Penetrating Neck Trauma and the Aberrant Subclavian Artery

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ABSTRACT

Vascular injuries from penetrating trauma to the base of the neck are accompanied by significant morbidity and potential mortality. These injuries require several diagnostic adjuncts in order to facilitate early diagnosis and appropriate treatment. Herein reported is the case of a patient who sustained penetrating injury to the thoracic inlet but had a fortuitous anomaly that prevented vascular injury and its attendant complications.

Trauma Penetrante de Cuello y la Arteria Subclava Aberrante

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RESUMEN

Las lesiones vasculares por trauma penetrante en la base del cuello van acompañadas de morbosidad significativa y mortalidad potencial. Estas lesiones requieren varios medios auxiliares diagnósticos para facilitar el diagnóstico temprano y el tratamiento apropiado. Aquí se reporta el caso de un paciente que sufrió una lesión penetrante hasta la entrada torácica, pero tenía una anomalía fortuita que previno la lesión vascular y sus complicaciones asociadas.

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INTRODUCTION

Much of the knowledge on vascular injury from penetrating trauma is derived from lessons learnt during combat experience (1). The pendulum has now swung from mandatory exploration in the wartime era, when several diagnostic adjuncts were unavailable, to the position of liberal investigation with angiography (1, 2).

Subclavian injuries are challenging to manage because of diagnostic difficulty and the relative inaccessibility of the vasculature. Ultimately, this translates into high concomitant morbidity and mortality (1, 2).

An unusual case of a patient who sustained penetrating trauma along the normal course of the subclavian artery with resultant brachial plexus injury, clavicular fracture and an ipsilateral pneumothorax is presented. Despite the extremely high index of suspicion for injury, this patient escaped arterial injury due to a fortuitous congenital anomaly.

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CASE REPORT

A 27-year old male presented to the emergency room one hour after sustaining a single gunshot wound to the right posterior chest. Upon presentation, he was cardiovascularly normal with a heart rate of 90 beats per minute and blood pressure of 143/104 mmHg. He was noted to be tachypnoeic at a rate of 28 breaths per minute with a central trachea and reduced air entry in the right chest.

Musculo-skeletal examination revealed a gunshot entry wound at the angle of the right scapula with an antero-superior trajectory and a corresponding exit wound at the ipsilateral supraclavicular fossa. A 2 cm non-expansile, non-pulsatile haematoma was noted at the right supraclavicular fossa and there was an obvious mid-clavicular fracture. Upper limb pulses were present bilaterally and equal in volume. Paresis was noted in the right upper limb with grade 2 power (MRC) at the wrist and elbow and there was patchy paraesthesiae at the forearm and hand.

A right basal thoracostomy tube drained 400 ml of blood initially. A plain chest radiograph confirmed proper placement of the thoracostomy tube and revealed the presence of a residual right haemopneumothorax, with fractures of the right 8th rib and right clavicle (Fig. 1).

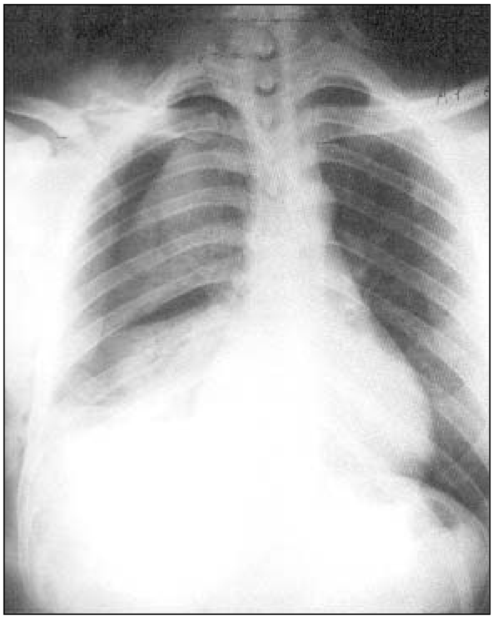

Fig. 1: Initial chest X-Ray showing right haemopneumothorax, with fractures of the right clavicle and right 8th rib.

With this bullet trajectory, right subclavian or axillary arterial injury was suspected. A subclavian angiogram *via* retrograde femoral cannulation was requested, but was delayed due to the presence of a coagulopathy with prothrombin time of 18.0/12.4 seconds and partial thromboplastin times of 31.1/30.0 seconds.

In the absence of angiography, contrast enhanced spiral computed tomography scan (CT) of the chest with thin slices of the path of the subclavian artery was done. This revealed that the right subclavian artery had an aberant retro-oesophageal course and an anomalous origin from the aortic arch (Fig. 2). The bullet path was noted in proximity to the course of the subclavian artery but there was no convincing evidence of arterial injury. Over the ensuing 24 hours, the haemoglobin fell from 14.2 g/dl to 12.0 g/dl but the patient remained haemodynamically normal with minimal thoracostomy drainage.

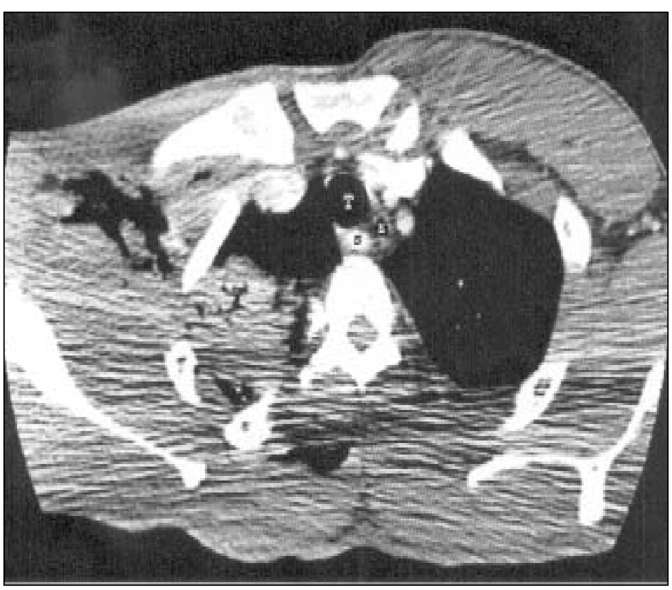

Fig. 2: Right subclavian artery (S) passing posterior to trachea (T) and oesophagus (E); right subclavian artery (intact).

Over this period of time, the coagulopathy was corrected with blood products and angiography was performed. Angiography confirmed the anomalous origin of the right subclavian artery and its aberrant course within the neck. Furthermore, it confirmed the absence of vascular injury (Fig. 3).

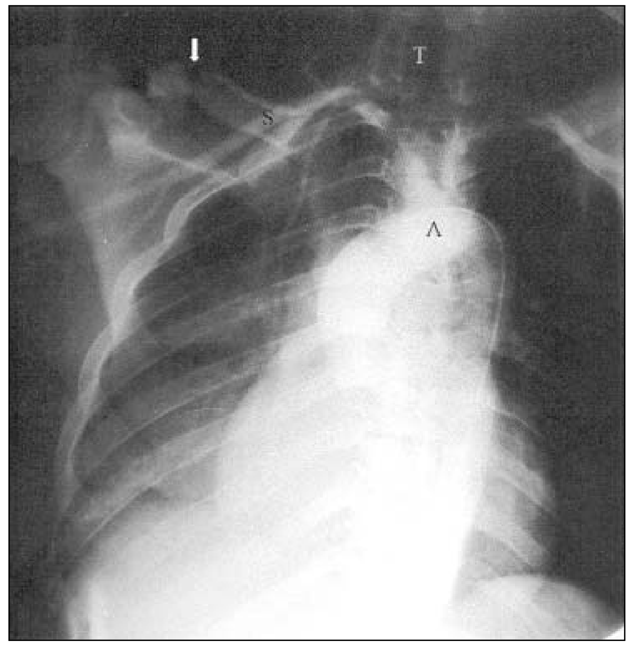

Fig. 3: Angiogram demonstrating intact anomalous right subclavian artery with origin from arch of aorta.

The patient remained well and the chest drain was discontinued after full lung re-expansion and minimal drainage was demonstrated. He was discharged four days after admission. His brachial plexus injury was managed as an outpatient in the orthopaedic clinic.

DISCUSSION

Penetrating trauma in proximity to the course of major arteries may result in vascular injury. It is important that these injuries be detected promptly to facilitate early treatment and minimize complications. Vascular injuries are easily detected when "hard signs" (absent pulses, arterial bleeding, expanding haematomas, vascular thrills, bruits or frank ischaemic changes) are present (3, 4). The diagnosis becomes more challenging in their absence but must be suspected in patients with proximity injuries (within 1 cm of the course of a named artery) and "soft signs" (stable haematoma, reduced capillary refill, pulse and nerve deficits).

These signs may be readily detected with peripheral arterial injuries (distal to the axilla in the upper limb) but the clinical features are usually occult when central arteries are involved (5–7). It was suspected that this patient had sustained vascular injury because the bullet trajectory was in proximity to the normal path of the subclavian artery which courses behind the midpoint of the clavicle. This suspicion was strengthened by the presence of soft signs – a stable haematoma and nerve deficits.

Subclavian arterial injuries are uncommon (5). Collective analysis of 1350 upper limb vascular injuries across five large population studies revealed that subclavian injuries account for 2% of cases in civilian trauma victims worldwide (8–12). Ramphal reported five cases in Jamaica managed over a single four-month period (7). They tend to occur most commonly in young males between the ages of 20 and 40 years who have sustained gunshot and stab wounds (1, 7, 10, 13). The incidence is rising concomitant with increases in civilian interpersonal violence (14). Subclavian arterial injuries are reported to carry nearly 100% morbidity (7, 5, 15, 16) and mortality rates between 10% (7, 17, 18) and 35% (6, 19). This does not include patients who never reach hospital alive (19). These injuries are difficult to detect clinically due to the relative inaccessibility of the vessels and a rich scapular anastomosis between branches from the first part of the subclavian artery (dorsal scapular and suprascapular arteries) and the third part of the axillary artery (subscapular and circumflex scapular arteries) (7, 20). With perfusion maintained *via* these rich collaterals, it is understandable that there may be a normal pulse in 40% (9, 20) to 50% (7) of the patients with injuries confirmed at operation. Several authors have noted a strong association with penetrating central vascular injury and brachial plexus injuries, pneumothoraces and fractures of the first rib or clavicle (6, 7, 20, 21, 22). This case has demonstrated that their presence is not pathognomonic of arterial injury.

The diagnosis of central vascular injury relies heavily upon investigations due to the unreliability of clinical examination (6, 7, 11). Angiography is the accepted gold standard for diagnosing these injuries (5, 6, 7, 11). Conventional angiography is a relatively safe procedure from which 0.16% – 2% of patients will experience complications, including haematoma formation, vascular spasm, thrombosis, distal embolization or vascular dissection (23). Unfortunately, complications involving the central nervous system can be catastrophic and potentially result in permanent damage. Despite this, the 10% – 35% reported mortality (6, 7, 17, 18, 19) and almost 100% morbidity (5, 7, 15, 16) associated with delayed diagnosis and treatment far outweigh the 0.16 – 2% potential morbidity that accompanies angiography. For this reason, angiography is routinely employed in patients with penetrating injuries in proximity to the course of a central artery (5–7, 11).

Recently, the use of angiography in clinically stable patients with penetrating proximity injuries has been questioned. Opponents have cited high cost, time consuming delays and the need for specialized equipment as drawbacks to its routine use (22). This has generated enthusiasm for alternative diagnostic modalities.

Recently, colour flow doppler (CFD) has been used as a screening tool in clinically stable patients, leaving angiography for suspicious cases or those requiring operative intervention. It is inexpensive, completely noninvasive and does not require administration of contrast medium. However, it is highly user-dependent and its accuracy may be limited by large haematomas or pneumothoraces that are common in zone I injuries.

Four prospective trials have utilized CFD to evaluate 279 patients with unselected penetrating neck injuries (24–27). Collective analysis reveals that CFD could exclude vascular injury in 77% of cases when compared to exploration and/or angiography. There were three reported false negatives, although some patients did not have any confirmatory investigations after negative CFD (25). There were 62 patients who had abnormal CFD and required exploration and/or angiography. Collective analysis revealed that CFD could identify vascular injuries after penetrating neck trauma with 95% sensitivity, 98.6% specificity, 97% positive predictive value and 98.6% negative predictive value. There is certainly a role for the use of CFD as a screening modality although it cannot be recommended to surplant angiography to diagnose these injuries (1).

Computed tomographic angiography (CTA) has also shown promise as an alternative for the initial assessment of stable patients with penetrating neck injuries. Computed tomographic angiography can reveal vascular injuries while providing valuable information regarding other vital structures in the neck (28–30). In addition, by depicting bullet trajectory, CT can guide further investigations resulting in significant savings (31–34). With the advent of multi-detector row CT and three-dimensional reconstruction, excellent image quality can be achieved in only 10 to 20 minutes (35, 36). Furthermore, the non-invasive nature is an obvious advantage over conventional angiography. Most authorities agree that the accuracy of CTA may be reduced when investigating penetrating zone I neck injuries, largely due to artifacts from bullet fragments, abundant soft tissue air from associated pneumothoraces and streak artifacts from the shoulders (28, 30, 37).

Three prospective trials specifically utilized CTA to investigate unselected penetrating neck injuries in a total of 270 patients (28, 30). Collective analysis revealed that CTA could reliably exclude arterial injuries in 80% of the patients who could be spared conventional angiography. Otherwise, CTA was non-diagnostic in 3% and diagnosed injuries in 17% of patients. This group of patients may require formal angiography for confirmation of injury, and some have voiced concern about the compounded contrast load in these cases. Overall CTA was reported to have only 0.4% false negativity, although some of the patients in the largest trial (30) had only clinical follow-up without confirmatory angiography or CFD. There is promising evidence that CTA may be used as a screening investigation in stable patients but it also needs further validation by larger prospective randomized trials before it can be recommended to surplant angiography.

This patient was investigated initially with a contrast CT that suggested the presence of a retro-oesophageal right subclavian artery but could not reliably exclude arterial injury due to the proximity of the bullet tract. The fractured clavicle and pneumothorax also made interpretation difficult and highlights some limitations of CT. The findings were eventually proven to be accurate when angiography confirmed the anomaly and excluded injury. The correlation between angiography and CT reinforces its potential use as a screening modality. Magnetic resonance angiography has been used to evaluate the neck vasculature in dissections and atherosclerotic disease (37). But to our knowledge, there have been no reports in the literature where MRA was used for vascular neck trauma. This is likely due to the difficulty in monitoring these acutely ill patients and contraindications due to metallic debris after gunshot wounds (37).

This patient had a demonstrable vascular anomaly – a right retro-oesophageal subclavian artery. Cadaver studies suggest that it occurs in 0.5% (38) to 2.5% (39) of persons, with a propensity to occur in women (40). It has also been reported to be commoner in patients with genetic anomalies including trisomy 21 (41) and chromosme 22q11 deletion (42). The right subclavian artery arises from the right brachiocephalic artery behind the sternoclavicular joint and continues as the axillary artery as it crosses over the outer border of the first rib behind the midpoint of the clavicle. Embryologically, the proximal right subclavian artery develops from the right fourth primitive aortic arch artery and the distal part from the seventh inter-segmental artery. Abnormal involution of the fourth right aortic arch causes the persistence of the inter-segmental artery that remains attached to the aorta and persists as the aberrant artery (42–46). These patients usually have a concomitant "non-recurrent" recurrent laryngeal nerve (45).

This anomaly is usually asymptomatic, being discovered incidentally or at autopsy (47, 48). But few case reports exist of symptomatic cases where patients present with atherosclerotic aneurysms (49) and symptomatic atherosclerotic stenoses (50) due to accelerated atherosclerosis at the retro-oesophageal course. There have also been two published case reports of upper limb ischaemia due to thrombosis at the retro-oesophageal course (51) and eventual embolism terminating in upper limb amputations (48).

Feugler reported 11 cases of arterio-oesophageal fistulae in patients who had indwelling nasogastric tubes. Fistula formation occurred in non-aneurysmal arteries and was thought to be due to necrosis from pulsatile compression of the oesophageal wall between the aberrant vessel and the catheter (46).

Patients may also develop *dysphagia lusoria* when the oesophagus is compressed between the aberrant artery posteriorly and the trachea anteriorly (47). The presence of this anomaly has also predisposed patients to increased risk of iatrogenic injury during surgical operations (45, 52, 53). Inadvertent ligation without reconstruction is reported to carry 30 – 45% incidence of critical ischaemia in the upper limb (54, 55) and may also produce the subclavian steal syndrome (45).

There are several ways in which the presence of a right retro-oesophageal subclavian artery may become clinically evident by causing problems. But this patient was fortunate to have this chance anomaly. The authors firmly believe that the aberant course protected the artery from injury since the bullet tract traversed the path of the normal subclavian artery. Because these anomalies are seldom suspected, radiologic investigations rarely diagnose them pre-operatively (45). This case was again unique in this respect as the anomaly was initially detected on CT scan. Hara (56) reported a small series where 25 cases were initially detected on contrast CT scan. They note that it may be easily missed or confused with the azygous vein in this aberrant location (45, 56). Most cases required confirmation with angiography as occurred in this patient.

Although this patient turned out not to have vascular injury, the case reinforces the fact that a high index of suspicion must be maintained since these injuries are notoriously difficult to predict. Also, although anecdotal, it supports the liberal use of investigations for central arterial injuries due to the unreliability of clinical examination.

CONCLUSION

Central vascular injuries after penetrating neck trauma are uncommon. They are accompanied by high morbidity and mortality because they are difficult to detect. In order to facilitate timely diagnoses, trauma surgeons must be familiar with the recommended diagnostic algorithms.

Angiography remains the gold standard investigation for diagnosis. It should be utilized liberally for central arterial injuries suspected on the basis of proximity or the presence of soft signs of injury. But CTA and CFD are being used increasingly to screen and select patients for angiography.

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