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Viabahn Stent Graft for Inadvertent Insertion of a Central Venous Catheter in the Subclavian Artery

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Abstract

Subclavian artery (SCA) injuries associated with central venous catheter (CVC) insertion are uncommon yet lethal complications that typically require surgical treatment. This case report presents the case of a 94-year-old man with an iatrogenic right SCA injury resulting from a misplaced CVC. Computed tomography revealed the catheter piercing the right internal jugular vein to enter the right SCA and then reaching the aortic arch. Emergent endovascular treatment was performed, and a 13-mm × 50-mm self-expanding Viabahn stent graft (W.L. Gore & Associates, Flagstaff, AZ, USA) was placed via the right brachial artery. The misplaced catheter was successfully removed under simultaneous postdeployment balloon dilatation. This case highlights the utility of the Viabahn stent graft for iatrogenic right SCA injury caused by a misplaced CVC and presents some insights and tips for a safer procedure.

Keywords

Central Venous Catheter Insertion, Iatrogenic Subclavian Artery Injury, Viabahn Stent Graft, Endovascular Treatment, Surgical Techniques

1. Introduction

The number of erroneous placements of a central venous catheter (CVC) has been reduced owing to the prevalence of the ultrasound-guided approach versus the anatomical landmark approach for catheter insertion. An estimated 3% - 5% of all CVC insertions develop complications [1] [2]. Subclavian artery (SCA) injuries associated with CVC insertion are uncommon yet lethal complications that typically require surgical treatment, because the pierced sites may not be effectively compressed manually [3]. No well-defined guidelines exist for the treat-

ment of inadvertent SCA puncture caused by a misplaced CVC, and various types of intervention strategies have been reported, including open thoracotomy (with or without clavicular resection) or sternotomy, video-assisted thoracic surgery, and endovascular techniques [4]. This case report presents the successful removal of a CVC misplaced in the right SCA with endovascular treatment using a self-expanding Viabahn stent graft. The report also describes some insights and tips for performing the procedure more safely.

2. Case Presentation

A 94-year-old Japanese man presented to the emergency department of our hospital with the complaint of neck pain after a fall one day in August, 2019. He had a medical history of atrial fibrillation and was being treated with warfarin. He was diagnosed with cervical fracture, and underwent orthopedic surgery for posterior cervical discectomy and fusion.

On postoperative Day 1, the patient was reintubated owing to laryngeal edema resulting from prolonged operative duration while in a prone position. Because of sustained hypotension, CVC (8 French) insertion was planned from the right internal jugular vein for the administration of inotropes. The procedure was performed under ultrasound guidance, and no immediate complications were evident. However, the pressure pattern obtained from the catheter indicated an arterial waveform and blood gas findings revealed high oxygen saturation, both of which suggested misplacement of the catheter in one of the arteries. Computed tomography scan revealed the catheter piercing the right internal jugular vein, then entering the right SCA, and eventually reaching the aortic arch (**Figure 1**). Vascular surgery consultation was requested, and urgent repair of the right SCA with endovascular treatment was decided.

Under general anesthesia, the right brachial artery was accessed just above the antecubital fossa through a longitudinal incision. A 5-Fr sheath was inserted through the right brachial artery and positioned in the right SCA. After the guidewire was inserted in the right SCA, the 5-Fr sheath was exchanged for a 12-Fr DrySeal sheath (W.L. Gore & Associates, Flagstaff, AZ). A manually injected retrograde angiogram was repeated to confirm the positional relationship between the perforation site and the right vertebral artery origin (**Figure 2**). A 13 mm × 50 mm self-expanding Viabahn stent graft (W.L. Gore & Associates, Flagstaff, AZ) was placed immediately distal to the right vertebral artery under fluoroscopic guidance, covering the perforation site. Then the misplaced catheter was partially pulled back to shorten the length within the right SCA. Postdeployment angioplasty was performed using a 12-mm × 4-cm balloon while the misplaced catheter was removed simultaneously. No endoleak was revealed in the guiding angiogram, and good flow in the right vertebral artery and good distal pulses in the right radial artery were confirmed (**Figure 3**). Because the anticoagulant was continued postoperatively to treat the patient's atrial fibrillation, antiplatelet therapy was not included after consideration of his advanced age. The patient

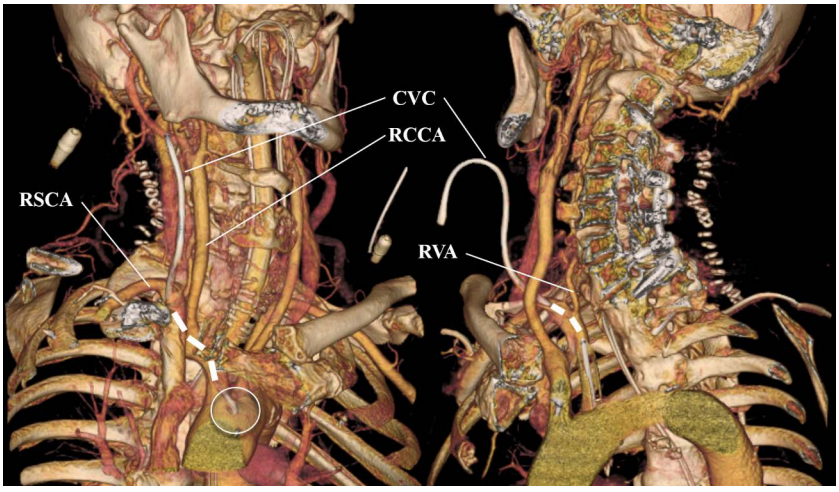

Figure 1. Three-dimensional reconstruction of preoperative computed tomography images shows the central venous catheter entering the right subclavian artery and eventually reaching the aortic arch. The white circle shows the tip of the catheter. CVC, central venous catheter; RCCA, right common carotid artery; RSCA, right subclavian artery; RVA, right vertebral artery.

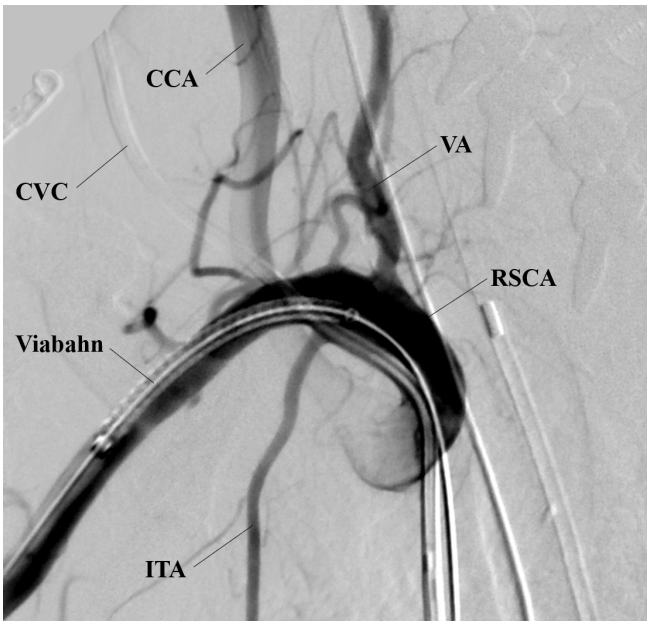

Figure 2. Manually injected retrograde angiogram performed to ensure the positional relationship between the perforation site and the right vertebral artery origin. CCA, common carotid artery; CVC, central venous catheter; ITA, internal thoracic artery; RSCA, right subclavian artery; VA, vertebral artery.

was transferred to a long-term care hospital on postoperative Day 102 after the endovascular treatment.

3. Discussion

Inadvertent puncture of the SCA is a rare complication that occurs in 0.5% - 4.0% of all patients who undergo CVC insertion [5]. No well-defined guidelines

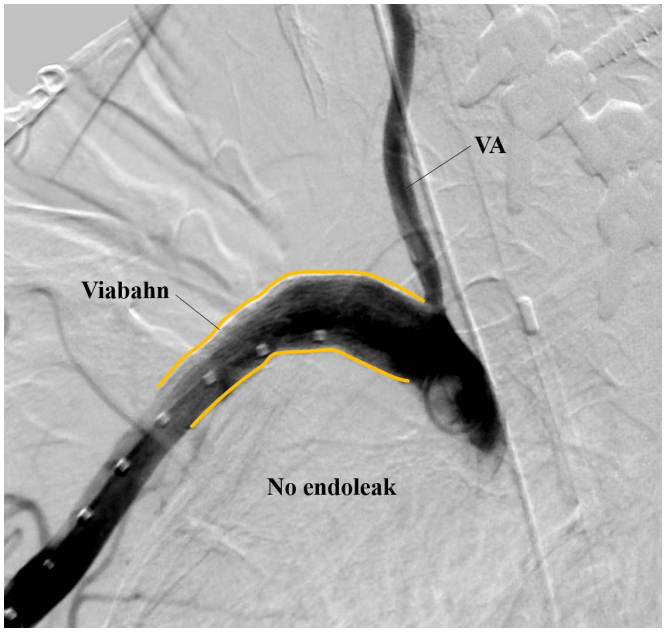

Figure 3. Guiding angiogram shows no endoleak and good flow in the right vertebral artery. The yellow lines indicate the location of Viabahn stent graft. VA, vertebral artery.

exist for the treatment of inadvertent puncture of the SCA resulting from a misplaced CVC. However, some cases of successful management with endovascular treatment, including stent graft, percutaneous closure device, and embolization, have been reported to date [3] [6] [7]. These reports predominantly focused on the clinical course and the CVC insertion techniques. To the best of our knowledge, none of the previous studies discuss the details of the surgical procedure. This report not only presents the successful removal of the misplaced CVC with endovascular treatment using a self-expanding Viabahn stent graft, but also provides important insights and tips for performing the procedure more safely.

Viabahn is the only self-expanding covered stent approved in Japan, made from a combination of a 100 μm ultra-thin wall expanded polytetrafluoroethylene (ePTFE) graft and a Nitinol™ stent frame. In addition to a high degree of extension retentive force and flexibility, long-term patency can be achieved by a heparin coating of the graft lumen and not exposing the metal surface to the lumen [8].

Once the bleeding occurs from the perforation site of the SCA—which is usually uncompressible—obtaining hemostasis is thought to be difficult [9]. Thus, performing the most reliable and safe procedure is crucial. However, literature on surgical techniques used to safely and effectively remove a misplaced CVC with endovascular treatment is scarce. Herrmann et al. reported that they first pulled back the CVC partially, and then deployed the self-expanding Viabahn stent graft for the iatrogenic injured vertebral artery while simultaneously withdrawing the misplaced CVC [5]. Among the surgical procedures described in the present report, it is necessary to emphasize the following important points: 1) to pull back the CVC partially between stent graft deployment and CVC removal,

and 2) to withdraw the misplaced CVC simultaneously with post deployment balloon dilatation. We believe that the former insight and practical tip can minimize the time gap between catheter removal and stent graft sealing, whereas the latter tip may ensure that the perforation site is occluded by the misplaced CVC for a longer time, both of which will potentially result in a lower possibility of hemorrhage.

Endovascular treatment has continued to evolve for vascular injuries of the upper extremities, providing less invasiveness and better performance, as an alternative to open surgery. A retrospective study comparing open versus endovascular management of axillosubclavian arterial injuries demonstrated that patients undergoing endovascular repair had significantly lower in-hospital mortality and surgical site infection rates compared with those undergoing open repair [10]. On the other hand, another study that retrospectively evaluated 57 patients who underwent stent graft repair for traumatic SCA injuries reported that for 25 patients with a mean follow-up time 49 months, 5 patients (20%) had angiographically significant stenosis and 3 (12%) had stent graft occlusion [11]. Access site pseudoaneurysm, endoleaks, stent-related thrombosis, and stent migration have also been noted as possible complications of Viabahn stent graft [10]. Despite the good short- and mid-term outcomes of endovascular treatment for vascular injuries of the upper extremities indicated above, further research is warranted to reveal the long-term outcomes, including the rates of reintervention and various possible complications.

Technical limitations of Viabahn stent graft include a significant lumenal size discrepancy between the proximal and distal parts of the involved artery, which potentially causes proximal endoleaks or distal over-sizing and vascular damage. However, this problem can be partly overcome by using tapered stents [11].

4. Conclusion

In the present case, a misplaced CVC in the right SCA was successfully removed with endovascular treatment using a self-expanding Viabahn stent graft. The report also provides insights and tips for performing a safer procedure. Although endovascular treatment has provided better performance and is a less-invasive alternative to open surgery for the repair of vascular injuries of the upper extremities, further research about its long-term outcomes is warranted.

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Ethical Approval

Informed consent has been obtained from the patient's family for publication of the case report and accompanying images.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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