization. It is believed that distal vertebral artery embolization is necessary to prevent embolism associated with traumatic vertebral artery occlusion in which a thrombus and collateral blood flow exist on the occluded distal side.

Ethical approval

The Institutional Review Board approval is not required.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI.

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