Online April 15, 2021
Journal of Neuroendovascular Therapy 2022; 16: 33–38
DOI: 10.5797/jnet.cr.2020-0208

Case Report

Acute Endovascular Therapy for Iatrogenic Vertebral Artery Injury: A Case Report

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Objective: Accidental puncture of the vertebral artery (VA) by central venous catheters and other devices has been reported as a rare complication. We performed endovascular therapy in the acute phase in a patient in whom a large-caliber sheath was misinserted into the VA.

Case Presentation: A 68-year-old woman scheduled for open heart surgery had an 8-Fr. sheath inserted through the right internal jugular vein (IJV). This sheath penetrated the IJV and was misplaced in the V1 segment of the right VA. Endovascular therapy was performed. First, a 9-Fr. balloon-guiding catheter (BGC) was inserted and a 0.035-inch guidewire was pulled through it and the 8-Fr. sheath misinserted into the right VA. A 6-Fr. guiding catheter was inserted into the left VA and the microcatheter reached distal of where the sheath was inserted via the basilarunion. Then, the same area was embolized with coils to block retrograde blood flow. The BGC was then guided to the right VA origin using a pull-through wire while the 8-Fr. sheath was carefully withdrawn. The sheath was pulled back until just before exiting the VA and additional coils were placed via a microcatheter inserted into the BGC to occlude the right VA. Postoperatively, the patient had no neurological findings.

Conclusion: We reported a rare case of iatrogenic VA injury. Attention to hemorrhage and intracranial blood flow resulted in a favorable outcome.

Keywords ▶ vertebral artery injury, endovascular therapy, iatrogenic

Introduction

Case reports on mispuncture of the vertebral artery (VA) related to internal jugular vein (IJV) puncture are rare, and most cases were reported as vertebral arteriovenous fistulae or pseudoaneurysms detected in the chronic phase after mispuncture.[1–3] The number of case reports in which acute-phase mispuncture required treatment is limited and there are no treatment guidelines.[4,5] We report a patient in whom an 8-Fr. sheath was misinserted into the right VA through the right IJV immediately before open heart surgery and endovascular therapy was performed immediately after mispuncture, leading to a favorable outcome.

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Received: December 7, 2020; Accepted: March 8, 2021
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Case Presentation

Patient: A 68-year-old woman.
Medical history: Not contributory.
Present illness: Open heart surgery for a left atrial tumor was scheduled and she was admitted. After general anesthesia was induced in the operating room, an 8-Fr. sheath (Radifocus Introducer II H, Terumo, Tokyo, Japan) was inserted into the right IJV to insert a Swan-Gantz catheter (Edwards Lifesciences, Irvine, CA, USA). The Swan-Gantz catheter, which was inserted through the sheath, was unable to be guided into the atrium, suggesting puncture of a blood vessel other than the target IJV. Blood gas analysis of the blood taken from the sheath showed that the blood was arterial blood, leading to the diagnosis of an accidental puncture of the artery. Mispuncture

Fig. 1 Manual angiography through a misinserted 8-Fr. sheath. Black arrow: The sheath was flexed, suggesting the site of misinsertion at the V1 segment of the VA. VA: vertebral artery

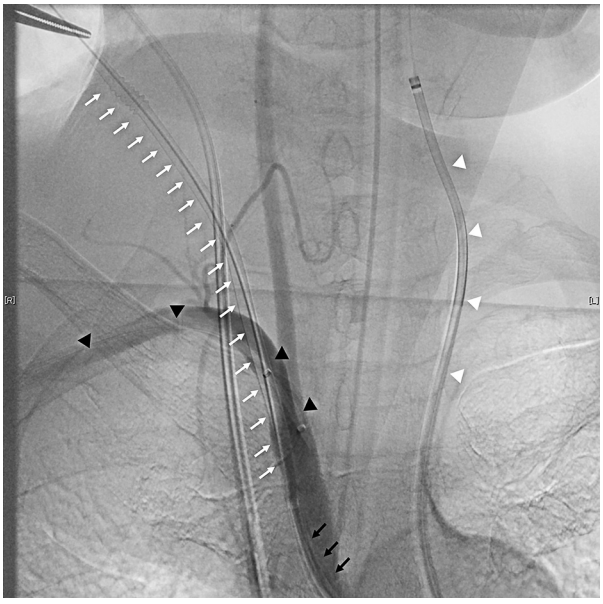

Fig. 2 Endovascular treatment. White arrows: An 8-Fr. sheath misinserted into the right VA. Its tip reached the origin of the right subclavian artery. White arrowheads: A 6-Fr. FUBUKI inserted into the left VA. Black arrows: A 9-Fr. Optimo EPD guided into the brachiocephalic artery. Black arrowhead: A 5-Fr. balloon catheter retrogradely inserted into the right subclavian artery through the right brachial artery. A 0.035-inch guidewire functioned as a "pull-through" wire between the 8-Fr. sheath and 9-Fr. Optimo. VA: vertebral artery

of the VA was suspected and the cardiac surgeon consulted our department for treatment.

Imaging findings: No ischemic intracranial lesion was found on preoperative MRI. Based on MRA findings, the left VA was estimated to be predominant.

Endovascular therapy

Under continued general anesthesia, the patient was transferred to a hybrid surgery room and angiography was performed through right femoral artery puncture. The 8-Fr. sheath had been inserted to the V1 segment of the right VA and its tip reached the origin of the subclavian artery (**Fig. 1**). Brachiocephalic arteriography revealed sheath-related occlusion of the right VA, and there was no distal blood flow. On left vertebral arteriography, posterior circulation involving the right posterior inferior cerebellar artery (PICA) was visualized. However, the left posterior cerebral artery was not visualized due to the fetal-type left posterior communicating artery. Based on these findings, right VA occlusion was considered possible and endovascular therapy was started. Sheath-related occlusion of the VA suggested the presence of a fistula with a similar diameter of the VA. Considering the possibility of fatal hemorrhage after sheath removal, we aimed at accurate hemostasis upon sheath removal and the prevention of distal embolism. Repair by direct surgery was considered impossible by a cardiovascular surgeon.

A 9-Fr. Optimo EPD (Tokai Medical Products, Aichi, Japan) was inserted to the origin of the right subclavian artery through the right femoral artery puncture. A 6-Fr. FUBUKI (ASAHI INTECC, Aichi, Japan) was inserted into the V2 segment of the left VA through the left femoral artery puncture. Furthermore, a 5-Fr. Selecon MP Catheter II (Terumo) was inserted into the distal right subclavian artery through right brachial artery puncture, considering the possibility of insufficient blockage of collateral pathway blood flow (**Fig. 2**). A Radifocus Guidewire M 0.035 inch 300 cm (Terumo) was guided into the brachiocephalic artery through the Optimo EPD, and passed out of the patient's body via the 8-Fr. sheath using a snare catheter inserted through the 8-Fr. sheath to prepare a "pull-through" state. Using this wire, the Optimo EPD tip was docked with the 8-Fr. sheath tip (**Fig. 3**). Initially, embolization from the distal side of the site of right VA injury was selected. A Headway Duo microcatheter (Terumo) was guided into the right VA beyond the BA union using a CHIKAI 0.014 (ASAHI INTECC) through the FUBUKI inserted into the left VA such that it reached the distal area of the sheath. The CHIKAI was unable to be guided to a proximal area beyond the sheath. Furthermore, microcatheter angiography was carefully performed through the Headway Duo and it was confirmed that the Headway Duo reached an area just distal to the site of sheath insertion (**Fig. 4A**). Through this microcatheter, embolization was

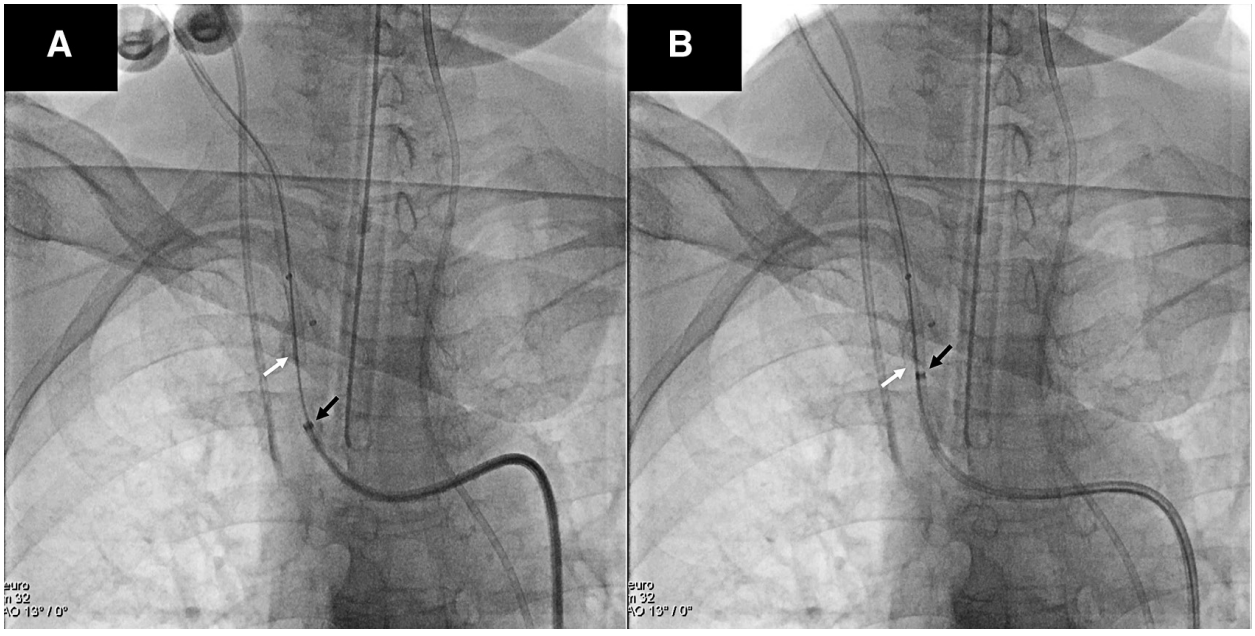

Fig. 3 (**A**) A 0.035-inch guidewire was used as a pull-through wire between the 8-Fr. sheath and 9-Fr. Optimo. (**B**) The Optimo EPD was guided along the wire and its tip was docked with the 8-Fr. sheath tip. White arrows: 8-Fr. sheath tip. Black arrows: 9-Fr. Optimo EPD tip.

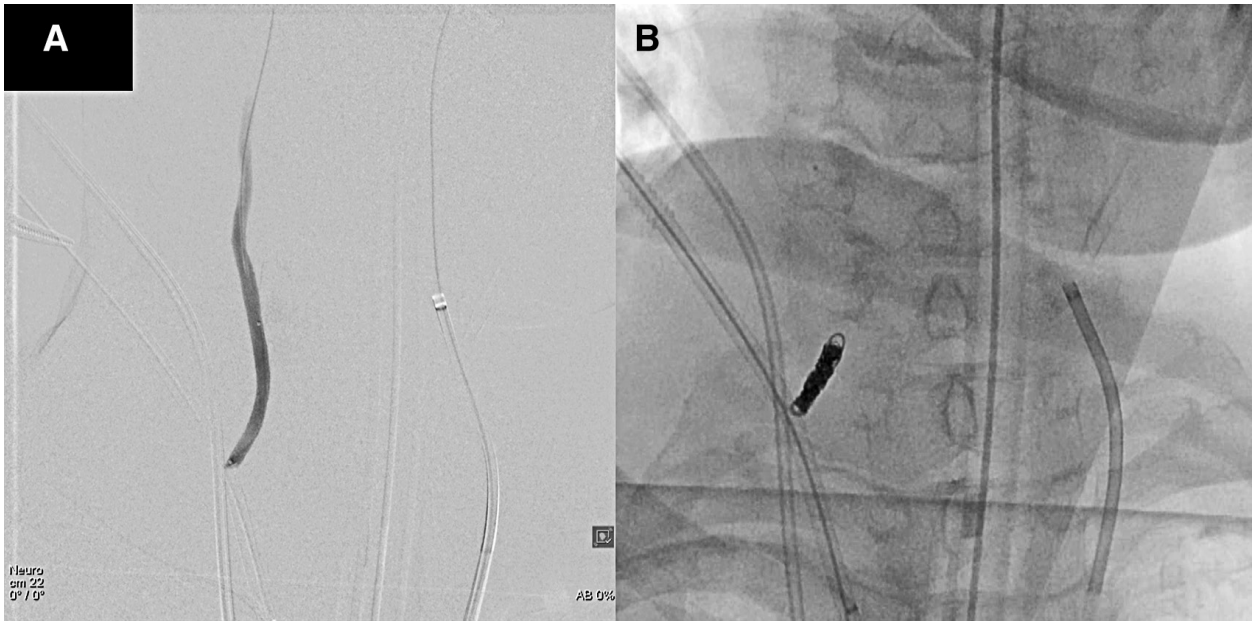

Fig. 4 (**A**) Microcatheter angiography through a Headway DUO. Sheath-related occlusion of the right VA was observed. A Headway DUO was guided to an area just distal to the sheath. (**B**) Embolization with five coils was performed through the Headway DUO to block retrograde blood flow. VA: vertebral artery

performed using five coils for retrograde blockage of blood flow to the site of injury (**Fig. 4B**). As the proximal area was occluded with the sheath, we were unable to confirm reliable distal embolization. Therefore, the Headway Duo was placed at an area adjacent to the distal coil mass until the completion of proximal embolization considering the necessity of additional embolization. Subsequently, the sheath was carefully pulled out under Optimo EPD and 8-Fr. sheath tip docking. When the sheath tip was placed in the VA, the Optimo EPD balloon was inflated to block the subclavian artery at the origin of the right VA for proximal flow control. In this state, the 8-Fr. sheath was further pulled out and placed immediately before the site of vascular injury. An Excelsior SL-10 (Stryker,

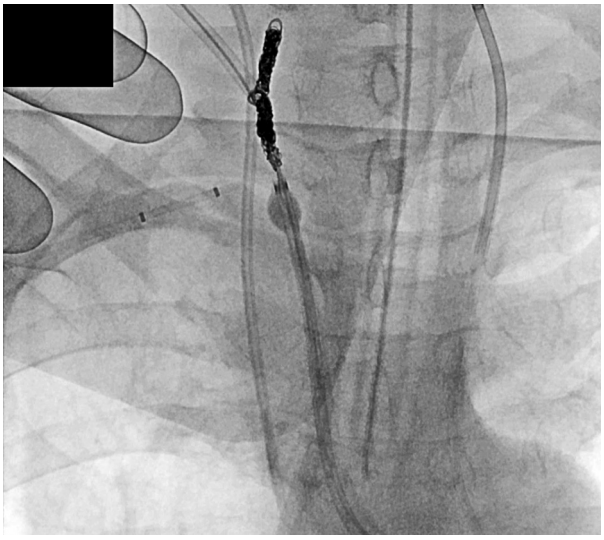

Fig. 5 An Optimo was inserted to the VA origin of the right subclavian artery and coil embolization of the VA was performed under proximal flow control. VA: vertebral artery

Fig. 6 Postoperative right subclavian arteriography. The VA was completely embolized and there was no extravasation. VA: vertebral artery

Kalamazoo, MI, USA) was inserted into the VA through the Optimo. As Excelsior SL-10 reached the distal coil mass, embolization with nine coils was conducted to block proximal blood flow (**Fig. 5**). During surgery, right subclavian arteriography was performed through the 5-Fr. balloon catheter at appropriate times, but there was no visualization of the right VA related to a right subclavian artery branch-mediated collateral pathway. Favorable flow control was achieved using the Optimo alone. Therefore, blockage with the balloon catheter inserted into the right subclavian artery was not adopted. Angiography through the Optimo pulled back into the subclavian artery confirmed the absence of extravasation (**Fig. 6**). Furthermore, left vertebral arteriography confirmed the visualization of posterior circulation involving the right PICA, and the procedure was completed. The Excelsior SL-10 microcatheter was placed in the right VA until the completion of all procedures considering the necessity of additional embolization.

Postoperative course

After surgery, the patient was admitted to the intensive care unit under general anesthesia. After confirming the absence of cervical hematoma the day after surgery, the patient was awoken from anesthesia. There was no new neurological finding. Aspirin medication was continued for 1 month, and after it was completed, cardiac surgery was performed again. During the 9-month follow-up after embolization, there was no recurrence or ischemic complication.

Discussion

Arterial mispuncture on central venous catheter insertion is a representative complication. In most cases of mispuncture on IJV puncture, the internal and common carotid arteries are mispunctured. The number of reports on VA mispuncture is limited, but 45 patients with symptomatic VA injury after central venous catheter insertion through the IJV have been reported according to a review published by Inamasu et al.[2] Of these, only two cases developed symptoms, such as brainstem infarction related to VA dissection, immediately after insertion,[6,7] whereas VA injury was detected based on delayed symptoms in most patients. Arteriovenous fistulae or pseudoaneurysms accounted for a high percentage. Many patients with arteriovenous fistulae noted pulsatile tinnitus. In those with pseudoaneurysms, VA injury was detected through the development of a cervical mass or airway compression related to a rapid increase in the aneurysm size. The number of patients in whom mispuncture of the VA with a catheter became clear in the acute phase, leading to treatment, is small.[4,5] Al Rayes et al. reported that stent-grafting for mispuncture of the right VA with a central venous catheter led to a favorable outcome, but there was no description of the postoperative course.[5] Tasopoulou et al. presented a patient with a large subcutaneous hematoma related to mispuncture of the right VA on dialytic catheter insertion and reported that treatment with a covered stent resulted in angiographic cure. However, this

patient died of primary disease after a few days.[4] Few studies have reported acute-phase treatment for VA mispuncture; there are no satisfactory treatment guidelines.

Regarding arterial mispuncture, according to the guidelines,[8] pressure hemostasis can be safely performed even when a 7-Fr. or thinner catheter is misinserted into an artery. On the other hand, when a >7-Fr. catheter is misinserted, the incidences of insufficient pressure hemostasis and complications are high[9]; endovascular therapy or repair by direct surgery should be selected without removal or hemostatic devices should be used. Furthermore, most of these studies were based on mispuncture of arteries such as the internal carotid artery. In the case of mispuncture of the VA, which is located in a deeper area, pressure hemostasis is difficult. A previous study reported VA dissection, cerebral infarction, and a pseudoaneurysm after removing a central venous catheter misinserted into the VA in the absence of strategies.[10]

In the present case, an 8-Fr. (large-diameter) sheath was misinserted into the V1 segment of the VA, of which mispuncture with a central venous catheter has been reported in a few studies. Sheath-related occlusion of the VA occurred, and prompt, accurate treatment was required considering the possibility of thrombus formation around the sheath, removal-related distal embolism, and fatal hemorrhage. As the point of our treatment, coil embolization on the distal side of the sheath was initially performed to prevent distal embolism. Furthermore, the sheath and Optimo tips, as a unit, were pulled into the VA using a pull-through wire. This facilitated smooth Optimo guiding into the VA and treatment under proximal blood flow blockage. As there is a collateral pathway between the subclavian artery branch and VA, in cases in which it is necessary to block these arteries, a balloon catheter can also be inserted into the subclavian artery. Thus, strategic embolization in consideration of distal embolism and hemorrhagic complications may have led to a favorable outcome.

Treatment options for misinsertion of a catheter into the proximal VA, as demonstrated in the present case, can be primarily classified into repair by direct surgery and endovascular therapy.

Many studies on repair by direct surgery reported treatment for traumatic VA injury.[11] Only a few studies adopted this procedure for mispuncture of the VA with a catheter.[12–17] In particular, in most of these studies, a cervical mass related to pseudoaneurysm formation was detected a few days after puncture and the pseudoaneurysm was resected; this is not a treatment option for a misinserted catheter. Concerning acute-phase repair for mispuncture with a central venous catheter, a previous study reported suture at the site of injury under proximal blockage with a balloon catheter.[18] In the present case, the vascular surgeon considered direct surgery impossible due to the large sheath diameter.

For endovascular therapy, a procedure with a covered stent or stent-graft can also be considered as an option in addition to VA embolization with a detachable coil. A patient in whom a sheath was misinserted into the VA under general anesthesia, as demonstrated in the present case, was previously reported and stent-grafting led to a favorable outcome.[19] In particular, this procedure is useful when it is necessary to maintain anterograde blood flow such as when hypoplasia of the contralateral VA is present. However, neither the safety of inserting a stent-graft into the VA with a relatively small diameter and completeness of hemostasis nor long-term results have been sufficiently examined. Parent artery (VA) embolization, which we selected, is frequently performed in patients with ruptured intracranial VA dissection. This procedure may be safe and accurate.

Conclusion

We reported a patient in whom parent artery embolization for VA injury related to large-diameter sheath misinsertion led to a favorable outcome. It may be important to establish a satisfactory treatment plan considering the prevention of distal embolism and accurate hemostasis.

Disclosure Statement

The authors declare no conflict of interest.

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