


Endovascular Management of a Subclavian Arterial Injury During Central Venous Catheter Placement for Hemodialysis

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Abstract: Subclavian artery injuries after central venous catheter placement constitute a rare but potentially fatal complication. The surgical repair of a subclavian artery trauma is a real challenge, associated with a high rate of morbidity and mortality. The role of endovascular treatment for vascular trauma, including injury to the subclavian artery, continues to evolve. In this manuscript, we report the case of an urgent endovascular repair by a covered stent graft of a subclavian artery perforation following the placement of a central venous catheter for dialysis in a 52-year-old patient, having a chronic kidney failure stage 5, with multiple comorbidities. The present case suggests that attention needs to be paid to preventing iatrogenic arterial cannulation during central vein catheterization to avoid potentially devastating complications. Endovascular treatment using a covered stent should be attempted as a first-line therapeutic option.

Keywords: subclavian artery, arterial injury, false aneurysm, dialysis, central venous catheter, endovascular

Introduction

The majority of the axillary and/or subclavian arteries lesions are the result of penetrating or iatrogenic trauma.¹ Iatrogenic trauma is usually secondary to an inadvertent arterial puncture during the placement of a central venous catheter at the level of the subclavian vein. The central line placement is a medical procedure of frequent recourse for several reasons, including having a temporary access for haemodialysis. However, it is sometimes associated with serious complications that can jeopardize the patient's life if they are not treated in a timely and adequate manner.²

Observation

We report the case of a 52-year-old woman having chronic stage 5 kidney disease with a history of uterine neoplasia who presented with liver metastases treated with radiotherapy and chemotherapy.

An attempt was made to place a central venous catheter via left subclavian vein without ultrasound guidance for temporary haemodialysis. The puncture was made according to anatomical landmarks with an 18-Gauge needle and a 12-French double-lumen haemodialysis catheter 15 cm in length was inserted. After the procedure, the catheter did not work properly and it was removed under local

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compression. Thirty minutes later, the patient complained of a feeling of suffocation and the nephrologist noted the rapid appearance of an expansive pulsatile mass in her left lower neck area with gradual alteration of the hemodynamic state. The blood pressure was 80/50 mmHg and heart rate was 130 bpm. Biological exams found haemoglobin at 5.9 g/dl and lactates at 3.2 mmol/l.

A Doppler ultrasound was done immediately, showing the presence of a pseudoaneurysm at the origin of the left subclavian artery.

Given to the patient's altered general condition and heavy comorbidities, we decided to try an endovascular treatment under local anaesthesia. Two hours later, the patient was taken to the interventional radiology suite for endovascular treatment.

Using a mini-surgical approach to the left humeral artery, we set up a 5 F vascular sheath. The patient received an intravenous injection of heparin at a dose of 50 mg. The first angiography confirmed the presence of an arterial defect and demonstrated contrast extravasation at the site of the proximal part of the left subclavian artery (Figure 1) with pseudoaneurysm formation (Figure 2). Proximal left subclavian artery diameter was 6.3 mm and the distal diameter was 6 mm.

We removed the 5F vascular sheath and exchanged it with an 8F vascular sheath. We then passed the lesion using a 0.035 hydrophilic guide wire with the help of 5F Bernstein diagnostic catheter. We exchanged the first wire with a stiff 0.035 wire which was advanced through the subclavian artery to the aorta. Finally, a 7-mm-diameter, 60-mm-long self-expanding covered stent (Fluency; Bard

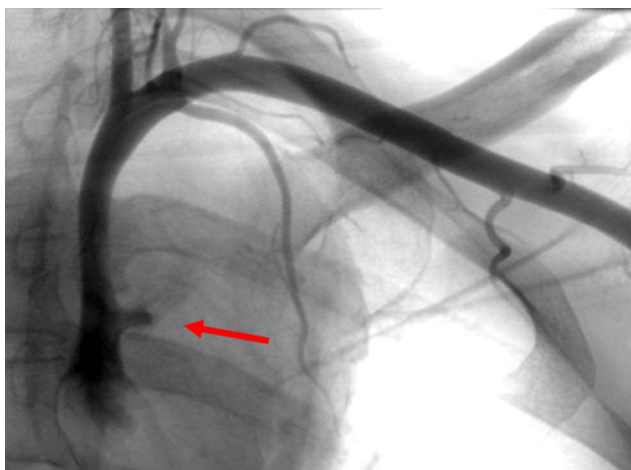


Figure 1 Subclavian angiography showing active extravasation on the proximal part of the left subclavian artery (red arrow).



Figure 2 Pseudoaneurysm of the proximal part of the left subclavian artery (red arrows).

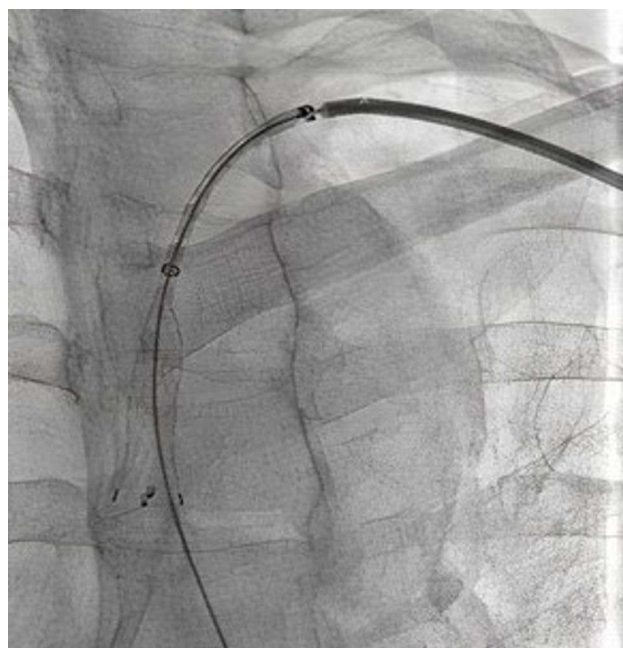


Figure 3 Deployment of the self-expanding covered stent.

Peripheral Vascular) (Figure 3) has been deployed with total exclusion of the rupture, including coverage of the vertebral artery (Figure 4).

Signs of active haemorrhage faded and the patient's condition improved quickly. The immediate evolution was marked by a stabilization of the hemodynamic state, the blood pressure was increased to 110/70 mmHg and heart

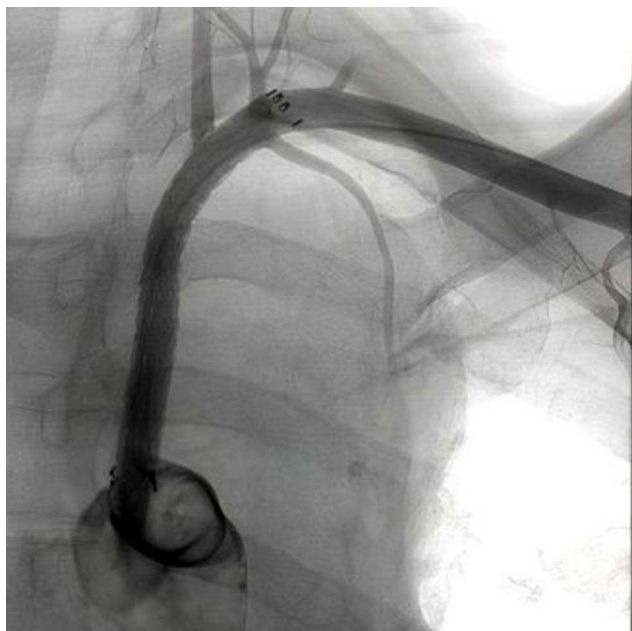


Figure 4 Angiography immediately after the intervention shows disappearance of extravasation and patency of the subclavian artery.

rate was 85 bpm. The total duration of the operation was 25 minutes.

The patient was transfused and dialyzed 3 hours after the operation.

One day later, and following transfusion by two units of packed red blood cells during a dialysis session, the hemoglobin was at 8.7 g/dl.

Adjunctive therapy after the procedure included 75 mg Clopidogrel per day for 6 months, and 100 mg acetylsalicylic acid per day for life. No additional intervention was needed for hematoma. A central venous catheter was placed via right internal jugular vein for dialysis under image guidance two days after the intervention. She was discharged from our department three days later.

Three months later, the patient received a right humerocephalic fistula.

One year after, control DUS showed correct position of the stent-graft and the patency of left subclavian artery.

Discussion

Percutaneous subclavian vein catheterization is known as a relatively reliable and safe procedure for attaining immediate dialysis access, permitting also drug administration or parenteral alimentation.³

However, the use of central venous catheters is associated with a complication rate of 4–35%.² Potential

complications include subclavian artery injury, brachial plexus injury, pneumothorax, or hemothorax.²

The subclavian artery is quite vulnerable; it is located behind and below the ipsilateral subclavian vein. Arterial lesion has been reported in 8% of cases during central catheter placement.⁴ This complication is particularly frequent in certain situations: in obese patients and/or with a short neck, pathological body mass index (BMI), technical difficulties (>3 attempts), lack of experience, hypovolemia, inappropriate patient positioning, anatomic variation or alteration due to previous operation or radiation, and the placement of the catheter in emergency situations and the absence of echo-guidance.^{5,6}

An iatrogenic arterial injury secondary to the percutaneous placement of a central catheter can lead to various serious complications, such as an arteriovenous fistula, arterial dissection, a pseudoaneurysm or even arterial perforation. The lesion becomes more common, more severe and complex when produced by large catheters, such as dialysis catheters.⁷

If the diagnosis of arterial perforation is suspected, immediate management involves urgently carrying out an arterial ultrasound which confirms the diagnosis, and specifies the injured artery and the site of the lesion,⁵ CT angiography has no place in this context of active bleeding.

Arterial injuries secondary to CVC attempts are managed in three different ways: Removal of the catheter and external compression, endovascular intervention and surgical arterial repair.⁸

In cases of subclavian artery pseudoaneurysm formation, like in our case, management should be immediate because of the inability to apply external pressure, the contiguity to vital intrathoracic structures, and the potential danger of rupture which can be fatal in the absence of rapid management.²

The anatomy of the punctured artery and resultant lesion, patient comorbidities, feasibility and risk of intervention are important parameters that should be considered before the decision and type of treatment.⁸

The surgical repair of a subclavian artery trauma is a real challenge, the proximal and distal control of the injured artery is not always easy and often needs a wide dissection, usually requiring of both supra-clavicular and infra-clavicular approach, and sometimes the use of thoracotomy or a median sternotomy.⁹ Therefore, such surgery must be done by a surgeon who knows the arterial anatomy of this region, the complex relationships of the artery with other vascular and nervous structures, in particular the vagus nerve, the recurrent laryngeal nerve, the phrenic nerve and the subclavian vein.

That is why this surgical treatment is associated with significant mortality and morbidity due mainly to the risk of injury to surrounding structures. Demetriades et al reported an overall mortality of 34.2% in a retrospective multi-centric cohort of 79 patients.¹⁰ Kalakuntla et al have reported a postoperative complication rate close to 24%.¹¹

Over the past decade, some authors have proposed an endovascular approach with the use of covered stents to treat this type of traumatic lesions.¹²

Endovascular techniques offer an interesting therapeutic alternative because they make it possible to avoid direct dissection in a difficult area, especially in a population of fragile patients with multiple comorbidities.¹³

Careful selection of patients is necessary because only focal arterial lesions can be crossed by a guide and thus benefit from a covered stent.¹

Patients with a limited life expectancy who cannot withstand general anaesthesia, as in the case of our patient, are ideal candidates for this type of less invasive technique.

The brachial access allows easier direct access to the lesion through a shorter and less tortuous route compared to the femoral approach, especially in an emergency context. However, the deployment of this type of cover stent requires the use of large calibre sheaths ranging from 7 to 9 French which sometimes forces the surgeon to carry out a direct surgical approach to the humeral artery.¹

Finally, despite the urgent nature of these procedures, exclusion of arterial structures such as vertebral artery or internal thoracic artery should be cautiously avoided.⁷ The covering of the vertebral artery in our case was unavoidable because we used a 6 cm long covered stent, which was the only available stent in our operating room with a 7 mm of diameter corresponding to that of the injured artery. This brings us back to the importance of having a wide range of equipment available to meet all the needs of daily practice.

The results of endovascular treatments have been reported by Du Toit¹³ and Patel¹⁴ and they are encouraging. Nevertheless, long-term follow-up is necessary to determine the late patency of this type of stent.

Late thrombosis of the stent, if it occurs, does not prevent further surgical treatment.¹

The best way to prevent this complication is the systematic use of ultrasound guidance during the placement of the central venous catheter in haemodialysis patients. This ultrasound-guided technique compared to traditional placement based on superficial anatomical landmarks allows for better localization of the vein and thus gives fewer complications.¹⁵

Conclusion

Inadvertent arterial cannulation during central vein catheterization can lead to potentially devastating complications. Endovascular treatment of traumatic lesions of the subclavian artery represents a real alternative to surgical treatment with less morbidity and mortality. We thought that endovascular treatment with covered stent should be attempted as a first-line therapeutic option.

Despite short-term patency of endovascular repair is appearing to be equal to that of open surgery treatment. However, like any new technique, long-term results are still being evaluated and require larger studies. Periodic monitoring of these patients is therefore necessary.

Institutional Approval

We have the approval of our institution to publish the case details.

Consent

A written informed consent was obtained from the patient for the publication of details, which can include photographs and/or videos and/or case history to be published in any printed/online journals.

Disclosure

The authors report no conflicts of interest in this work.

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