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CASE REPORT

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Successful endovascular management of inadvertent catheterization of subclavian artery

Adrian Jan Karacz, Łukasz Stanisław Dzieciuchowicz, Zuzanna Wardęga

University Hospital Karol Marcinkowski in Zielona Góra, Poland

Abstract

Although the insertion of central venous catheters (CVC) is commonly performed especially in intensive care patients the procedure itself might lead to life-threatening complications such as an iatrogenic arterial injury. In this case report a case on an inadvertent insertion of CVC through the right internal jugular vein into the proximal right subclavian artery is presented. After adequate imaging, the injury was sealed with a balloon-protected application of a plug-based closure device.

Keywords: central venous catheters, inadvertent catheterization of subclavian artery, endovascular management

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Introduction

Placement of central venous catheters (CVC) is nowadays almost obligatory for all major surgical procedures as well as in patients requiring intensive care. In the United States, more than 5 million central venous catheters are inserted every year [1]. This relatively safe procedure may have some serious complications such as pneumothorax, haemothorax, nerve or arterial injury or malposition [2]. Although it has been demonstrated that placement of CVC under ultrasound guidance reduces the number of complications still many of these procedures are performed based on anatomic landmarks [3]. In this report, a case of malposition of CVC after being guided by anatomic landmarks uneventful and correct placement that was resolved successfully by endovascular techniques is presented.

Case presentation

A 50-year-old man underwent the procedure of insertion of a central venous catheter (CVC). The patient was hospitalized in the Intensive Care Unit because of septic shock and multi-organ failure following the surgery of colorectal cancer. The patient was intubated and on mechanical ventilation. His past medical history included stroke and acute pancreatitis. At the time of CVC insertion, the patient was afebrile, and his vital signs were stable. The body habitus was normal, and he was slightly overweight with a BMI of 26.7 (kg/m^2). The patient was on a prophylactic dose of low-molecular-weight heparin. His white blood cell count, platelet count, haemoglobin, Activated Partial Thromboplastin Time and Prothrombin Time (INR) were 15.8 (1000/dL), 55.5 (1000/dL), 9.3 (g/dL), 31.2 seconds and 1.1, respectively. The CVC insertion was guided by anatomic landmarks. The right internal jugular vein (IJV) in the mid-neck was punctured and a dual lumen 6 Fr CVC (Arrow International) was placed according to the standard procedure. The procedure itself was uneventful. As soon as the central venous line was connected to the pressure transducer, very high pressures were noted that raised the suspicion of an intraarterial position of the CVC. At that point, a vascular surgeon

Address for correspondence: Adrian Jan Karacz MD, University Hospital Karol Marcinkowski in Zielona Góra, ul. Zyty 26, 65–046 Zielona Góra, Poland, e-mail: karaczadrian@gmail.com

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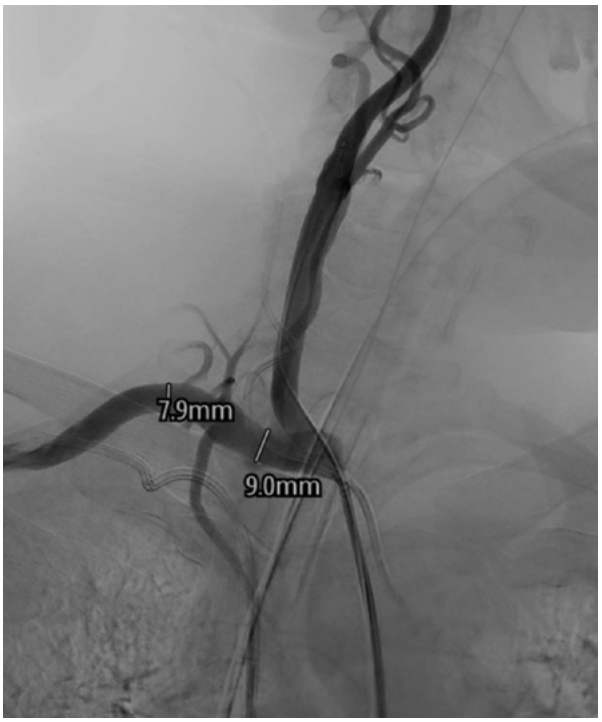

Figure 1. Intraprocedural arteriography showing right common carotid artery and diameter of right subclavian artery

was consulted who decided to transfer the patient to the hybrid operating room. The inspection confirmed the presence of the CVC entering through a mid-neck puncture. Ultrasound scan demonstrated that the CVC was present in the mid-neck portion of IJV and was exiting its lumen at the base of the neck through its posterior wall. Through percutaneous femoral access, a Pig-tail catheter was introduced into an ascending aorta. Using a fluoroscopic interventional system (Azurion Clarity IQ, Koninklijke Philips N.V., Holandia) a cone beam CT was performed that confirmed the ultrasound findings and demonstrated the presence of a CVC in the aortic arch entering the arterial tree through the proximal part of right subclavian artery (RSA).

A decision was made to close the RSA puncture site with a 6 Fr plug-based arterial closure device (AngioSeal VIP, Terumo Europe). Through the femoral access right common carotid artery was catheterized and a 90 cm long 6F introducer sheath was placed into the innominate artery. Selective arteriography confirmed the presence of entry of CVC in the proximal portion of RSA. The diameter of RSA was measured and was 9 (mm) (Fig. 1).

Then RSA was selectively catheterized, and a 9 × 40 (mm) angioplasty balloon (Advance®35LP, COOK Medical) was introduced into the proximal portion of RSA. The balloon was inflated, and occlusion of RSA was confirmed in arteriography and the balloon was deflated. A guidewire of arterial closure device was introduced through the CVC catheter into a descending aorta. The RSA balloon was inflated again, the CVC catheter was removed, and an arterial closure device insertion sheath was introduced over the guidewire while the RSA balloon was being deflated (Fig. 2). RSA puncture was closed with an arterial closure device in a standard fashion.

The completion arteriography demonstrated the patency of the subclavian artery and a complete seal of the puncture site (Fig. 3). The balloon catheter was removed.

The intracranial angiography was performed which showed an intact cerebral circulation. The femoral introducer was removed, and the femoral artery puncture was closed with another 6 Fr plug-based arterial closure device (AngioSeal VIP, Terumo Europe).

Discussion

This case report presents a rare but potentially dangerous complication of CVC insertion in a critically ill patient that was managed successfully by endovascular techniques. Interestingly, as in the majority of described

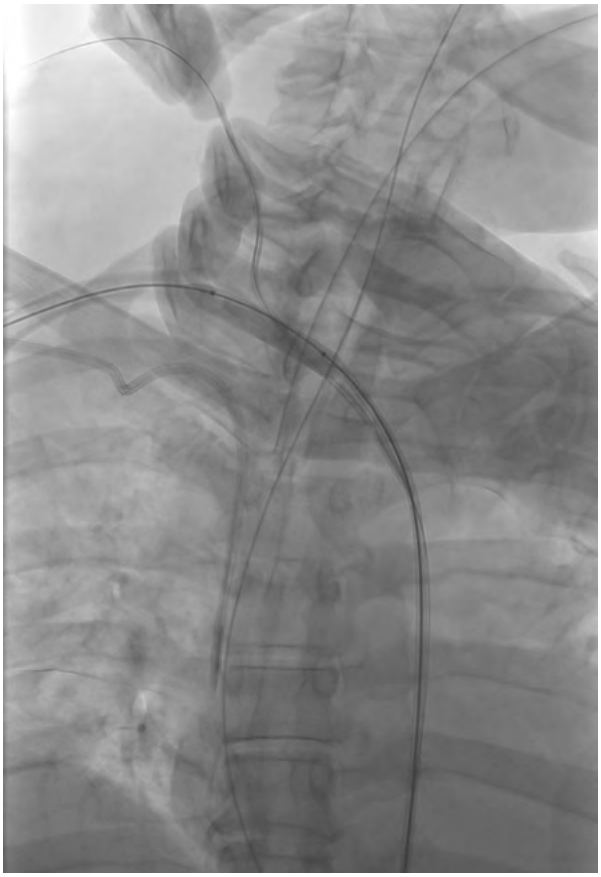

Figure 2. Intraoperative arteriography showing the moment of introducing an arterial closure device insertion sheath over the guidewire

cases, the intraarterial placement was noticed no sooner than after the completed insertion of the CVC [2]. The first important issue that should be emphasized is the necessity of proper diagnostic imaging before an attempt to remove a misplaced CVC. Looking at the mid-neck entry of the CVC one could have thought that CVC entered the arterial system through a common carotid artery. This is the most common route, in a recent review 51 of 80 inadvertent arterial injuries during central venous catheterization were localized in the common carotid artery [2]. That assumption would have led to an improper therapeutic solution most probably a surgical neck exploration or even worse a blind extraction of the catheter with an attempt to control the puncture site by manual compression. The former would be the good option in the case of carotid artery injury but much worse in the case of injury of the proximal portion of RSA due to the difficult surgical access [2]. The latter would have resulted in a massive haemorrhage and most probably death of the patient [2]. In the described patient due to his poor general condition, it was decided to perform vascular imaging in the hybrid operating room instead of transporting the patient to the computed tomography suite. Nowadays, modern interventional fluoroscopy systems enable high-quality three-dimensional imaging and guidance of complex interventional procedures in the hybrid operating room [4]. In the presented case a cone-beam computed tomography allowed for fast and adequate imaging of the course and position of the mispositioned catheter. It was decided to close the RSA puncture site percutaneously with a plug-based closure device. The other solution would be a repair of a punctured RSA with a cover stent. This although might seem a more secure technique was not the first option. Firstly, the proximity of the puncture of RSA to the bifurcation of the brachio-cephalic trunk and too short an overlap with the intact vessel wall could have compromised an adequate seal. Secondly, the proximity to the take-off of the vertebral artery would have required the coverage of its ostium [5]. Thirdly due to the septic state a risk of infection of a covered stent existed. Probably a covered stent would be the first option if the profile of mispositioned CVC were more than 9 Fr.

The closure of the inadvertent puncture of the subclavian artery with a suture-based closure device was also reported in the literature [6, 7]. The authors used a plug-based closure device because they believe that is more reliable and because only a 6 Fr hole needed to be closed. The possibility of a failure of a closure device must be always kept in mind and a bail-out procedure should be planned. In this case, a puncture site would be temporarily secured with balloon occlusion followed by covered stent implantation or surgical repair.

Figure 3. Intraprocedural arteriography showing the patency of the subclavian artery and a complete seal of the puncture site

This case also showed that the insertion of CVC guided by anatomic landmarks although apparently uneventful and successful may incur a dangerous complication. Most probably the puncture needle was introduced too deep and pierced the subclavian artery. This would not have happened if ultrasound guidance had been used. It has been documented in several randomized studies that ultrasound guidance decreases the incidence of complications, including an inadvertent arterial puncture, following the CVC placement [3, 8]. In one prospective, randomized study, that compared real-time ultrasound-guided cannulation of the internal jugular vein with landmark technique in groups of 450 critical care patients, an inadvertent carotid artery puncture occurred in 1,1% and 10,6% of patients, respectively [8].

Conclusions

It may be concluded that an inadvertent placement of a central venous catheter may occur even after apparently correct and uneventful insertion. The arterial injury may be distant from the skin entry of the CVC. This complication may be managed successfully by endovascular technics however proper pre-interventional imaging is essential.

Article information and declarations

Ethics statement: Ethical approval does not apply to this article.

Author contributions: Adrian Karacz — sending the text for publication, development of text for publication, making abstract and introduction, making case presentation, finding materials; Zuzanna Wardęga — making abstract and introduction, finding materials; Prof. dr hab. n. med. Łukasz Dzieciuchowicz — making discussion, making the conclusion, making case presentation, mentoring.

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Conflict of interest: The authors declare that they have no competing interests.

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