



# An Analysis of 50 Surgically Managed Penetrating Subclavian Artery Injuries<sup>☆,☆☆</sup>

S. Sobnach<sup>a</sup>, A.J. Nicol<sup>a</sup>, H. Nathire<sup>a</sup>, S. Edu<sup>a</sup>, D. Kahn<sup>b</sup>, P.H. Navsaria<sup>a,\*</sup>

<sup>a</sup> Trauma Center, Groote Schuur Hospital and the University of Cape Town, Cape Town, South Africa

<sup>b</sup> Department of Surgery, Groote Schuur Hospital and the University of Cape Town, Cape Town, South Africa

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## KEYWORDS

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**Abstract Objectives:** The surgical management and outcome of penetrating subclavian artery (SCA) injuries is presented in this article.

**Design:** A retrospective chart review is used to detail the management and outcome of penetrating SCA injuries.

**Patients and methods:** Patients with penetrating SCA injuries presenting to the Groote Schuur Hospital from January 1997 to December 2007 were reviewed. Demographic data, mechanism of injury, associated injuries, angiographic findings, surgical treatment, hospital stay, complications and mortality were noted.

**Results:** Fifty patients with penetrating SCA injuries were identified from an operating trauma database. Stab and gunshot wounds accounted for 40 and 10 SCA injuries, respectively. The mean Revised Trauma Score (RTS) was 7.2. Angiography was obtained in 37 patients; false aneurysm (13) and total occlusion (nine) were the two most common findings. A median sternotomy was required in 25 (50%) patients and emergency room thoracotomy was performed in two patients (4%) for initial haemorrhage control. Primary repair of SCA injuries was possible in 52% of the patients. Three SCA injuries (6%) were ligated and one patient received an endovascular stent. Morbidity was restricted to associated brachial plexus injuries. The limb salvage rate was 100% and there were no deaths.

**Conclusion:** Preoperative angiography was useful in planning an operative approach. Primary repair was possible in the majority of the patients and ligation of SCA injuries was life-saving in critically ill patients.

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\* Corresponding author at: Trauma Center – C14, Groote Schuur Hospital, Observatory, 7925 Cape Town, South Africa. Tel.: +27 21 404 4117; fax: +27 21 404 4115.

E-mail address: [pradeep.navsaria@uct.ac.za](mailto:pradeep.navsaria@uct.ac.za) (P.H. Navsaria).

## Introduction

Penetrating subclavian artery (SCA) injuries occur infrequently and constitute less than 2% of all civilian vascular traumas.<sup>1–4</sup> Limited clinical experience, complex local anatomy and difficult exposure of proximal mediastinal vessels have rendered management of these injuries particularly difficult. The operative mortality rate ranges from 5% to 30% and is attributed to rapid exsanguination and a high incidence of concomitant injuries.<sup>5,6</sup> The purpose of this study was to review the surgical treatment and outcome of SCA injuries in an urban trauma centre with a high incidence of penetrating trauma.

## Patients and methods

The records of all patients undergoing surgery for a penetrating SCA injury in the Trauma Center at the Groote Schuur Hospital during the 11-year period from January 1997 to December 2007 were retrieved from a prospective trauma operating theatre database and retrospectively reviewed. There were no cases of non-operated SCA injuries.

Standard demographic information, mechanism of injury, admission vital signs, peripheral neurological deficit, haemoglobin concentration, blood transfusion requirements and diagnostic methods were recorded. Operation notes documented the location of the SCA injury, method of repair and local associated injuries. Admissions to the intensive care unit (ICU), duration of ICU and hospital stays as well as complications were noted. Initial management and resuscitation were conducted along standard Advanced Trauma and Life Support (ATLS)<sup>®</sup> guidelines. Emergency room thoracotomy (ERT) was performed in patients with no signs of life or with imminent cardiac arrest and/or immediate drainage of 1500 ml of blood from tube thoracostomy. Patients presenting in shock with active bleeding, or with an ischaemic limb, were resuscitated and expediently taken to the operative room (OR) for emergency exploration. Haemodynamically stable patients and those who stabilised after simple resuscitation (less than 2 l crystalloids) underwent further evaluation. Indications for angiography were: ipsilateral distal pulse discrepancy, absent pulse in the presence of a viable limb, large haematoma, thrill/bruit and mediastinal changes on plain chest radiograph. Transmediastinal tracts were investigated with a computed tomography of the chest and/or neck to determine trajectory, and angiography was then performed in the presence of mediastinal haematoma and/or an inconclusive CT finding, that is, the radiologist was not confident that an injury could be excluded.

## Operative technique

Surgical access to the subclavian artery depends on the clinical presentation and site of vascular injury. Patients with no signs of life or in imminent cardiac arrest require emergency room thoracotomy. Haemodynamically unstable patients are transferred to the operating room immediately. In the presence of active bleeding, patients are placed in the Trendelenburg position to minimise the risk of

air embolism and control of external haemorrhage is achieved by simple digital or manual pressure. Foley-catheter balloon tamponade (FCBT) can be used in an attempt to control bleeding, especially from the retroclavicular region. Further, a 'swab on a stick' can be used to apply pressure to minimise bleeding during exposure.

In the OR, all patients are positioned supine with a bolster beneath the shoulders; the head is placed in a head ring and turned to the opposite side with slight extension of the neck. The ipsilateral arm is down at the side. All patients are prepped and draped as for a median sternotomy, which allows for supra-, cross- and infraclavicular extensions. The groin is also prepared for harvesting the saphenous vein. Patients bleeding actively from the supraclavicular region undergo median sternotomy with supraclavicular extension and proximal control of the subclavian vessels. Patients bleeding from the infraclavicular region undergo supraclavicular exposure and proximal control if possible, failing this, a median sternotomy is performed. Patients undergoing surgery following confirmation of an injury on angiography undergo median sternotomy initially if the injury is proximal to the vertebral artery and/or involving the first part of the subclavian artery; all other injuries are approached through a supraclavicular incision, failing which, a median sternotomy is rapidly performed. Distal control is mandatory because of the extensive collateral circulation in the neck and shoulder region and is usually achieved with an infraclavicular incision in the deltopectoral groove. The supra- and infraclavicular incisions can be joined over the clavicle, which can be divided when necessary. Damage control surgery is reserved for the critically ill exsanguinating patient approaching the 'triad of death' of hypothermia, coagulopathy and acidosis. An initial 'bail out' operation for penetrating SCA injuries will include temporary shunting with pieces of nasogastric tubes, suction catheters and intravenous lines or ligation of the artery with or without packing of the surgical dissection with swabs. The patient is then resuscitated in the ICU and definitive arterial repair performed 24–48 h later on a stable, rewarmed patient with an acceptable coagulation profile.

## Results

Fifty patients with penetrating SCA injuries comprised the study group. There were 49 men and one woman with a mean age of 27 (range: 15–54) years. The mechanism of injury was a stab wound in 40 (80%) patients and gunshot wound (GSW) in 10 patients. Twenty-eight patients (56%) sustained injuries to the left SCA and 22 (44%) had right-sided injuries. Forty-eight patients (96%) presented within 24 h of their injuries and two patients (4%) had significant delays of 4 and 7 days, respectively. The mean Revised Trauma Score (RTS) was 7.2 (range: 3.0–7.8). The mean finger-prick haemoglobin estimation on admission was 9.4 (range: 4–14) G%. Seven patients (14%) were hypotensive (systolic blood pressure <90 mmHg) on arrival to the emergency room, whilst 43 patients (86%) were haemodynamically normal on presentation. A pulse deficit was present in 29 patients (58%). FCBT was used in four patients; in three patients bleeding was arrested and patients stabilised enough for formal angiography.

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