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Case Report

Endovascular treatment of subclavian artery injury with a complex post-traumatic fistula: Case report

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ABSTRACT

Background: Endovascular treatment in trauma is a promising strategy to reduce perioperative morbidity and mortality. We report the case of a gunshot wound causing an initially undiagnosed subclavian artery injury, with delayed progression to a complex, difficult-to-manage arteriovenous (AV) fistula. Placement of an encapsulated endovascular stent graft resolved the primary lesion, but persistent cervical arteriovenous communications were only repaired after multiple, sequential embolization procedures.

Report: A 25-year-old male sustained a gunshot wound to the right neck. Initial treatment failed to identify any vascular injury, and the patient was discharged. Three weeks later, he presented to our facility with headache and a palpable right-sided cervical thrill. Arteriography showed contrast extravasation from the right subclavian artery and an AV fistula with the ipsilateral internal jugular vein. The arterial injury was repaired with an encapsulated stent graft, but residual contrast leak persisted on follow-up angiography. Three months after the first intervention, cervical thrill was still present; a right vertebral–right internal jugular AV fistula was identified and repaired by distal coil embolization. One month later, persistent symptoms prompted repeat arteriography, which again identified contrast extravasation, now involving the thyrocervical trunk. Selective thyrocervical embolization was ultimately successful, with resolution of symptoms and no further evidence of contrast leak.

Conclusion: Delayed management of neck trauma can be challenging due to neovascularization, which hinders open repair in this delicate region. Post-traumatic arteriovenous fistulas are thus a particularly fearsome complication, and can be very difficult to approach; as in our patient, multiple interventions may be required. This case highlights the importance of detecting vascular trauma as early as possible, as a delay in diagnosis can hinder treatment and eventuate challenging late complications. Further studies are needed to demonstrate the long-term benefits of endovascular management of complex vascular injuries of the neck region.

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Introduction

Endovascular treatment is considered a promising strategy for trauma, reducing operative time, blood loss, and morbidity while carrying lower rates of sepsis and mortality. However, as endovascular techniques are relatively new, there is a lack of long-term studies to support management of penetrating trauma [1,2].

We report the case of a patient who sustained a gunshot wound to the neck with subclavian artery injury. Despite successful treatment of the primary arterial injury, the patient developed a difficult-to-manage arteriovenous fistula involving the cervical vessels that required multiple interventions.

Case report

A healthy 25-year-old male sustained a gunshot wound to the right neck (between zones I and II). The projectile was retained in the supraclavicular fossa. He was initially treated at another facility and discharged when no vascular injury was identified. Three weeks later, he presented to another facility complaining of headache and right-sided cervical thrill. The patient had no data related to the initial care.

Urgent arteriography showed contrast leakage in the proximal third of the right subclavian artery, as well as a communication with the right internal jugular vein. The injury was repaired by implantation of a Fluency 13.5 × 80 mm stent graft. The decision about the stent diameter was based on the assessment of computed tomography angiography with an overlap of 20 to 30%. As there was a significant reduction in contrast leakage after stent implantation, the procedure was concluded because it considered that residual leakage would cease with the interruption of the main communication. Clopidogrel 75 mg QD for 30 days and indefinite aspirin therapy (100 mg QD) were prescribed. On follow-up arteriography at 40 days, there was significant improvement in contrast leak, but some residual late-phase extravasation remained near the projectile (Fig. 1).

The right cervical thrill persisted on follow-up. Therefore, arteriography was performed 90 days after the first intervention. Persistent contrast leak in the vicinity of the projectile was identified, with probable retrograde filling by the contralateral vertebral artery, as well as a communication between the right vertebral artery and the right internal jugular vein, which was massively dilated. The circle of Willis was visualized in its entirety.

As the vertebral artery origin was inaccessible by the stent graft, Neurosurgery was consulted and an open skull-base dissection of the right vertebral artery was performed, followed by distal embolization with two 5 × 15 and two 4 × 12 microcoils (ev3 Inc.). The procedure was completed with a significant reduction in contrast leak. (Fig. 2).

In the two previous situations, the residual leaks after the procedures were minimal and with a significant improvement in the flow of arteriovenous communication. As a result, the procedures were interrupted, considering that the drastic reduction in flow could cease communication with thrombosis and thus prevent the implantation of more materials, which are not always widely available in the public health system.

At 1-month follow-up, however, the thrill persisted. Repeat arteriography showed successful coil occlusion of the right vertebral artery, but contrast extravasation continued to occur, now involving branches of the thyrocervical trunk, in addition to late contraction

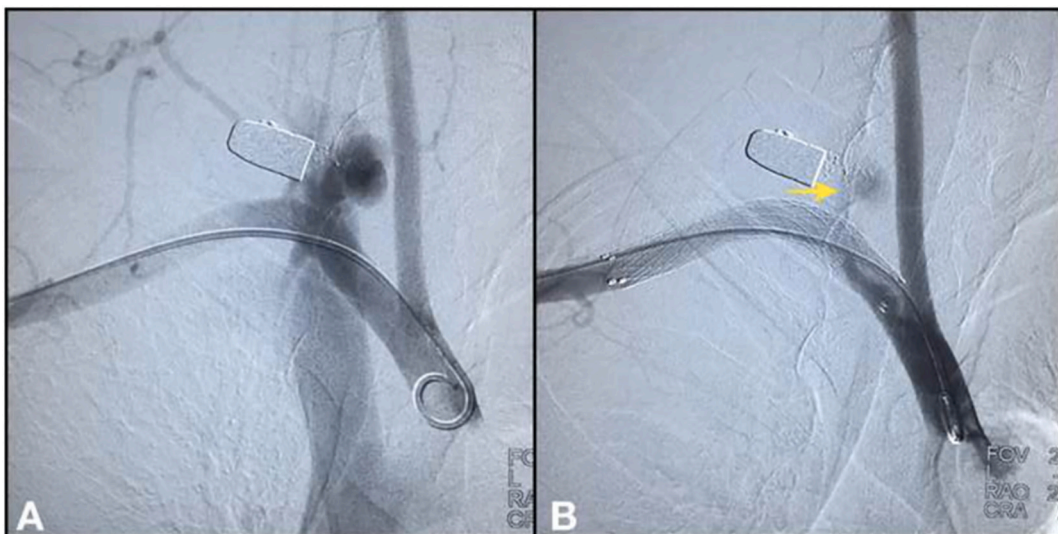


Fig. 1. A) Pre-treatment arteriography, showing contrast leakage in the region of the proximal third of the subclavian artery. B) Control arteriography after implantation of a 13.5 × 80 mm Fluency stent graft, showing significant improvement in contrast leakage but minor, persistent late-phase extravasation (yellow arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

of the right internal jugular vein (indicative of a persistent fistula). Selective microcatheterization of branches of the subclavian artery was performed, followed by embolization of the thyrocervical trunk with three microcoils (7×20 , 5×15 , and 4×15 ; ev3 Inc.) (Fig. 3).

The headache and cervical thrill resolved. CT angiography performed 30 days after the last procedure showed good stent graft apposition, proper coil placement and no appreciable contrast leak (Fig. 4).

Discussion

Subclavian artery trauma is associated with severe bleeding and significant mortality (~34%). Adequate exposure via the open route is hampered by proximity to neurovascular and skeletal structures, which increases morbidity. Therefore, repair of subclavian artery trauma was one of the first procedures to be attempted via endovascular techniques. In 2012, a study reviewed 32 publications on the endovascular treatment of subclavian-axillary artery trauma. A 97% overall procedure success rate was reported, with 84% patency for up to 70 months of follow-up. In addition, comparison with previous research showed that endovascular repair greatly reduced operative time, blood loss, and brachial plexus trauma compared to open repair [2].

Patient selection for endovascular treatment must take into account the risk associated with complex dissections in critically ill patients. Injuries associated with arteriovenous fistula and neurologic involvement are challenging, as dissection can cause additional insults. However, in patients who require multiple interventions, open repair is the route of choice; in these cases, the endovascular technique can be used for temporizing hemostasis [3]. Long injuries with no proximal neck for fixation, large discrepancy in diameters of the injured vessel, impossibility of catheterization, compressive symptoms, aerodigestive tract trauma, and infected lesions are all contraindications to endovascular repair. These factors were also considered for the case reported herein [2,4].

Arteriovenous fistulas are among the several complications that can result from penetrating or blunt trauma, as well as from endovascular or conventional attempts at repair. They are rare in the head and neck region, occurring in approximately 4% of arterial injuries [5]. Post-traumatic fistulas resulting from a gunshot wound are usually caused by a low-velocity projectile. Unless identified early, arteriovenous fistulas may progress to heart failure, murmurs, and thrills on physical examination; if a limb is involved, there may be edema and decreased perfusion due to steal phenomenon. The cavitation process caused by the projectile can also be responsible for the damage of adjacent tissues and vessels, promoting inflammation, angiogenesis and delaying the resolution of arteriovenous fistulas. Prompt treatment is recommended to prevent these complications [4,5]. The patient in this report developed an arteriovenous fistula involving the internal jugular vein and the subclavian artery and its branches, after failure to diagnose trauma to the subclavian artery. Treatment is often challenging, as persistent adjacent neovascularization can develop over time; this increases the odds of recurrence and of a complex dissection, making open repair a less attractive option. In this scenario, endovascular repair is associated with less morbidity, but long-term outcomes remain unclear.

For initial treatment of the subclavian artery lesion, a self-expanding encapsulated stent (Fluency) was used. Among the various available stents, self-expanding models are more flexible and can conform to different diameters in a single vessel, in addition to providing over-expansion capacity and resistance to deformation in case of kinking. Balloon-expandable stents can be used in non-mobile areas and in minor injuries (especially those caused by catheters), and provide more precision in implantation [1,2].

The key concern in endovascular repair of arterial trauma is technical success. Thrombosis remains the main cause of amputation, and complication rates after stenting or distal embolization range from 0 to 25%. Some studies have reported encouraging results with

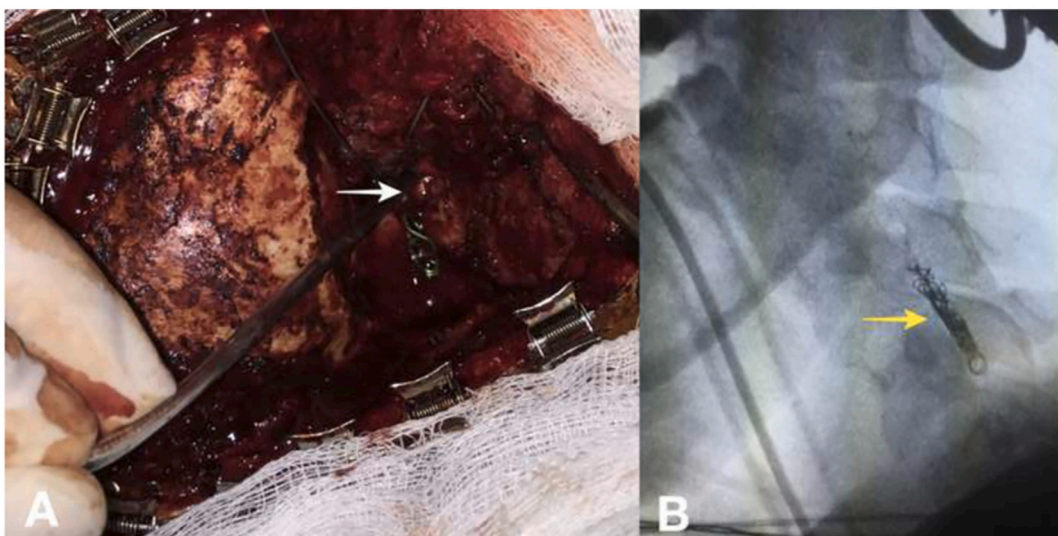


Fig. 2. A) Open dissection of the right vertebral artery at the base of the skull (white arrow). B) Distal embolization with ev3 coils (yellow arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

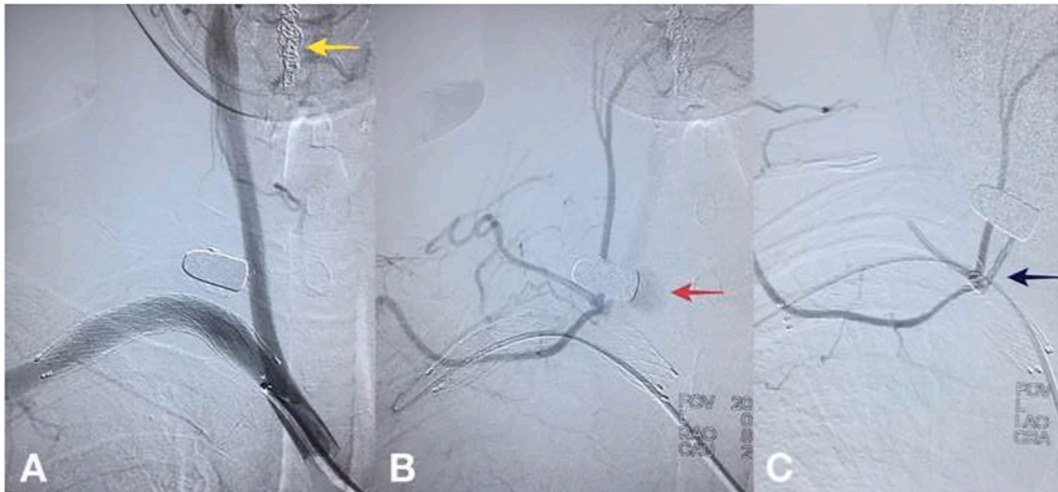


Fig. 3. A) Selective arteriography of the brachiocephalic trunk showing absence of opacification of the right vertebral artery due to successful coil occlusion (yellow arrow). B) Contrast extravasation, probably from branches of the thyrocervical trunk, with visible filling of the internal jugular vein (red arrow). C) Selective microcatheterization of branches of the subclavian artery for coil embolization of the thyrocervical trunk (black arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

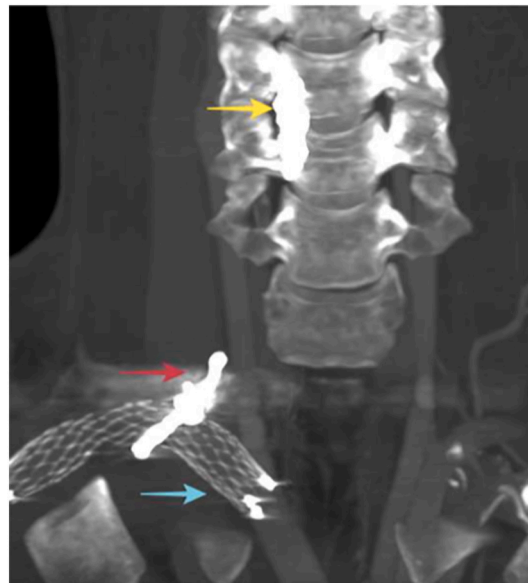


Fig. 4. Control CT angiogram showing good stent graft apposition (blue arrow), embolization coils in the vertebral artery (yellow arrow) and thyrocervical trunk (red arrow), and absence of contrast extravasation. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

endovascular technique. The Endovascular Skills for Trauma and Resuscitative Surgery group reported their experience with endovascular repair of subclavian and axillary in 160 patients from 1996 to 2012; technical success was achieved in 97% of cases [3]. In 2008, du Toit et al. [6] assessed 57 patients who had sustained subclavian artery trauma from 1997 to 2007 and were treated with a coated stent graft. Neither anticoagulation nor antiplatelet therapy was prescribed postoperatively. Within the first 30 days after the procedure, 5% experienced stent thrombosis, which was successfully treated with a new endovascular procedure. At 30 days, 31 patients had been lost to follow-up. The mean follow-up duration of the remaining patients was 4 years. At late follow-up, 20% of patients had experienced at least 50% intrastent stenosis, with 12% progressing to complete occlusion. All stenoses were treated by angioplasty. There were no cases of limb loss or disabling symptoms. The author also compared early failure rates of endovascular treatment versus open repair; both were similar at approximately 5%. After coated stent graft implantation, restenosis occurs more frequently at the ends of the stent. Doppler ultrasound is the most appropriate method for monitoring these patients. Another

important aspect during follow-up is the postoperative medication regimen, with protocols still differing widely among authors. Most studies advocate antiplatelet therapy with a 4-week course of clopidogrel and indefinite aspirin therapy, as was proposed to the patient reported herein [1].

Despite stent-graft repair of the subclavian artery lesion, the patient continued to exhibit a cervical thrill and developed several new arteriovenous communications involving the vertebral artery and, subsequently, branches of the thyrocervical trunk and the internal jugular vein, all of which were treated by coil embolization. After stent implantation, it was considered that a drastic reduction in venous contrast and sealing of that arteriovenous communication with the stent would be sufficient to resolve the fistula. In addition, other communications present at that time were not identified or they may have developed later, which required multiple procedures for definitive resolution. The internal jugular vein could be an access possibility but the arteriovenous fistula also involved other veins and it was chosen for its preservation.

Garcia et al. [7] reported their experience at a trauma center with 11 patients experiencing post-traumatic fistulas. The average time since primary trauma was 3.5 years, and all were treated by endovascular techniques (stent implantation, embolization, or both). All patients had a brief hospital stay. Complete resolution was achieved in 9 cases; the remaining 2 developed persistent fistulas and early stent stenosis. These results demonstrate that the endovascular technique can still be a limiting factor in the choice of treatment and require additional procedures in a minority of patients, as occurred with the patient in question.

Fistulas or vessel leaks too small to allow for stent placement but still amenable to microcatheter access may be embolized with microcoils, Gelfoam particles, or glue. Larger lesions will require conventional coils or vascular plugs [8]. Arteriovenous fistulas involving vertebral vessels may be associated with neurological complications and pose a challenge to open access [8]. Accordingly, in the present case, the Neurosurgery team was called in to assist with vertebral artery access and enable coil embolization.

Conclusion

Endovascular treatment of vascular trauma can reduce early morbidity and mortality, but there is still little evidence of long-term benefit and, consequently, a lack of guidelines [2]. Continuous monitoring and careful follow-up of cases is required to evaluate long-term results [1].

In the present case, endovascular treatment proved advantageous due to the location of the primary injury, late diagnosis, and development of a complex fistula, which is associated with increased morbidity at open repair and risk of heart failure unless treated effectively. This case highlights the need for early diagnosis of vascular lesions in trauma patients. In addition, it shows how the detection and treatment of cervical lesions can be challenging, due to complex anatomy. When diagnosed late, such lesions can be complicated by neovascularization subsequent to local inflammatory reaction, potentially leading to fistulas and hindering surgical access to the site of injury.

Informed consent

Informed consent was obtained from the patient.

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Declaration of competing interest

None.

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