

Endovascular Repair Using Suture-Mediated Closure Devices and Balloon Tamponade following Inadvertent Subclavian Artery Catheterization with Large-Caliber Hemodialysis Catheter

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Accidental subclavian artery cannulation is an uncommon but potentially serious complication of central venous catheterization. Removal of a catheter inadvertently placed in the subclavian artery can lead to substantial bleeding, as achieving hemostasis in this area through manual compression presents considerable difficulty. Additionally, surgical treatment might be unsuitable for high-risk patients due to comorbidities. Here, we report a case of an inadvertently-inserted 11.5-French hemodialysis catheter in the subclavian artery during internal jugular venous catheterization. We performed percutaneous closure of the subclavian artery using three 6-French Perclose Proglide® devices with a balloon tamponade in the proximal part of the subclavian artery. Closure was completed without embolic neurological complications. **(Korean Circ J 2016;46(4):584-587)**

KEYWORDS: Central venous catheterization; Hemodialysis; Complications; Vascular closure device.

Introduction

Central venous catheterization with a large-bore catheter is widely used to gain vascular access while performing hemodialysis or continuous renal replacement therapy. Arterial misplacement of the hemodialysis catheter can occur despite ultrasound guidance¹⁾ and can lead to serious complications including hematoma, hemothorax, pseudoaneurysm, arteriovenous fistula, or stroke due to an intra-arterial thrombus.²⁾ Open repair is a safe choice for management, but the site of arterial injury is potentially difficult to

expose surgically. Additionally, underlying comorbidities can make surgical operations difficult for critically ill patients.³⁾ Here we report a case of an inadvertently catheterized subclavian artery with an 11.5-French large-caliber hemodialysis catheter and successful percutaneous repair using suture-mediated closure devices and a temporary balloon tamponade.

Case

A 57-year-old man with decompensated liver cirrhosis underwent liver transplantation. Massive bleeding occurred during and after the operation, and the total estimated blood loss was approximately 25 L. Despite resuscitation with intravenous fluids and transfusions, he became anuric, and the transplant surgeons decided to start continuous renal replacement therapy. A temporary 11.5-French, dual-lumen, Mahurka™ catheter (Covidien, Mansfield, MA, USA) was placed at the left internal jugular vein, but the tip of the catheter appeared to lie within the descending thoracic aorta in the chest X-ray (Fig. 1A). Computed tomography angiography revealed that the catheter had penetrated the vessel wall of the left internal jugular vein and entered the left subclavian artery, extending into the descending thoracic aorta (Fig. 1B and Video in the online-only Data Supplement). Considering the burden of

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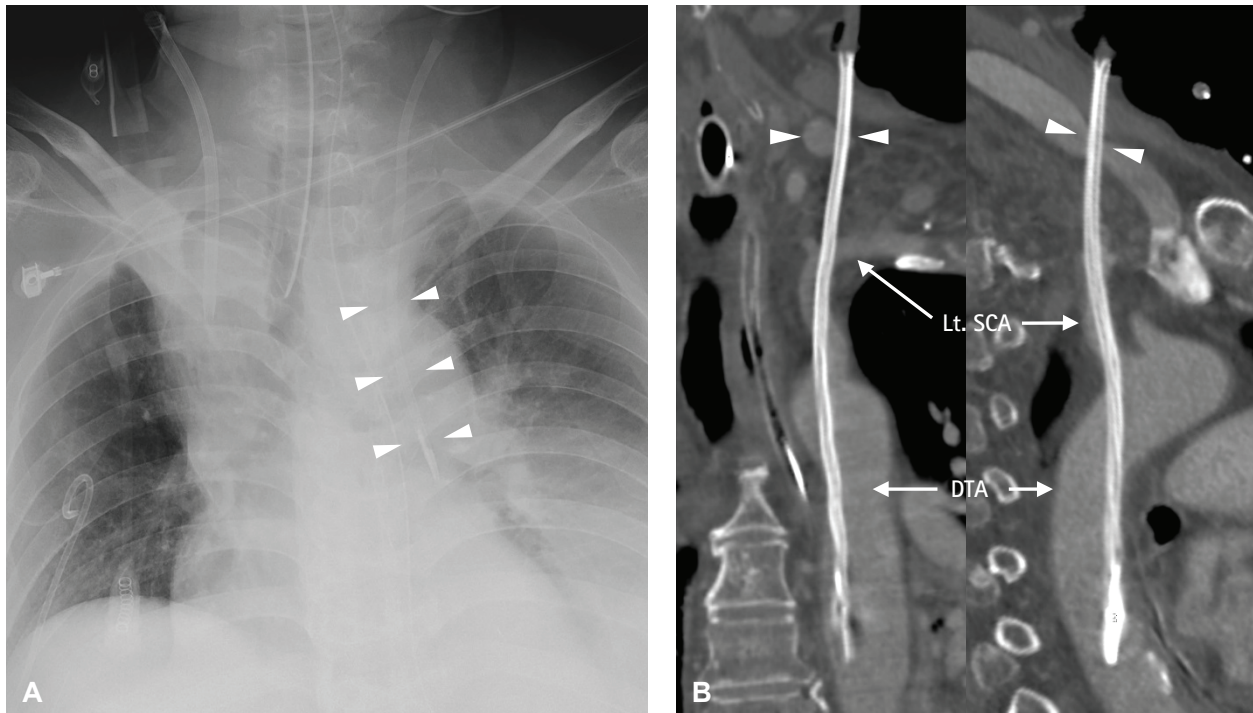


Fig. 1. Chest X-ray and three-dimensional computed tomography angiography. (A) Chest X-ray showing the misplaced catheter tip in the descending thoracic aorta (DTA, white arrowhead). (B) Curved planar reformatting image of three-dimensional computed tomography angiography of the neck, confirming that the inadvertently inserted catheter penetrated the left internal jugular vein (white arrowhead), entered the left subclavian artery (SCA), and extended into the DTA.

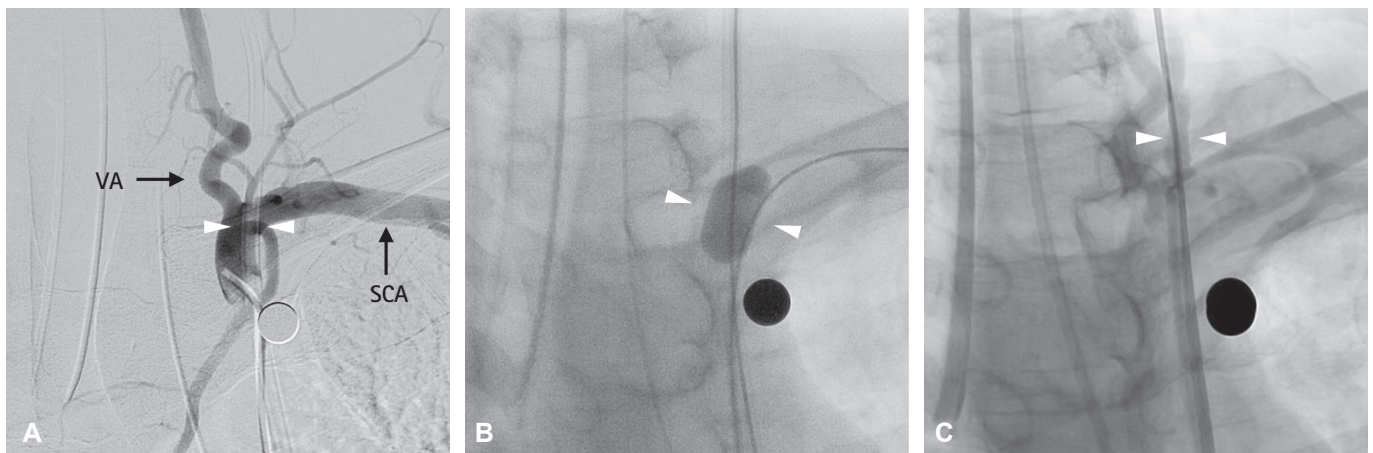


Fig. 2. Temporary balloon tamponade. (A) Angiography showing the catheter's position in the left subclavian artery (SCA) and its insertion site close to the origin of the left vertebral artery (VA, white arrowhead). (B) A 13-mm-diameter occlusion balloon catheter was inflated just distal to the entry site of the misplaced catheter (white arrowhead). (C) Extravasation continued from the entry site of the misplaced catheter, despite more than 1 hour of hemostasis (white arrowhead).

general anesthesia and the need for thoracotomy or partial removal of the first rib during surgery, the patient was referred to us for endovascular repair of the subclavian artery. After acquisition of informed consent from the patient and family members, the patient was moved to a hybrid room that allowed intervention and

open surgery to be performed.

The left upper chest, neck, and right groin area were prepared in a sterile fashion, and an 8.5-French sheath was placed in the right common femoral artery. Angiography revealed malposition of the catheter in the left subclavian artery with an insertion site

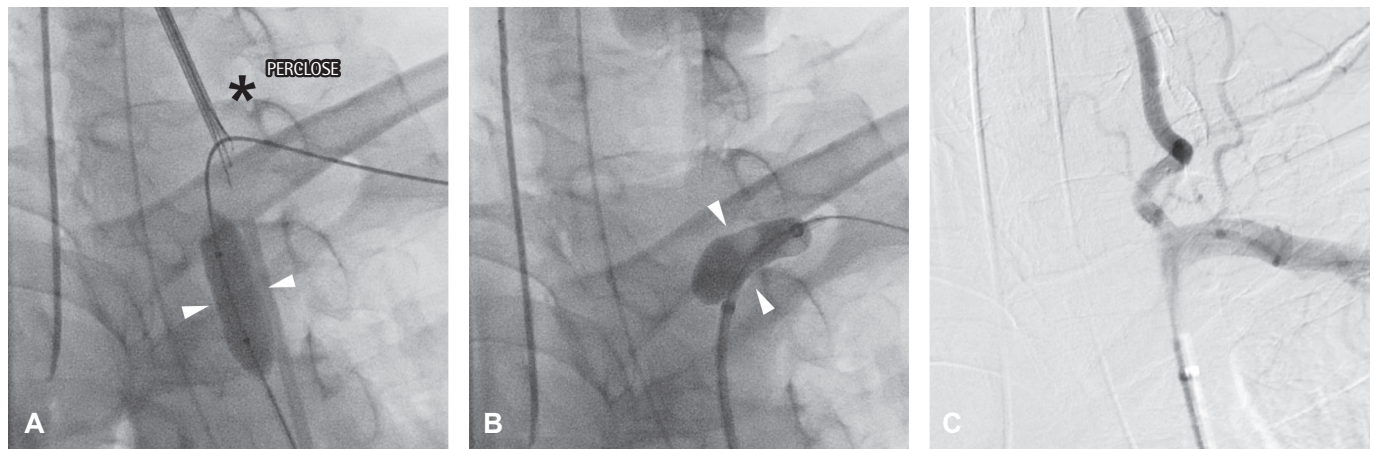


Fig. 3. Endovascular repair using suture-mediated closure devices and a temporary balloon tamponade. (A) A 10-mm-diameter, 20-mm-long, Armada™ 35 percutaneous transluminal angioplasty catheter (Abbott Vascular, Redwood, CA, USA) was inflated within the proximal part of the subclavian artery (white arrowhead). A Perclose Proglide® device (Abbott Vascular, Redwood, CA, USA) was advanced over the guidewire and deployed after removing the guidewire (black asterisk). (B) A 20-mm-diameter occlusion balloon catheter was inflated for longer than 20 minutes just distal to the site of extravasation (white arrowhead). (C) Final angiography showed no extravasation of contrast, confirming successful closure of the subclavian artery.

close to the origin of the left vertebral artery (Fig. 2A). A 0.035-inch Glidewire®, hydrophilic coated guidewire (Terumo, Tokyo, Japan) was placed through the misplaced catheter. Immediately after catheter withdrawal, balloon tamponade was performed by placing a 13-mm-diameter occlusion balloon catheter just distal to the entry site of the misplaced catheter (Fig. 2B). Despite hemostasis lasting longer than 1 hour, continuous extravasation was observed from the entry site of the misplaced catheter (Fig. 2C). We therefore decided to perform percutaneous closing of the subclavian artery using two 6-French Perclose Proglide® (Abbott Vascular, Redwood, CA, USA) devices, the largest of such devices available in Korea. Balloon tamponade was performed at the proximal part of the subclavian artery using a 10-mm-diameter, 20-mm-long, Armada™ 35 percutaneous transluminal angioplasty catheter (Abbott Vascular, Redwood, CA, USA). The angioplasty catheter was 1 mm less in caliber than the subclavian artery in order to minimize bleeding during removal of the malpositioned catheter and reintroduction of the Perclose Proglide® through the guidewire. A Perclose Proglide® device was advanced over the guidewire, medially rotated by approximately 30°, and then deployed (Fig. 3A). The strands were left outside of the body and tagged with a small clamp. Guidewire access was maintained, and a second Perclose Proglide® device was inserted, laterally rotated 30°, and deployed. While maintaining guidewire access, the knots of the two sutures were cinched over the guidewire. Due to the persistence of mild extravasation, a third Perclose Proglide® device was deployed before removal of the guidewire. The balloon catheter was exchanged for a 20-mm-diameter occlusion balloon catheter, which remained inflated for longer than 20 minutes just distal to

the site of extravasation (Fig. 3B). Final angiography showed no extravasation of contrast, confirming successful closure of the subclavian artery (Fig. 3C). The patient was discharged 45 days after the procedure without any complications.

Discussion

Accidental arterial puncture occurs in approximately 2.7% of subclavian approaches.⁴⁾ There is an increased risk of serious complications such as active hemorrhage and pseudoaneurysm formation if catheter removal is attempted at a non-compressible site. Inadvertent subclavian artery catheter insertion can be treated by surgical or endovascular techniques or with a combination of these approaches. Both critically ill patients and those with coagulopathies have limited endovascular options and are poor candidates for surgical treatment. Stent grafts are known to have 94–100% success rates for treatment of inadvertent subclavian artery catheter placement.⁵⁾ In Korea, stent grafts are covered by health insurance and are cheaper than percutaneous closure devices. Although stent graft placement at the subclavian artery presents the risk of vertebral artery occlusion, it is possible to deploy a stent graft without vertebral artery occlusion by following the digital subtraction angiography “road map”. If the right vertebral artery was dominant and patent, posterior circulatory territory could not be compromised despite occlusion of the left vertebral artery. However, in our patient, the line pierced the subclavian artery close below the left clavicle, and stent fracture or compression could occur between the first rib and clavicle.

Using angiography, an observation study reported significant stenosis (20%) and occlusion (12%) during a 10-year period.⁶⁾ In addition, long-term antiplatelet therapy could increase the bleeding risk in patients with recent massive bleeding and liver transplantation. Balloon tamponade offers technically feasible and effective hemostasis, but prolonged balloon dilatation can lead to limb ischemia, thromboembolism, and delayed pseudoaneurysm formation.⁷⁾ Furthermore, this instrument is difficult to seal within large puncture sites such as in our patient.⁸⁾

After invasive procedures, the use of percutaneous closure devices via the femoral artery is recommended to achieve faster hemostasis and allow earlier patient mobilization.⁹⁾ The off-label application of these devices in inadvertently catheterized subclavian arteries has been described previously, where serious complications arose including device failure, infection, incomplete hemostasis, pseudoaneurysm, and embolic stroke.¹⁰⁾ We have also experienced a case of embolic stroke possibly from thrombi around the misplaced catheter. We believe that it is helpful to explore the thrombi using pre-procedural ultrasound and to use heparin with monitoring of the activated clotting time. One previous case of a misplaced subclavian catheter with a diameter larger than 11 French was successfully repaired using a 10-French Prostar XL[®] (Abbott Vascular, Redwood, CA, USA) device and a temporary balloon tamponade.¹¹⁾ The Prostar XL device[®] deploys 4 needles and is commonly used for closing arterial access sites for catheter sizes up to 18-French using the preclosure technique. The 6-French Perclose ProGlide[®], which is the largest size available in Korea, deploys 2 needles and is certified for use in 5- to 21-French access sites. For access sites larger than 8-French, at least two devices and the preclosure technique are required.¹²⁾ However, it is impossible to close an inadvertently catheterized subclavian artery using the preclosure technique. Therefore, we used a balloon tamponade at the proximal part of the subclavian artery in order to minimize the risk of bleeding, and hemostasis was achieved by the sequential implementation of three 6-French Perclose ProGlide[®] devices, instead of a 10-French Prostar XL[®] device.

In conclusion, we report a case of inadvertent subclavian artery catheterization with an 11.5-French, large-caliber hemodialysis catheter that was successfully repaired percutaneously using suture-mediated closure devices and a temporary balloon tamponade. The procedure was performed without embolic neurological complications. Sequential implementation of suture-mediated closure devices with a temporary balloon tamponade backup can be considered as a reasonable alternative for poor surgical candidates with inadvertent arterial catheterization at non-compressible sites.

Supplementary Materials

The online-only Data Supplement is available with this article at <http://dx.doi.org/10.4070/kcj.2016.46.4.584>.

References

1. Rabindranath KS, Kumar E, Shail R, Vaux EC. Ultrasound use for the placement of haemodialysis catheters. *Cochrane Database Syst Rev* 2011;CD005279.
2. Guilbert MC, Elkouri S, Bracco D, et al. Arterial trauma during central venous catheter insertion: case series, review and proposed algorithm. *J Vasc Surg* 2008;48:918-25; discussion 925.
3. Pikwer A, Acosta S, Kölbl T, Malina M, Sonesson B, Akeson J. Management of inadvertent arterial catheterisation associated with central venous access procedures. *Eur J Vasc Endovasc Surg* 2009;38:707-14.
4. Eisen LA, Narasimhan M, Berger JS, Mayo PH, Rosen MJ, Schneider RF. Mechanical complications of central venous catheters. *J Intensive Care Med* 2006;21:40-6.
5. Schoder M, Cejna M, Hölzenbein T, et al. Elective and emergent endovascular treatment of subclavian artery aneurysms and injuries. *J Endovasc Ther* 2003;10:58-65.
6. du Toit DF, Lambrechts AV, Stark H, Warren BL. Long-term results of stent graft treatment of subclavian artery injuries: management of choice for stable patients? *J Vasc Surg* 2008;47:739-43.
7. Fraizer MC, Chu WW, Gudjonsson T, Wolff MR. Use of a percutaneous vascular suture device for closure of an inadvertent subclavian artery puncture. *Catheter Cardiovasc Interv* 2003;59:369-71.
8. Wallace MJ, Ahrar K. Percutaneous closure of a subclavian artery injury after inadvertent catheterization. *J Vasc Interv Radiol* 2001;12:1227-30.
9. Patel MR, Jneid H, Derdeyn CP, et al. Arteriotomy closure devices for cardiovascular procedures: a scientific statement from the American Heart Association. *Circulation* 2010;122:1882-93.
10. Jahromi BS, Tummala RP, Levy EI. Inadvertent subclavian artery catheter placement complicated by stroke: endovascular management and review. *Catheter Cardiovasc Interv* 2009;73:706-11.
11. Berlet MH, Steffen D, Shaughnessy G, Hanner J. Closure using a surgical closure device of inadvertent subclavian artery punctures during central venous catheter placement. *Cardiovasc Intervent Radiol* 2001;24:122-4.
12. Abbott Vascular. Perclose ProGlide Suture-Mediated Closure System. Instructions for use. Unites States: Abbott Vascular; 2015 June. Available from: <http://www.abbottvascular.com/ifu>.