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Urgent endovascular stent-graft placement for traumatic penetrating subclavian artery injuries

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Abstract

Penetrating injuries may infrequently cause pseudoaneurysms, lacerations and arteriovenous fistulas involving the subclavian artery. These injuries present with life-threatening bleedings, associated regional injuries and critical limb ischemia and although surgery has been considered the treatment of choice, subclavian injuries pose a real surgical challenge. We prospectively examined data of six patients presenting with penetrating subclavian artery injuries that were treated by urgent endovascular stent-graft placements. All stent-grafts were deployed successfully achieving complete exclusion of the pseudoaneurysm, control of bleeding and reconstruction of the injured artery. No procedural complications, stent thrombosis or stent infections occurred during hospitalization. One patient developed stenosis at 7 months, which required angioplasty. The series mean clinical and ultrasound-CTA follow-up is 38 +/− 19.7 months (range 11–60 months) and 28 +/− 19.1 months (range 6–58 months), respectively. This series shows the feasibility of endovascular repair by means of stent-grafts for selected patients with acute penetrating injuries of the subclavian arteries. This approach proved to be safe and effective in restoring the arterial lumen and patency, excluding the pseudoaneurysms and controlling the bleeding caused by subclavian lacerations. Mid-term follow-up on stent-graft patency rates are encouraging.

Keywords: Penetrating injury; Subclavian artery; Pseudoaneurysms; Arteriovenous fistula; Stent-graft

1. Introduction

Penetrating injuries to the subclavian artery (SA) are relatively uncommon but may be associated with considerable morbidity and mortality [1–3]. When active bleeding or critical limb ischemia is evident, urgent surgical repair has been considered the treatment of choice. Although different surgical approaches have been proposed for the emergency management of SA injuries, they are technically complex in an already debilitated patient and consequently entail considerable morbidity and mortality rates [4–7]. In recent years, stent-grafts have emerged as a valuable alternative to surgery in selected cases of SA injuries with encouraging results [8–11,13–18]. However, only a very limited number of these patients with SA penetrating injuries undergo urgent endovascular treatment in the acute setting [8,9,17]. We present our experience in a series of 6 patients with acute traumatic penetrating SA injuries that was urgently treated with stent-grafts.

2. Material and methods

During a 5-year period we prospectively examined six patients (six men; age range 16–32; mean age 22 years) admitted to our institutions for acute penetrating injury to the

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SA and that were urgently treated during the first 6 h after admission, by endovascular stent-graft placement (Table 1). A multidisciplinary approach was used in the care of these patients; involving the vascular, trauma, cardiothoracic, neurosurgery and radiology departments. During the initial resuscitation all the patients required endotracheal intubation and tube thoracostomy. In all the cases, partial or total control of the bleeding source was achieved by various means of external or internal compression and urgent arteriogram was immediately followed by therapeutic intervention. Inclusion criteria to this study were: patients who suffered penetrating injuries causing pseudoaneurysm with or without associated arteriovenous fistulas and/or focal laceration of the SA amenable to endovascular stenting, with bleeding controlled by external or internal compression, and no major contraindications for antithrombotic therapy. In patients admitted with massive uncontrolled bleeding, complex injuries requiring surgical repair or debridement, with extended arterial injuries or presenting upper extremity compartment syndrome with neurovascular compression surgical repair was considered the first option. Patients who treated with SA stent-grafts for pure arteriovenous fistulas, subacute or chronic traumatic lesions, iatrogenic or non-penetrating injuries were excluded from this study. Four of the patients suffered stab injuries and two from gunshot wound (GSW) injuries.

All the procedures except one (Patient #6), were performed under general anesthesia. In all the cases the selected endovascular route was transfemoral (unilateral, when a guiding catheter was used and bilateral, when sheathless approach was chosen) (Figs. 1 and 2); in two cases combined transfemoral and retrograde transbrachial approaches were used (Fig. 3). In this series of acute cases, no heparin bolus was administered before stent implantation and confirmed control of the active bleeding (clinical and angiographic) with adequate arterial reconstruction. Then, a single bolus of 80 IU/kg body weight of intravenous heparin was given and double antiplatelet therapy (clopidogrel 75 mg/day and aspirin 100 mg/ day) was initiated and maintained for 3 months. Due to the open nature of the trauma, all the patients received prophylactic pre-procedural antibiotic treatment.

Anatomical location and characteristics of the lesions, proximal and distal parent vessel diameters and relations between the injured segment and the main collateral arteries were determined with transfemoral high resolution digital angiography. Vertebral artery (VA) cross-flow was checked if one of the VA's was potentially endangered by the stent-graft.

The introducer sheath size varied from 9 to 10 F in the main femoral access and 4–5 F for the secondary access (femoral or brachial). Guiding catheters or long interventional sheaths are advanced to the origin of the injured subclavian artery. The

Table 1
Angiographic characteristics of the lesions, method of treatment and results

Patient no./age (years)/sex	Mechanism of injury/clinical presentation/surgical procedures before stenting	Location and type of lesion	SBP <90 at procedure (uninjured arm)	Endovascular approach/ implanted stent	Clinical/Doppler-CTA f/u(mo)
1/24/M	Knife injury/external and internal hemorrhage, hemo-pneumothorax, limb ischemia, shock/exploratory thoracotomy.	R-SA, mid-third pseudoaneurysm, extravasation	Yes	Transfemoral/Jostent 6×38 mm	12/12
2/16/M	Knife injury/external and internal hemorrhage, hemo-pneumothorax, shock/chest tube.	L-SA, mid-third blow-out pseudoaneurysms, extravasation	Yes	Transfemoral bilateral/Jostent 6×38 mm	55/49
3/32/M	GSW/external bleeding, brachial plexus injury, pneumothorax, limb ischemia, shock/chest tube.	R-SA, mid-third laceration, pseudoaneurysm and R-SA/R-BCV AVF, complete SA occlusion	Yes	Transfemoral and transbrachial/ Wallgraft 8×50 mm	60/58
4/27/M	GSW/external and internal hemorrhage, brachial plexus injury, lung contusion, carotid ischemic CVA, limb ischemia, shock/chest tube.	L-SA, mid-third SA blow-out, pseudoaneurysms	Yes	Transfemoral/fluency 8×40 mm and 9×40 mm	11/6
5/17/M	Knife injury/hemothorax, brachial plexus injury and limb ischemia/chest tube.	R-SA, mid-third SA pseudoaneurysm	No	Transfemoral/Jostent 6×38	50/18
6/22/M	Knife injury/external hemorrhage, hemothorax and limb ischemia/chest tube	R-SA, mid-third blow-out, pseudoaneurysms and R-SA/R-BCV AVF, complete SA occlusion	No	Transfemoral and Transbrachial/Wallgraft 8×30 mm	42/24

M: male, GSW: gunshot wound, SA: subclavian artery, AVF: arteriovenous fistula, BCV: brachicephalic vein, CVA: cerebrovascular accident.