Hong Kong J Radiol. 2020;23:134-8 | https://doi.org/10.12809/hkjr2017125

CASE REPORT

Percutaneous Repair of Inadvertent Brachiocephalic Arterial Puncture by Closure Device: A Case Report

KTF Ng, CM Chau, HF Chan, LF Cheng, KF Ma, KM Chan

Department of Radiology, Princess Margaret Hospital, Laichikok, Hong Kong

INTRODUCTION

Central venous catheter (CVC) insertion is a common bedside procedure and essential to the management of critically ill patients. However, placement of a CVC is not without risk, as a multitude of complications may present during or after the procedure.[1] Accidental arterial puncture is a common but serious complication during CVC insertion. Timely detection and prompt vascular repair may prevent potentially fatal complications including active haemorrhage or cerebrovascular thromboembolic events. We report a case of inadvertent arterial puncture during CVC placement followed by successful percutaneous repair using a suture-mediated closure device.

CASE REPORT

A 65-year-old woman was admitted in a coma to our hospital via the emergency department following a road traffic accident. She had sustained multiple injuries including a severe head injury, multiple rib fractures, and pelvic fractures. Emergency surgery was performed and the patient was transferred to the intensive care unit for further management. Insertion of a 7-Fr CVC was attempted through the subclavian vein. However, following insertion, the return flow was noted to be pulsatile, and inadvertent arterial puncture was suspected.

On computed tomography angiogram, the right brachiocephalic artery was punctured by the CVC at a retro-clavicular site, just beneath the proximal head of the right clavicle and close to the arterial bifurcation (Figure 1). It travelled retrogradely with the tip reaching the origin of the artery at the aortic arch. No hematoma or pseudoaneurysm was detected. Arterial flow was preserved in the right brachiocephalic, vertebral and subclavian arteries.

The patient was transferred to a hybrid operating theatre for fluoroscopic-guided intervention. The patient underwent general anaesthesia. The right upper anterior chest wall, right neck and bilateral groin regions were prepared aseptically.

The CVC insertion site over the right upper chest wall was dissected down and a 0.035-inch Glidewire® (Terumo, Tokyo, Japan) was inserted through the right subclavian catheter lumen. The CVC was then replaced with an 11-cm 6-Fr vascular sheath over the guidewire, securing the vascular access.

Correspondence: *Dr KTF Ng, Department of Radiology, Princess Margaret Hospital, Laichikok, Hong Kong*
Email: ntf808@ha.org.hk

Submitted: 24 May 2019; Accepted: 29 Jul 2019.

Contributors: All authors contributed to the concept and design of the study, acquisition and interpretation of the data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content. All authors had full access to the data, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of Interest: The authors have no conflicts of interest to disclose.

Funding/Support: This case report received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethics Approval: The patient was treated in accordance with the Declaration of Helsinki. The patient suffered from cognitive impairment after the traumatic event. Verbal consent was obtained from the patient's sister.

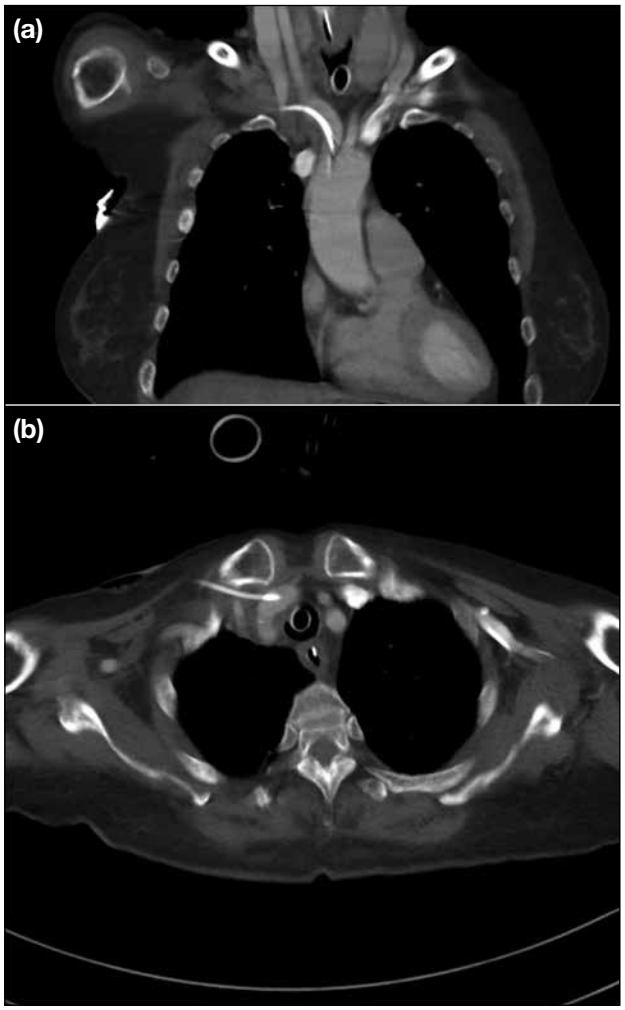

Figure 1. (a) Coronal and (b) axial computed tomography angiograms showing a central venous catheter punctured and entered the lumen of the right brachiocephalic artery at a retroclavicular site, just beneath the proximal head of the right clavicle and close to the arterial bifurcation.

Additional vascular accesses were created in both groins. A 7-Fr and a 4-Fr sheath were inserted into the right and left femoral artery, respectively. Left vertebral and right brachiocephalic arteriograms were performed for procedure planning, showing: (1) no active extravasation or pseudoaneurysm in the innominate angiogram after removal of the subclavian triple lumen catheter (Figure 2); (2) right brachiocephalic artery, right subclavian artery, right vertebral artery, and right common carotid artery were patent without filling defects or dissections, and (3) basilar artery was adequately supplied by the left vertebral artery.

A 0.035-inch Stiff Terumo Glidewire® was inserted through the right subclavian arterial access and positioned at the abdominal aorta with the help of a 4-Fr catheter.

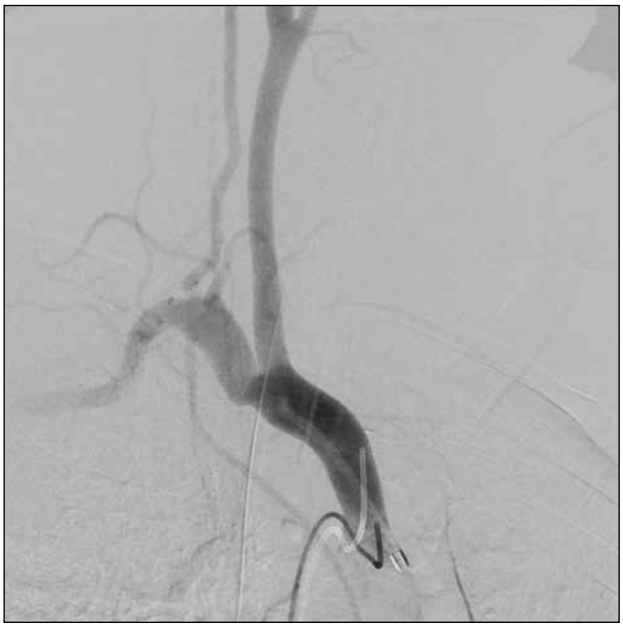

Figure 2. Right brachiocephalic arteriogram showing no active extravasation or pseudoaneurysm in the region after removing the subclavian triple lumen catheter and replaced by a 6-Fr sheath.

Another 0.035-inch Amplatz Super Stiff® guidewire (Boston Scientific, Marlborough [MA], United States) was inserted through the right femoral arterial access and rested at the proximal right brachial artery, with the help of a 4-Fr catheter, acting as a "safety wire" to maintain secondary access to the target vessel (Figure 3).

With guidewires confirmed in place, the 6-Fr sheath at the right subclavian artery was removed and a 6-Fr Perclose Proglide® (Abbott Vascular, Redwood [CA], United States) closure device was deployed over the Stiff Terumo Glidewire® (Figure 4). Subsequent right subclavian angiogram confirmed successful repair of the vessel with no extravasation, pseudoaneurysm or stricture (Figure 5).

DISCUSSION

CVC insertion is an essential procedure in the management of a critically ill patient. Accidental arterial puncture is a known complication with potentially fatal outcomes including active haemorrhage or cerebrovascular thromboembolic events. The incidences of arterial puncture are about 1% and 2.7% for CVC insertion through the jugular and subclavian veins, respectively.[2,3] CVC insertion under ultrasound guidance can reduce but not completely eliminate the risk.[4-7]

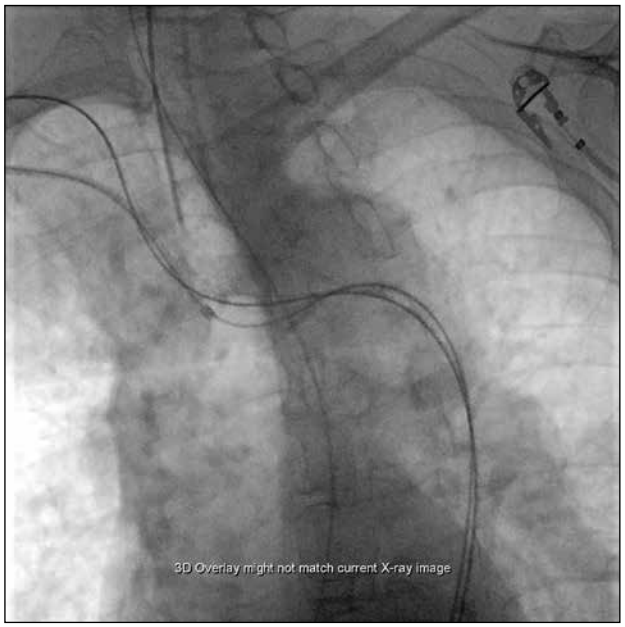

Figure 3. A 0.035-inch Stiff Terumo Glidewire® was inserted through the right subclavian arterial access and positioned at the abdominal aorta for insertion of a closure device; another 0.035-inch Amplatz Super Stiff® guidewire was inserted through the right femoral arterial access and rested at the proximal right brachial artery, acting as a "safety wire" to maintain secondary access to the target vessel.

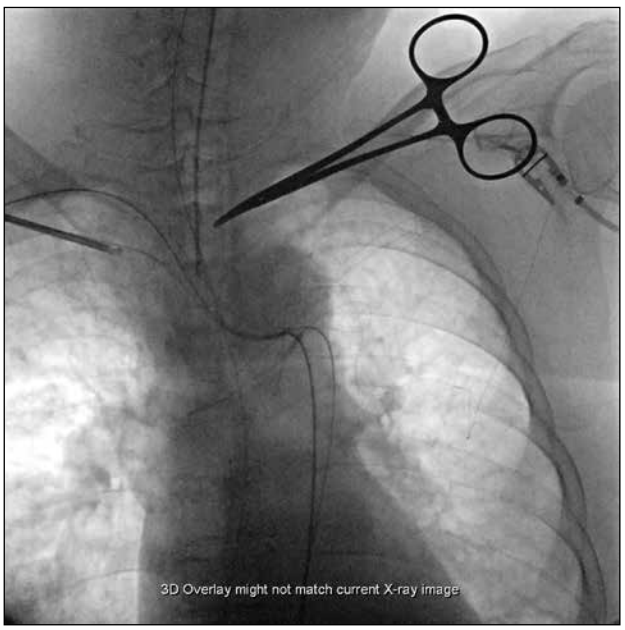

Figure 4. A 6-Fr Perclose Proglide® closure device deployed over the Stiff Terumo Glidewire®, ready for vascular repair.

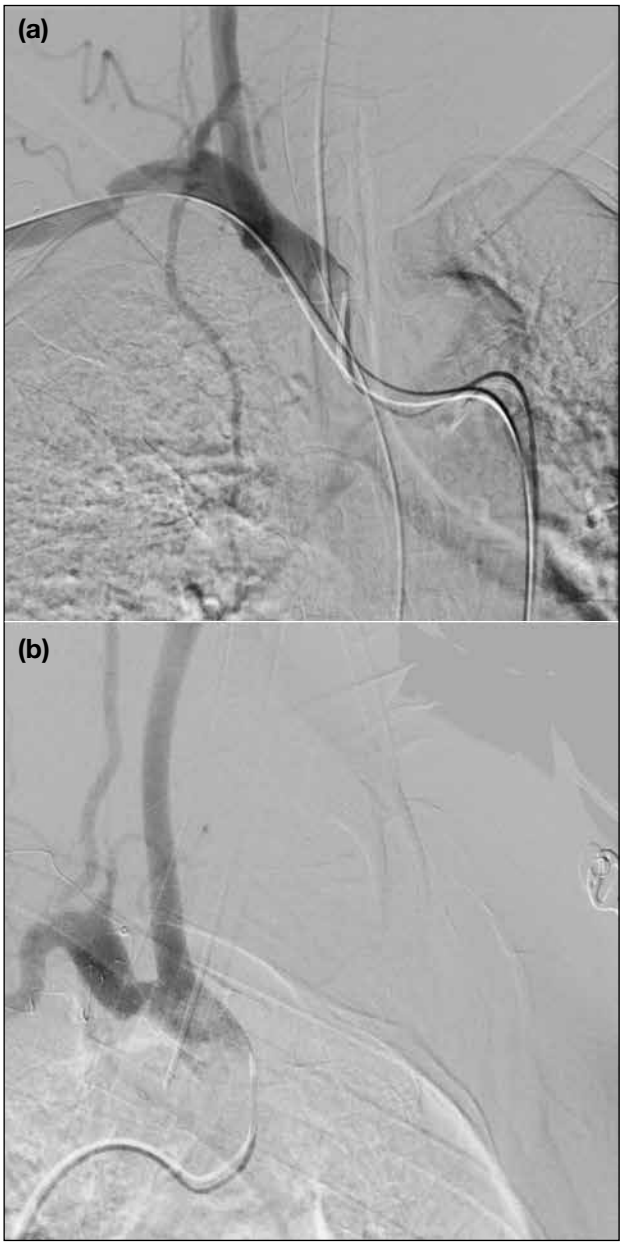

Figure 5. (a) Anterior and (b) oblique angiograms after surgery confirmed successful repair of the vessel with no extravasation, pseudoaneurysm or stricture evident.

Where puncture occurs, treatment options include open surgical repair, placement of a stent-graft across the puncture site, or repair of the arterial puncture with a percutaneous closure device. Additional application of intra-arterial balloon for temporary tamponade is optional. Open surgical repair may pose greater risk in a critically ill patient with poor premorbid state. Placement of a stent-graft is a promising treatment with good success rate as high as 94% to 100%.[8] Use of a percutaneous closure device is another convenient and readily available option.

These treatment options were evaluated for treatment planning in our case. Considering the relatively deep and central puncture site at a retroclavicular site at the brachiocephalic artery, direct compression was not possible. A deep and extensive incision might be needed to expose the puncture site for surgical repair, with the risk of partial clavicular resection or need for conversion to thoracotomy for adequate exposure. Such major surgery may have posed high surgical risk and was deemed unsuitable for a fragile patient with multiple injuries. We therefore adopt a percutaneous approach for catheter removal with vascular repair performed using a suture-mediated closure device. The procedure was arranged in a hybrid operating theatre equipped with digital subtraction angiography, where conversion to open surgery was feasible if necessary.

One advantage of a suture-mediated closure device is that it involves only suture lines with minimal intraluminal material, so reducing any risk of dislodgement or distal vascular thromboembolic event. Secondly, in case of initial suture failure to anchor or achieve only partial haemostasis, additional sutures can be deployed along the guidewire that remains in place throughout the procedure. Use of a percutaneous closure device has been approved in the closure of femoral arterial puncture, and has been proven to be a safe and reliable method with additional benefits of earlier haemostasis and patient mobilisation.[9] As the femoral artery locates more superficially than the brachiocephalic artery, we slightly dissected and dilated the CVC insertion tract to advance the relatively soft and flexible insertion tip of the closure device, which was designed for a more superficial structure, into the deep puncture site. Use of a percutaneous closure device for subclavian arterial puncture repair is yet to be approved and still considered off-label use. However, some successful cases of subclavian artery puncture repair of various diameters solely with percutaneous closure devices or in conjunction with a balloon catheter have been reported.[10-13]

In view of the centrally located puncture, any failed haemostasis could lead to rapid, massive and fatal haemomediastinum, compromising the cardiovascular system. Therefore we retained a "safety wire" across the puncture site, running from the site of femoral assess to the proximal right brachial artery, throughout the procedure until haemostasis was confirmed on final angiogram. In case of failed haemostasis by the closure device, a balloon catheter could be rapidly deployed along the "safety wire" for immediate haemostasis and a covered stent could also be deployed.

The option of stent-graft repair may be considered if the punctured artery needs to be preserved. However, in our case, the puncture site was so close to the origin of the right subclavian and common carotid arteries in order to preserve blood flow to both major arteries, two stents had to be placed in a kissing fashion with each stent landed in each of the major arteries. Secondly, since the right vertebral artery arose at the proximal right subclavian artery, the arterial supply to the former would likely be compromised if the stent-graft were in place. These technical factors increased procedure complexity and in turn increased the risk of neurovascular complications. In addition, the need for antiplatelet therapy following stent-graft placement was a clinical dilemma. Without antiplatelet therapy, the stent-graft could be easily thrombosed, resulting in cerebral infarct or upper limb ischaemia; yet antiplatelet therapy could increase the intracranial bleeding risk in our patient with recent head trauma. Under these circumstances, stent-graft repair was considered less favourable than use of a closure device repair. However, the option of stent-graft repair remained in case of closure device failure. As deployment of a stent graft at the right subclavian artery might impair right vertebral artery perfusion, a complete cerebral angiogram was performed before the vascular repair to assess the patency of bilateral carotid and vertebral arteries, as well as to look for potential collateral supplies.

We successfully repaired the 7-Fr subclavian arterial puncture with application of one suture across the site using a suture-mediated percutaneous closure device. Temporary control of blood flow with tamponade effect by a balloon catheter is a useful adjunct during repair with a closure device.

CONCLUSION

We report successful repair of an inadvertent subclavian artery puncture by a 7-Fr CVC using a percutaneous closure device. With increased experience and success rates of using percutaneous closure devices, this technique may become a promising treatment for subclavian arterial puncture. We await further clinical data.

REFERENCES

1. Kornbau C, Lee KC, Hughes GD, Firstenberg M. Central line complications. Int J Crit Illn Inj Sci. 2015;5:170-8.
2. Iovino F, Pittiruti M, Buononato M, Lo Schiavo F. Central venous

catheterization: Complications of different placements [in French]. Ann Chir. 2001;126:1001-6.
3. Szkup PL. A minimally invasive technique for closing an iatrogenic subclavian artery cannulation using the Angio-Seal closure device: Two case reports. J Med Case Rep. 2012;6:82.
4. Randolph AG, Cook DJ, Gonzales CA, Pribble CG. Ultrasound guidance for placement of central venous catheters: A meta-analysis of the literature. Crit Care Med. 1996;24:2053-8.
5. Hind D, Calvert N, McWilliams R, Davidson A, Paisley S, Beverley C, et al. Ultrasonic locating devices for central venous cannulation: meta-analysis. BMJ. 2003;327:361.
6. Parsons AJ, Alfa J. Carotid dissection. A complication of internal jugular vein cannulation with the use of ultrasound. Anesth Analg. 2009;109:135-6.
7. Thompson C, Barrows T. Carotid arterial cannulation. Removing the risk with ultrasound? Can J Anaesth. 2009;56:471-2.
8. Schoder M, Cejna M, Hölzenbein T, Bischof G, Lomoschitz F, Funovics M, et al. Elective and emergent endovascular treatment of subclavian artery aneurysms and injuries. J Endovasc Ther. 2003;10:58-65.
9. Patel MR, Jneid H, Derdeyn CP, Klein LW, Levine GN, Lookstein RA, et al. Arteriotomy closure devices for cardiovascular procedures: a scientific statement from the American Heart Association. Circulation. 2010;122:1882-93.
10. Wallace MJ, Ahrar K. Percutaneous closure of subclavian artery injury after inadvertent catheterization. J Vasc Interv Radiol. 2001;12:1227-30.
11. Shetty SV, Kwolek CJ, Garasic JM. Percutaneous closure after inadvertent subclavian artery cannulation. Catheter Cardiovasc Interv. 2007;69:1050-2.
12. Chivate RS, Kulkarni SS, Shetty NS, Polnaya AM, Gala KB, Patel PG. Percutaneous repair of iatrogenic subclavian artery injury by suture-mediated closure device. Indian J Radiol Imaging. 2016;26:262-6.
13. Park TK, Yang JH, Choi SH. Endovascular repair using suture-mediated closure devices and balloon tamponade following inadvertent subclavian artery catheterization with large-caliber hemodialysis catheter. Korean Circ J. 2016;46:584-7.