CASE REPORT

Acute subclavian artery occlusion with associated clavicle fracture managed with bypass graft alone

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SUMMARY

Subclavian artery injury is a rare consequence of clavicle fracture. It most often results from penetrating trauma but can result from blunt trauma with adjacent bone fragments causing rupture, pseudoaneurysm, dissection or thrombosis of the artery. If flow through the subclavian artery is compromised there is a risk of ipsilateral upper limb ischaemia. Life-threatening haemorrhage may result in cases of laceration, and cerebral infarction may result from dissection. Vascular injury in association with clavicle fracture is typically regarded as an indication for internal fixation of the fracture. We present a case of subclavian artery thrombosis in association with a comminuted midshaft clavicle fracture causing limb ischaemia managed by carotid to brachial artery bypass without internal fracture fixation. The fracture united at 4 weeks and there was no sustained vascular or neurological impairment at follow-up. We advocate urgent vascular intervention in subclavian artery injury. There is little discussion in the literature regarding non-operative management of clavicle fractures with subclavian artery injury. We suggest that select clavicle fractures with subclavian artery injury can be safely managed non-operatively.

BACKGROUND

Acute traumatic subclavian artery (SA) occlusion is rare. Recognition of acute SA injury is critical to avoid serious sequelae. This case describes a clavicle fracture associated with SA injury and upper limb ischaemia with clinical photographs, preoperative radiographs, CT and clinical examination findings, at the time of injury and at follow-up.

CASE PRESENTATION

A 73-year-old right hand dominant man presented following a 1.5 m fall from a ladder with right midshaft comminuted clavicular fracture. He described losing balance on the ladder and falling onto his outstretched right hand with his shoulder flexed and elbow extended to break his fall. On hitting the ground, he felt immediate pain in his right clavicle, and shortly thereafter was unable to move his right upper limb and had associated paraesthesia in the arm and hand. On initial examination, the patient was unable to move his arm, had reduced sensation in the distribution of all cords of the brachial plexus and had a cold, pulseless limb. A CT angiogram of the chest confirmed a 7 cm filling defect in the right SA extending into the axillary artery. Haematoma surrounded the SA but no active extravasation was seen. Contrast was present in the vessels distal to the filling defect (figure 1). The level of arterial occlusion corresponded to the site of clavicle fracture seen on radiograph (figure 2). Other injuries included an undisplaced right third rib fracture, T1 right transverse process fracture and soft tissue haematomas on all limbs.

Significant medical history included ischaemic heart disease with previous midline sternotomy for coronary artery bypass surgery using the patient's right great saphenous vein.

The patient was provided a bolus of 5000 units of low-molecular-weight heparin and commenced on a heparin infusion before being transported to our centre. On arrival, repeat clinical examination was performed in which there was grossly normal right arm motor function, but sustained abnormal sensation. There were no radial, ulnar or brachial pulses palpable, although capillary refill had returned to a time of <2s. A repeat CT angiogram of the chest did not show any significant change to the SA filling defect.

Surgical intervention was discussed between senior members of the Vascular, Orthopaedic and Cardiothoracic surgical units. A decision was made to bypass the injured vessel with reverse saphenous vein graft and manage the clavicle fracture non-operatively. The rationale for this course of action was in order to avoid directly approaching the artery and thereby risking dislodging surrounding clot and causing significant bleeding. Bleeding in that situation may be difficult to control and could require performing a revision sternotomy through scarred tissue which would be difficult in a timely manner. Considering the clavicle fracture, we felt that it in isolation did not warrant fixation, especially if its

Figure 1 CT with 3D reconstruction in the acute setting showing filling defect in the right SA extending to the axillary artery. SA, subclavian artery.

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Figure 2 X-ray of the comminuted right clavicular fracture.

fixation may result in disturbance of the SA and surrounding stable haematoma.

TREATMENT

Approximately 30cm of the left great saphenous vein was harvested. The graft was reversed and anastomosed to the right common carotid artery and burrowed subcutaneously to the proximal right brachial artery. Postoperatively, strong distal pulses were palpable and motor and sensory function returned to normal in the right upper limb. No reperfusion injury was sustained.

OUTCOME AND FOLLOW-UP

The patient was discharged after 5 days in hospital. His right arm was immobilised in a sling for 4 weeks to allow the clavicle to heal. Subsequent ultrasound graft studies at 1 month, 3 months and 6 months demonstrated a widely patent carotid to brachial artery bypass graft with triphasic waveforms in the outflow vessels. The patient has no longstanding neurological deficit and has been able to return to his premorbid functioning with no significant chronic symptoms.

DISCUSSION

SA injury must be suspected in patients that sustain high-energy trauma to shoulder and thoracic regions. Evaluation of injuries with history, examination and appropriate imaging is mandatory. Examination should include assessment of skin colour, temperature, sensation, hand function and the presence of pulses.¹ Contrast CT is a key diagnostic exam, while angiography offers both a diagnostic and a therapeutic approach. Associated radiographic findings include haemothorax, and upper rib, cervicothoracic spine and clavicular fracture.

Clavicular fractures have an annual incidence of approximately 30–60 cases per 100 000 people. Fortunately, neurovascular compromise is rare but recognised to occur in <1% of all clavicle fractures.^{2–5} The most common complication is non-union which is documented to occur between 4.5% and 15% and is dependent on the location of fracture.^{6,7} Internal fixation of clavicle fractures may reduce the rate of non-union, but can result in other complications such as plate prominence, cutaneous sensory disturbance and very rarely local vascular injury that have caused death.^{8,9} The cited indications for clavicle fracture fixation include open fracture, skin tenting with imminent perforation, associated vascular injury, painful non-union and pathological fracture. Relative indications for clavicle fixation include the degree of displacement and location of fracture,

floating shoulder and for the purpose of expediting recovery or aiding nursing care in the setting of polytrauma.

SA injuries from clavicle fracture most commonly presents as a closed injury with new paraesthesia of the upper limb. Although this case describes injury from a minimally displaced fracture, it is more common with a posterior bone shard which usually results from a high force injury such as with a motor vehicle accident.¹⁰ This sort of injury is more often associated with an isolated thrombus formation in the vessel rather than a rupture, dissection or pseudoaneurysm,¹¹ and although delayed presentations have been treated successfully in late phases,^{12,13} documented cases of massive haemorrhage with fatality due to rupture of the SA¹⁴ or acute cerebral infarction due to retrograde thromboembolisation¹⁵ highlight the importance of urgent therapeutic management of SA injury.

Many authors divide treatment of SA injuries based on an algorithm of haemodynamic stability. Unstable patients require open surgical or endovascular management whereas stable patients may be treated by less invasive modalities. Medical management may include anticoagulation therapy and catheter-directed thrombolytic therapy.

Open surgery in the region can be hazardous as it may require either a sternotomy or a supraclavicular and infraclavicular approach for safe proximal and distal control of the vessel. In this case, the patient had previously a sternotomy and would thus have granted difficult thoracic access. Direct approach to the injured region of vessel risks significant blood loss and injuries to nearby neurovascular structures, and thus in our case, the decision was made to avoid the injured region and perform a carotid to brachial artery bypass. The 5-year patency rates for such bypass procedures are approximately 90%.¹⁶ Carotid steal syndrome is a rare consequence of such a procedure.¹⁷ The disadvantage of bypass techniques are inadequate visualisation of the injured artery and inability remove bone fragments that further arterial injury.

Endovascular treatment and stent deployment have been described in SA dissection and pseudoaneurysm resulting in thrombus and upper limb ischaemia, as well as penetrating trauma.^{18,19} Five-year patency rates are approximately 82% for stenting procedures.¹⁶ Endovascular approaches offer the advantage of being less invasive than open techniques but have the inherent problem of not being able to visualise the injured artery and adjacent structures. In our case, the exact nature of underlying crush injury causing occlusive thrombus was not clear based on CT, and instrumentation of the area was deemed to risk haemorrhage without immediate options for controlling it.

A generally accepted principal of treating fractures with associated vascular injury is that bony stability should be achieved before vascular repair is performed. This is because tension on the graft may cause failure without fracture fixation. There are some exceptions to this such as axillary artery injury with dislocation of the shoulder where complete immobilisation of the shoulder is not indicated or practical. Whether this is true for the clavicle which has multiple soft tissue attachments and a relatively restricted range of motion is not known. The clavicle acts as strut to support the shoulder girdle. At the sternoclavicular joint there is approximately 15° protraction to 15° retraction and 45° elevation to 10° depression.²⁰ From medial to lateral, sternocleidomastoid, pectoralis major, deltoid and trapezius attach. The costoclavicular and coroclavicular ligaments also act to stabilise the clavicle to chest and shoulder girdle, respectively. On the inferior surface, subclavius is thought to play a protective role for adjacent neurovascular structures in the event of

fracture. If direct repair of the SA is undertaken, then it seems logical to proceed with reduction and internal fixation of the associated clavicle fracture. Access to the SA may be improved by clavicle fracture in a similar way that osteotomy of the clavicle may facilitate access. It can be reasonably assumed that fixation at the time of vascular repair adds little risk and ensures maximum protection of the repaired artery.

Learning points

- ▶ Subclavian artery (SA) injury is a rare complication that should be always be considered in the setting of clavicle fracture.
- ▶ Endovascular and open surgical treatment are both viable management options for SA obstruction.
- ▶ It is unclear whether clavicle fixation offers benefits if alternative techniques to direct arterial repair are employed.

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