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Combination of endovascular and open repair for the management of subclavian artery injury

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ABSTRACT

Axillosubclavian artery injury is relatively uncommon; however, it is related to a high rate of morbidity and mortality. Although open repair as well as endovascular techniques have been proposed for the treatment of axillosubclavian artery injury, the ideal approach is still under investigation. We present a case of a 20-year-old patient who suffered from complete subclavian artery transection, following blunt thoracic trauma. Using percutaneous access, a balloon catheter was inflated under fluoroscopy, in the origin of his affected subclavian artery ceasing the haemorrhage, thus immediately afterwards he was submitted to arterial bypass. The combination of endovascular and open repair ensured his life and limb salvage while the complications of an otherwise extensive dissection were obviated.

Introduction

Management of axillosubclavian artery injuries (ASAI) is quite challenging as the rarity of these cases has resulted in limited experience and lack of wide available expertise [1]. We present a case of complete subclavian artery transection where a balloon catheter was deployed under fluoroscopy, to provide the proximal control for the subsequent arterial bypass; thus, avoiding the disadvantages of an extensive dissection. Informed consent was obtained from the patient before publishing his images and history.

Case presentation

A 24-year-old male patient initially presented to the emergency department of a peripheral district general hospital after his motorcycle collision. Being haemodynamically stable with a Glasgow Coma Scale of 15/15, he exhibited a large haematoma in his left supraclavicular area which was extending to his shoulder. More alarming was that his ipsilateral upper limb was pulseless, pallor and cold with prominent paralysis and paraesthesia. Besides a small laceration in his left parietal area, his physical examination was otherwise negative for findings. He had a free past medical history and soon his blood exams showed a significant decrease in his haematocrit (from 43 % to 38 %) and haemoglobin (from 14 mg/dL to 12 mg/dL). As long as he was remaining stable, he underwent a full-body Computed Tomography which revealed a huge haematoma in the apex of his left lung with areas of extravasation as his left subclavian artery (LSA) which was completely transected, had thrombosed causing the absence of distal perfusion to his left arm. Other

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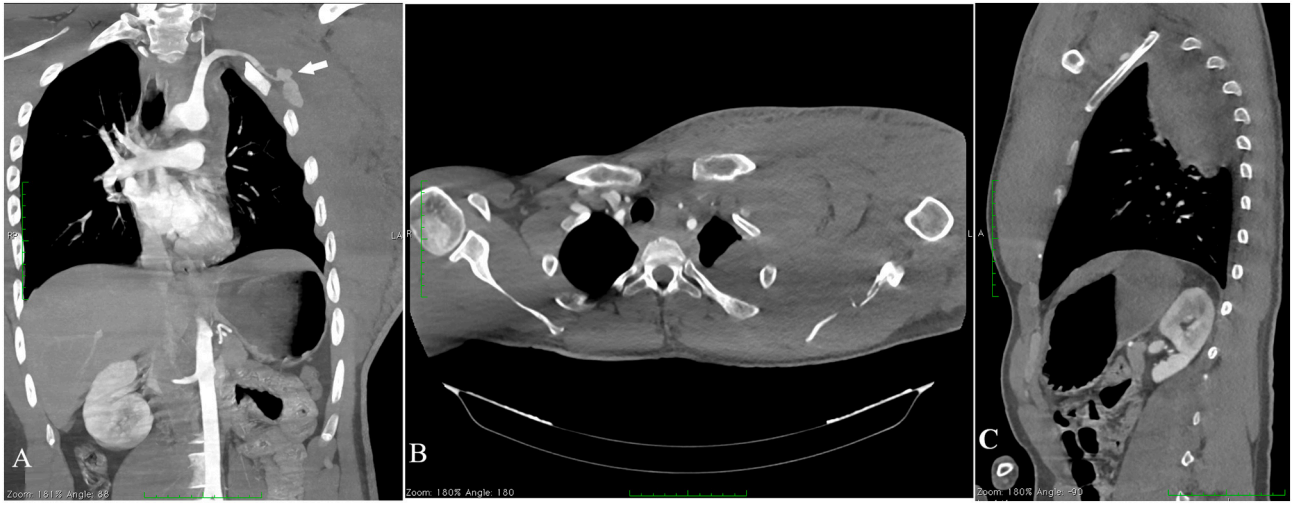

Fig. 1. Preoperative computed tomography scan. (A) The coronal plane where the white arrow indicates the area of extravasation following the complete transection of the left subclavian artery. (B) Axial plane showing the haematoma of the left hemithorax and the comminuted fracture of the left scapular body. (C) Sagittal plane showing the haematoma at the apex of the left lung.

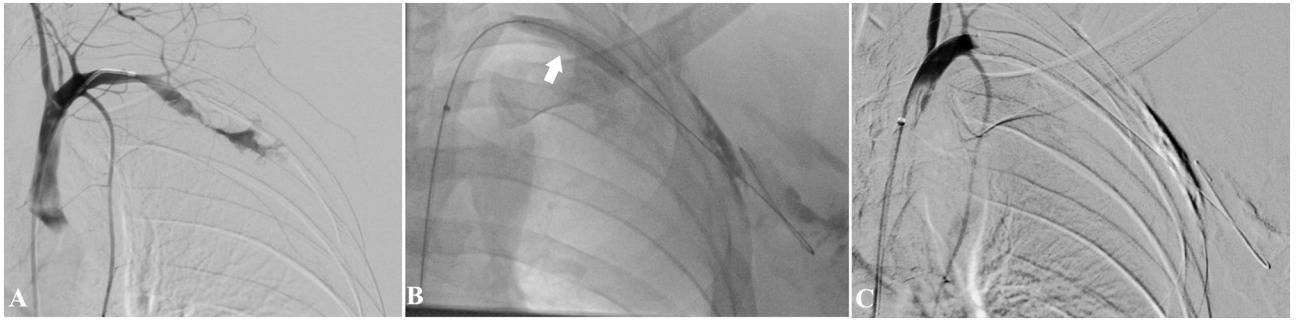

Fig. 2. Preoperative digital subtraction angiography. (A) Selective angiography of the left subclavian artery confirmed the complete transection and the active extravasation. (B) A 7 × 40 mm balloon catheter (Evercross, Medtronic, Minneapolis, Minnesota USA) was deployed at the stump of the left subclavian artery and controlled the haemorrhage. (C) New angiography confirmed the haemorrhage cessation.

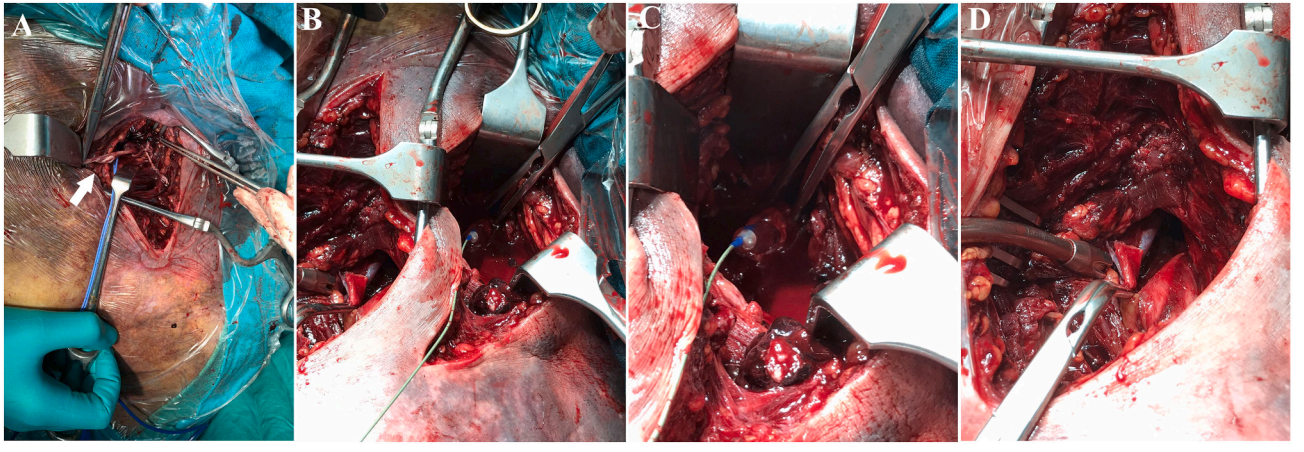

Fig. 3. Intraoperative images. (A) Supraclavicular incision exposed the avulsed left brachial plexus. (B) Supraclavicular and infraclavicular incisions to expose the proximal and the distal stump of the left subclavian artery with the previously, under fluoroscopy deployed balloon catheter inflated inside the proximal stump. (C) The proximal stump of the left subclavian artery with the balloon catheter in place and ready to be cross-clamped. (D) The distal stump of the left subclavian artery is cross-clamped.

findings were a comminuted fracture of his left scapular body and nondisplaced left oblique manubrium sternum fracture (Fig. 1). Considering the severity of his injuries and the lack of expertise the patient was urgently transferred to our institution. Upon presentation, six hours after the accident, his status had deteriorated featuring hypotension tachycardia and agitation. A digital subtractive angiography was performed where under moderate sedation using percutaneous access through his left femoral artery the origin of his LSA was catheterized using a standard J-shaped guidewire. The selective angiography confirmed the complete transection of the LSA and the active extravasation. A 7 × 40 mm balloon catheter (Evercross, Medtronic, Minneapolis, Minnesota USA) was deployed at the stump of the LSA and controlled the haemorrhage (Fig. 2). An attempt was also made for a provisional endovascular repair, to cross the lesion and deploy a stentgraft through a percutaneous puncture of his left brachial artery which was unsuccessful due to poor brachial access, regarding the severe ischaemia and the profound vasoconstriction. Having the balloon catheter in place, the patient was transferred to the operating theatre where under general anaesthesia a supraclavicular incision was performed. The proximal part of the LSA was vigilantly exposed and cross-clamped after the removal of the balloon catheter, in a safe manner. The haematoma was drained; however, his brachial plexus was severely avulsed as well as his subclavian vein which was ligated. An infraclavicular incision was performed where the distal stump of the LSA was exposed and cross-clamped (Fig. 3). After a thromboembolectomy, an 8 mm expanded polytetrafluoroethylene graft (FlowLine, JOTEC, Hechingen, Germany) was tunnelled under the clavicle and anastomosed consecutively to the proximal and the distal part of the LSA. Having restored the perfusion, extended

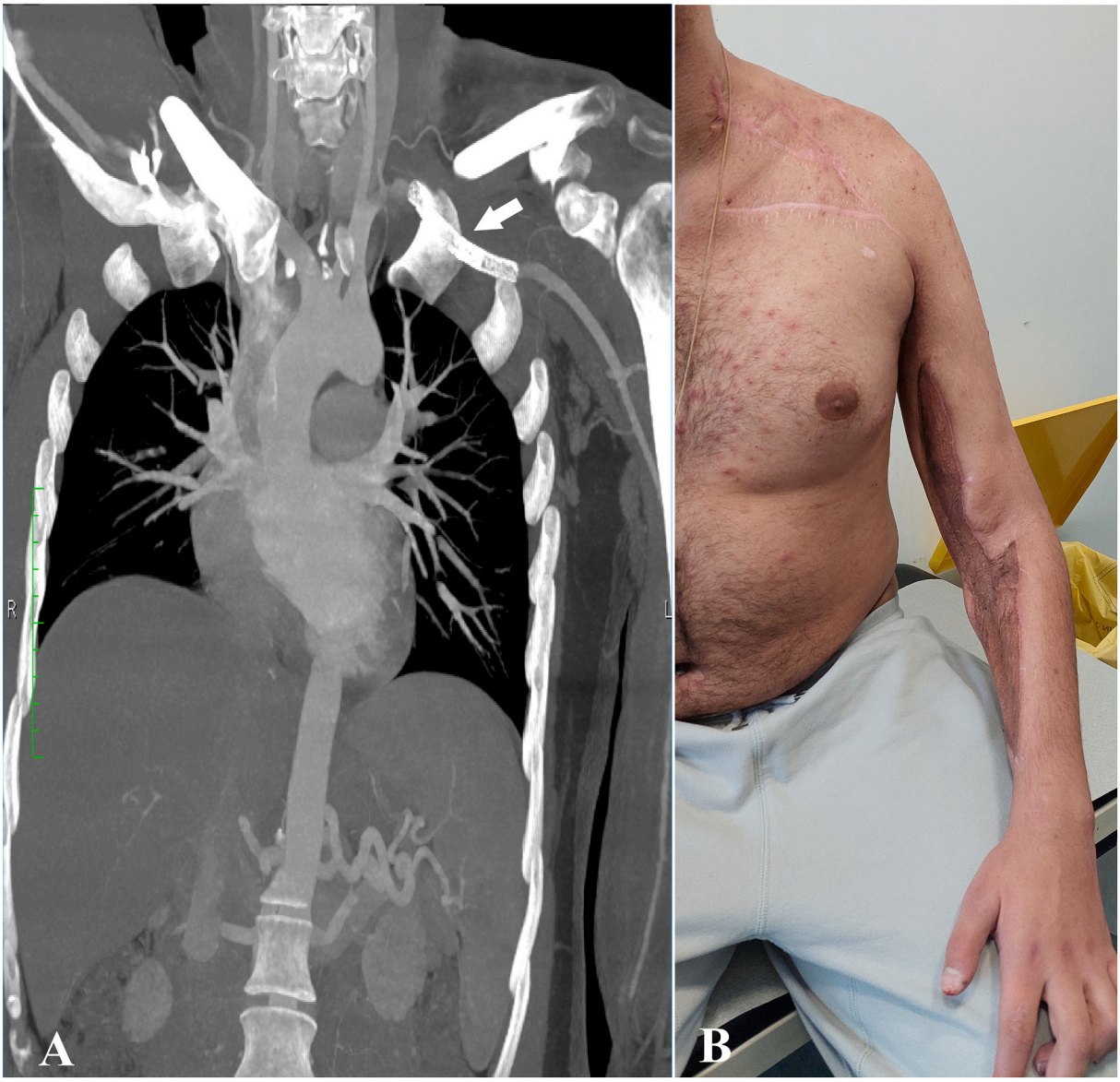

Fig. 4. Follow-up six months after the accident. (A) Computed tomography where the white arrow indicates the patent arterial bypass. (B) Photograph of the left arm being viable but significantly affected.

fasciotomies were performed at the upper arm and forearm as well as a left thoracic drainage was introduced. The patient was transferred intubated to the intensive care unit (ICU) where the extensive oedema of his left immobilised arm and the need for vasoconstriction led to a new episode of acute limb ischaemia, on the ninth postoperative day. A thromboembolectomy along with stenting of the anastomoses restored the perfusion. Although the viability of the affected arm was ensured, the injured brachial plexus had caused a flail limb. Vacuum-assisted closure devices were recruited to accelerate the healing of the fasciotomy wounds and eventually, split-thickness skin grafting was performed. Following the discharge, he was admitted to the microsurgery department for reconstructive surgery of his brachial plexus. Six months after the accident, the patient still attends a rehabilitation program showing substantial improvement (Fig. 4).

Discussion

Axillosubclavian artery injuries are relatively rare counting for 5 % to 9 % of all vascular injuries; however, data suggest that the incidence of ASAI has increased over time which causes great concern as the associated mortality is high as 34% [2]. The type of ASAI varies with the pseudoaneurysm being more often after a penetrating trauma and complete transection being usually the result of a blunt thoracic trauma [3]. In our case, the deceleration injury following the motorcycle collision caused the complete transection of the LSA. The exsanguination following the ASAI is the reason why two-thirds of these patients die before the surgery [2]. The thrombosis of the LSA, in our patient, limited the haemorrhage and induced the ischaemia of the left upper limb. Open repair was traditionally considered the first approach of ASAI cases [4]. Given that open repair necessitates broad exposure like median sternotomy or anterolateral thoracotomy, the associated mortality and mobility have caused a shift towards less invasive endovascular techniques [5]. Branco et al. using a propensity score matching analysis for cases of ASAI, they concluded that the mortality of endovascular repair was 5.6 % while for open repair was 27.8 %, with the difference being statistically significant [6]. Matsagkas et al. recently reported that the endovascular approach is reliable and recommended that given the wide availability and the considerable evolution of the endovascular expertise, the endovascular techniques should be the first-line intervention even for haemodynamically unstable cases or incidents of complete transection which were deemed to be treated only by open repair [7].

However, many authors across the English-speaking literature agree that due to poor follow-up of the trauma patients, data regarding long-term outcomes are still lacking [3,5,6,8]. Given the unknown long-term durability of the endovascular approach and trying to avoid the complications of an extensive open exposure, we adopted a hybrid solution. Using percutaneous femoral access, a balloon catheter was inflated at the origin of the LSA to control the bleeding and stabilize the patient. With the balloon catheter in place, the patient was transferred to the operating theatre whereby performing supraclavicular and infraclavicular incisions, the stumps of the LSA were dissected and following the evacuation of the haematoma a bypass, tunnelled under the clavicle, was constructed.

The inflation of a balloon catheter at the origin of the LSA, by using percutaneous femoral access, offered a potentially faster and more efficient initial control of the bleeding. Without the risk of the exsanguination and with the patient stabilized, it is possible to proceed subsequently with endovascular or open repair [9]. Even in cases where it is known preoperatively that the exclusively endovascular approach would not be feasible due to anatomic limitations, the advantages of the percutaneously applied balloon catheter inflation as a first approach, are still valid as this strategy ensures the haemodynamic stability without the possible complications of a major procedure like the median sternotomy or anterolateral thoracotomy [5,6].

Various combinations of hybrid procedures for ASAI with sufficient outcomes have been reported in the literature [3]. Karkos et al. reported the inflation of a balloon catheter in the LSA origin followed by ligation as a secondary procedure to resuscitate a patient with an infected bypass for ASAI [10].

Up to 50 % of ASAI coexist with significant brachial plexus injury whereas 18 % of the cases will eventually have a flail limb [1]. The reconstructive surgery of the affected brachial plexus and the rehabilitation programme has helped our patient to regain a part of his arm motion, till now.

Conclusion

The provisional inflation of a balloon catheter in the origin of the subclavian artery, combined with arterial bypass is a sufficient, alternative method for managing ASAI as it obviates the complications of extensive open exposure.

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Declaration of competing interest

None declared.

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