



Endovascular Repair of Inadvertent Arterial Injury Induced by Central Venous Catheterization Using a Vascular Closure Device: A Case Report

중심정맥관 삽입 시 실수로 쇄골하동맥에 설치된 카테터에서 경피적 혈관 지혈기구를 이용한 중재적 시술: 증례 보고

So Hee Kim, MD¹, Woo Jin Jang, MD², Ju Heyon Oh, MD², Yun Gyu Song, MD^{1*}

¹Department of Radiology, Samsung Changwon Hospital, Sungkyunkwan University School of Medicine, Changwon, Korea

²Division of Cardiology, Department of Internal Medicine, Samsung Changwon Hospital, Sungkyunkwan University School of Medicine, Changwon, Korea

Central venous catheterization can cause various complications. Inadvertent subclavian artery catheterization was performed during insertion of a central venous catheter in a 73-year-old man suffering from panperitonitis due to small-bowel perforation. Endovascular treatment was conducted to treat the injured subclavian artery with a FemoSeal vascular closure device.

Index terms

Central Venous Catheters
Subclavian Artery
Vascular System Injuries
Vascular Closure Devices

INTRODUCTION

Central venous catheterization (CVC) is commonly used for hemodynamic monitoring, rapid large-volume replacement, antibiotic administration, and hemodialysis. However, inadvertent arterial puncture or arterial placement frequently occurs during insertion of a central venous catheter (1). Iatrogenic arterial injury at a non-compressible site can lead to serious complications, including fatal hemorrhage, while the catheter is removed. This complication can be treated by traditional surgical approaches or endovascular treatment. We report a rare case of inadvertent puncture of the subclavian artery during CVC that was successfully managed with a FemoSeal (St. Jude Medical Systems, Uppsala, Sweden) closure device. This study was approved by the

Institutional Review Board. The requirement for obtaining informed consent was waived because of the retrospective nature of the study.

CASE REPORT

A 73-year-old man was admitted with peritonitis secondary to small bowel perforation. Following laparotomic small bowel resection, attempts were made to place a central line in the intensive care unit. A 7 French (Fr) catheter was introduced via the right subclavian approach. Post-procedural chest radiography revealed that the catheter projected to the left of the intended position, suggesting inadvertent arterial placement (Fig. 1A), as well as right pneumothorax. Following chest tube placement

Received May 14, 2016

Revised July 29, 2016

Accepted September 19, 2016

*Corresponding author: Yun Gyu Song, MD

Department of Radiology Samsung Changwon Hospital, Sungkyunkwan University School of Medicine, 158 Paryong-ro, Masanhoewon-gu, Changwon 51353, Korea.

Tel. 82-55-233-5602 Fax. 82-55-233-5604

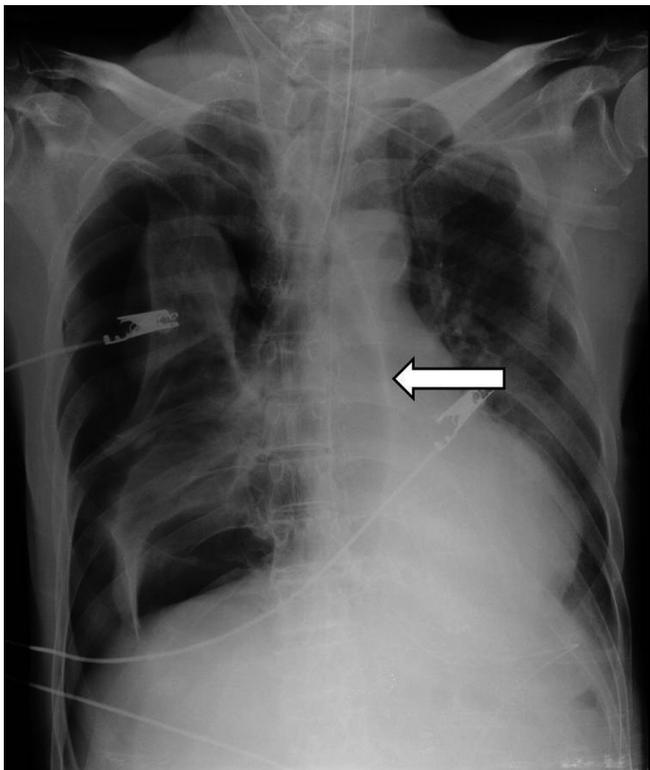
E-mail: yawoo114@naver.com

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

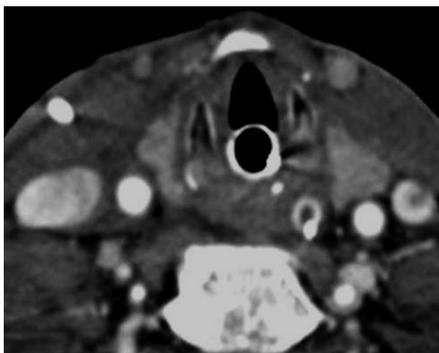
for pneumothorax, CT angiography (CTA) of the neck was undertaken to confirm the presence of the inadvertently inserted catheter and its relation to the subclavian vessels (Fig. 1B-E). CTA revealed that the catheter was placed in the right subclavian artery near the ostium of the right internal mammary artery, just below the origin of the vertebral artery, with the tip lying in the descending aorta. The internal jugular vein, the brachiocephalic vein and lymph nodes were not involved. No intramuscular hemorrhage was seen at the site surrounding the catheter.

Also, no intraluminal thrombus or occlusion was noted within any of the great vessels arising from the aortic arch.

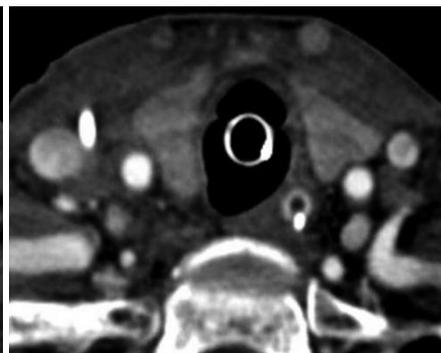
The catheter was left *in situ* without performing immediate catheter removal or direct external compression due to the concern of uncontrollable arterial bleeding that might result from the pull or pressure technique. As the patient remained hemodynamically stable, the clinical team consulted the interventional radiology team for removal of the 7 Fr catheter. Femoral artery access was gained, and an aortic arch angiogram was performed,



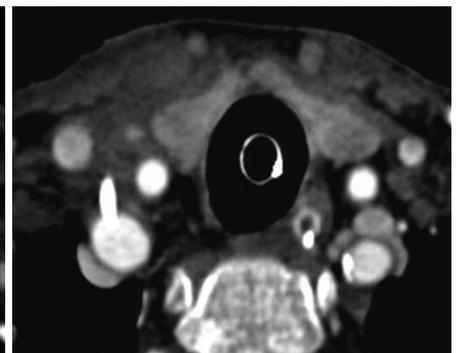
A



B



C



D

Fig. 1. Inadvertent subclavian artery cannulation treated by FemoSeal in a 73-year-old man.

A. Chest radiography following central vein cannulation shows the abnormal position of the right central venous catheter (white arrow) with right pneumothorax.

B-D. Initial CT angiography images show that the catheter is obliquely passed through the right sternocleidomastoid muscle. The catheter was placed in the right subclavian artery.

which confirmed that the catheter was situated in the right subclavian artery with extension into the descending aorta. If covered-stent deployment was performed, there was a risk of occluding the dominant vertebral artery because the inadvertently inserted catheter was in close relation to the origin of the right vertebral artery; hence, a vascular closure device (VSD) was cho-

sen for treatment.

A 0.035-inch guide-wire was placed through the misplaced 7 Fr central catheter and the catheter was exchanged for a 6 Fr sheath. Then, a 0.038-inch FemoSeal guide-wire was inserted through the existing 6 Fr sheath to achieve a position inside the right subclavian artery. After removing the procedural 6 Fr

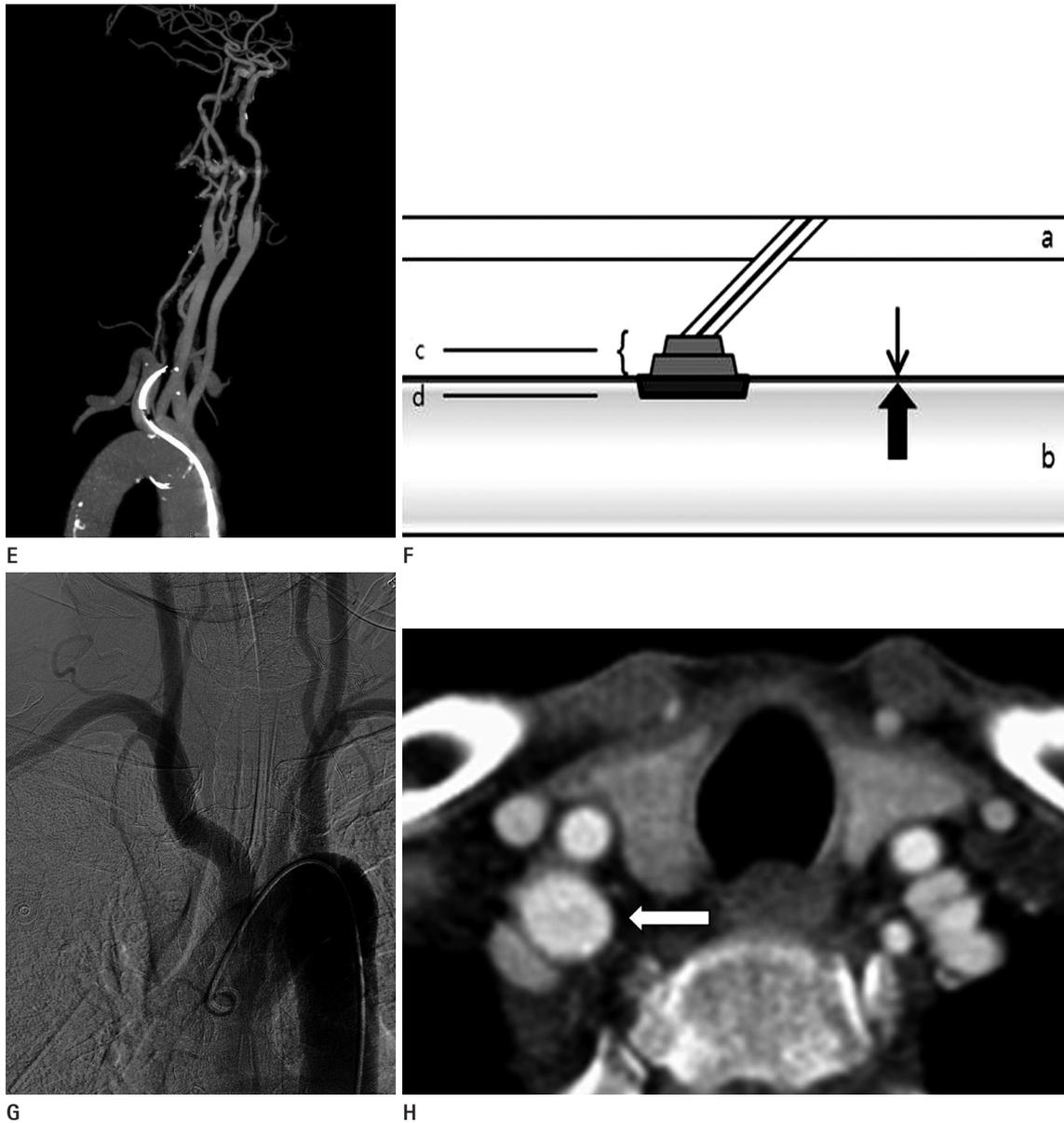


Fig. 1. Inadvertent subclavian artery cannulation treated by FemoSeal in a 73-year-old man.
E. Three-dimensional reconstruction (maximum intensity projection) of the computed tomographic angiography confirms the presence of an inadvertently inserted catheter in the right subclavian artery.
F. Schematic drawing of the arteriotomy site using a FemoSeal closure device. It shows the Inner Seal (d) sitting abut with the inner wall of the artery (thick black arrow) and the Outer Locking Disc (c) sealing the puncture site from outside of the artery (thin black arrow). a = skin, b = artery, c = FemoSeal Outer Locking Disc, d = Inner Seal
G. Angiography performed immediately after deployment of the FemoSeal device shows no extravasation of contrast with preservation of the major arteries.
H. Three weeks later, follow up CT angiography reveals an intact right subclavian artery (white arrow).

sheath, a threaded FemoSeal unit, consisting of a sheath and a dilator, was advanced over the guide-wire into the right subclavian artery. While slowly retracting the FemoSeal Safety Catch, we removed the Safety Catch with the dilator. The intra-arterial positioning of the FemoSeal device was confirmed by visualization of the blood flow into the transparent window at the proximal portion of the sheath. At a distance, the button was pressed twice, first for the deployment of the Inner Seal and then for the Outer Locking Disc. We removed the FemoSeal Unit and applied tension to the suture as it was cut below the skin level. It took approximately 2 minutes to position and deploy the FemoSeal Unit in the subclavian artery (Fig. 1F).

Final angiography obtained immediately after the deployment of the FemoSeal device showed preservation of the major arteries, no signs of contrast medium extravasation or pseudoaneurysm, and confirmed procedural success (Fig. 1G). During his hospital stay, the patient experienced no neurological deficits. Follow-up CTA performed 3 weeks later demonstrated that the right subclavian arterial lumen was patent and there was fatty infiltration in the surrounding vessel without any vascular complications (Fig. 1H).

DISCUSSION

Insertion of a central venous catheter is a commonly performed procedure for critically ill patients in real-world practice. The increasing use of central venous catheters has been associated with a proportionate increase in the frequency of iatrogenic mechanical complications, including the formation of an arteriovenous fistula, arterial dissection or pseudoaneurysm, airway obstruction due to a cervical hematoma, shock from hemothorax, stroke from arterial thrombosis or cerebral emboli, or death (1). When a catheter has been inadvertently inserted into an artery at a compressible site, the misplacement can be easily corrected by removal and manual compression. However, if catheter removal is attempted at a non-compressible site, there is a greater propensity for serious complications such as uncontrolled hemorrhage and death.

The management of iatrogenic subclavian arterial injury is challenging because it is located at a non-compressible site. The incidence of inadvertent subclavian arterial cannulation during placement of a central venous catheter is low, accounting for 2.7–

4.9% of all cases (1, 2). It is easy to recognize this misplacement, but it is difficult to correct it because of a potentially lethal situation during removal of the catheter.

Several options have been reported for the management of inadvertent subclavian arterial cannulation. Surgical treatment usually requires partial removal of the 1st rib or a thoracotomy on the condition that the patient's vital signs are stable without the presence of coagulopathy. With recent technical and device advancements, endovascular approaches have been increasingly used and they have been reported to be successful in managing subclavian artery injury (3). Endovascular management appears to be safe, minimally invasive, and relatively inexpensive. There are various endovascular treatment options such as covered stents, VSDs, tract embolization, or gradual downsizing of transarterial catheters. The choice for these options depends on multiple factors such as location of the arterial injury.

The use of a stent-graft is a good choice for patients who have lateral subclavian arterial injury and are on antiplatelet therapy. In our case, there was a risk of occluding the dominant vertebral artery after stent deployment due to the fact that the right subclavian artery is in close relation to the origin of the right vertebral artery. Balloon angioplasty is required during management with tract embolization using Gelfoam in order to minimize the risk of Gelfoam migration into the artery, with the concern of controlling any bleeding that might occur from the injured artery. Gradual downsizing of transarterial catheters takes a long time with the need for prolonged common femoral arterial access for angiographic evaluation at the time of each downsizing procedure, and therefore, it is not appropriate for life-threatening subclavian arterial cannulation. If the length of the tract from the skin entry site to the arteriotomy is less than 5 cm, a VSD may be considered, although it is contraindicated at bifurcations and in small vessels (3).

FemoSeal is a new non-collagen, resorbable VSD that contains two resorbable polymer discs with an intra-arterial anchor (10 × 5 mm) and an extra-arterial cap (5 mm) (4), which are held together by a resorbable multifilament. The advantages of FemoSeal include a significantly lower rate of large hematoma formation and faster hemostasis compared to closure by manual compression (5). Time to hemostasis is less than 125 seconds in all cases with excellent deliverability by an experienced practitioner (6). According to Leijdekkers et al. (7), the maximum length of

the tract needed to close the arteriotomy site using a VCD depends on the maximum working length of the VCD. The FemoSeal might be considered as long as the length of the tract is less than 10 cm, which is the maximum working length of a FemoSeal. In our case, the length of the tract from the skin entry site was 6 cm. Hence, we successfully used the FemoSeal.

In conclusion, endovascular management of inadvertent subclavian artery injury induced by CVC using a FemoSeal VCD may be safe and effective without the need for surgical management. These results are expected to be helpful in the management of inadvertent subclavian artery cannulation.

REFERENCES

1. McGee DC, Gould MK. Preventing complications of central venous catheterization. *N Engl J Med* 2003;348:1123-1133
2. Iovino F, Pittiruti M, Buononato M, Lo Schiavo F. [Central venous catheterization: complications of different placements]. *Ann Chir* 2001;126:1001-1006
3. Abi-Jaoudeh N, Turba UC, Arslan B, Hagspiel KD, Angle JF, Schenk WG, et al. Management of subclavian arterial injuries following inadvertent arterial puncture during central venous catheter placement. *J Vasc Interv Radiol* 2009;20:396-402
4. De Poli F, Leddet P, Couppie P, Daessle JM, Uhry S, Hanssen M. FemoSeal Evaluation Registry (FER). Prospective study of femoral arterial closure with a mechanical system on 100 patients who underwent angioplasty procedures. *Ann Cardiol Angeiol (Paris)* 2014;63:339-344
5. Holm NR, Sindberg B, Schou M, Maeng M, Kaltoft A, Bøttcher M, et al. Randomised comparison of manual compression and FemoSeal™ vascular closure device for closure after femoral artery access coronary angiography: the CLOSURE dEvices Used in everyday Practice (CLOSE-UP) study. *EuroIntervention* 2014;10:183-190
6. Wanitschek MM, Suessenbacher A, Dörler J, Pachinger O, Moes N, Alber HF. Safety and efficacy of femoral artery closure with the FemoSeal(R) device after coronary angiography using a 7 French sheath. *Perfusion* 2011;26:447-452
7. Leijdekkers VJ, Go HL, Legemate DA, Reekers JA. The use of a percutaneous closure device for closure of an accidental puncture of the aortic arch; a simple solution for a difficult problem. *Eur J Vasc Endovasc Surg* 2006;32:94-96

중심정맥관 삽입 시 실수로 쇄골하동맥에 설치된 카테터에서 경피적 혈관 지혈기구를 이용한 중재적 시술: 증례 보고

김소희¹ · 장우진² · 오주현² · 송윤규^{1*}

중심정맥관 삽입술은 여러 가지 합병증을 유발할 수 있다. 소장 천공으로 인한 복막염을 진단받은 73세 남성에서 중심정맥관 삽입을 시도하다가 쇄골하동맥을 통해 중심정맥관이 실수로 삽입되었다. 본 저자들은 중심정맥관 삽입 시 실수로 쇄골하동맥에 설치된 카테터를 경피적 혈관지혈기구인 FemoSeal을 사용하여 혈관 내 치료를 성공적으로 한 증례를 보고하고자 한다.

성균관대학교 의과대학 삼성창원병원 ¹영상의학과, ²순환기내과