CASE REPORT

Locking plate external fixation and negative pressure wound therapy for treatment of a primary infection in a closed clavicle fracture

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SUMMARY

Infection in a clavicle fracture is uncommon, but remains a challenging problem. A paucity of soft tissue coverage often combined with significant displacement and interfragmentary movement add complexity to an already difficult situation for effective infection treatment.

External fixation in principle offers a means of achieving fracture stability, while the infection is being eradicated. We present the case of a closed clavicle fracture, initially treated conservatively, that presented 5 weeks later with infection. The fracture was definitively treated with external fixation using a locking plate positioned superficially to the skin, plus negative pressure wound therapy and subsequent secondary closure and antibiotic therapy. This case illustrates a novel method of treatment in this unusual presentation that was well tolerated by the patient and resulted in a good clinical outcome.

BACKGROUND

Infection is a recognised complication of clavicle surgery and a risk that should be considered when determining the most suitable treatment of choice for a clavicle fracture.¹ Occasionally, patients may present with open fractures of the clavicle or with closed fractures in which the skin is under pressure and deemed to be at high risk of necrosis. Cases such as this potentially pose a much greater risk of infection.^{2–4} Infection is not ordinarily considered a significant risk in closed clavicle fractures.¹

Established infection in a clavicle fracture poses a major treatment challenge as the surgeon seeks to create stability at the fracture site without introducing further foreign material or metal that will potentially provide a locus for infection. External fixation is a common technique used for treatment of fractures in which metal at the fracture site is ideally avoided. In addition, it allows for optimal treatment of soft tissue injuries. External fixation for treatment of clavicle fractures has been well described; however, some authors have noted that it may be poorly tolerated by some patients.⁵ We describe a case of a closed clavicle fracture, initially treated conservatively, that subsequently developed an infection a number of weeks following the injury. This was successfully treated with a novel method of external fixation (figure 1).

CASE PRESENTATION

A right-hand-dominant male aged 37 years presented acutely to the emergency department following a road traffic accident in which his

motorcycle had collided with another vehicle. At the time of the accident, he had been wearing full protective gear, including helmet and leathers. He was travelling at ~20 km/hour when the car in front had braked suddenly, causing him to collide with the rear end of the vehicle. On presentation, he had discomfort in his lower back, reduced range of motion in his right shoulder girdle and pain associated with an obvious deformity of the right clavicle. The injury was closed with no skin tenting. Plain film X-ray revealed a comminuted displaced midshaft fracture of the right clavicle (figure 2). There were no bony injuries of the lumbar spine. The patient had no comorbidities or other medical or social history of note.

The patient was initially managed in a broad arm sling. He was reviewed in an orthopaedic clinic at 7 days postinjury, his options were discussed and the decision was made to manage the fracture conservatively. At this review, it was again noted that the skin over the fracture site was intact and was not under any tension.

He was subsequently seen again in the outpatients department for routine review at 5 weeks postinjury. At this stage, it was noted that there was an 8 cm area of swelling and erythema around the midclavicle consistent with cellulitis. The skin remained intact and there was no punctum or areas of necrosis. The patient reported that this increased swelling had developed in the preceding week. He had otherwise been well and there were no other obvious sources of infection. He was started on oral antibiotics (phenoxymethylpenicillin and flucloxacillin) and he was booked for review at the outpatient clinic the following week. At 6 weeks postinjury, the skin remained unbroken; however, an area of fluctuance was observed around the

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Figure 1 Clavicle locking plate external fixator.

Figure 2 Initial plain film X-ray.

Figure 3 MRI of the periclavicular collection.

fracture site. The patient described increasing pain in the region and had been feeling generally unwell for the preceding 3 days, with associated night sweats. His inflammatory markers were moderately raised with a C reactive protein of 19 mg/L and an ESR of 44 mm/hour. One millilitre of pus was aspirated from the swelling and sent for culture and sensitivity. An MRI was performed of the clavicle in order to evaluate the relationship between the collection and the underlying vessels ([figure 3](#)). The cultured sample subsequently grew a penicillin-sensitive strain of *Staphylococcus aureus*.

TREATMENT

The patient was admitted to hospital and started on intravenous flucloxacillin. The following day, he was brought to theatre. He underwent an incision and drainage of the collection. An oblique incision was made over the clavicle and a 15 mL collection of frank pus consistent with infected haematoma was evacuated. The abscess was thoroughly debrided and irrigated with separate solutions of normal saline, chlorhexidine, betadine and hydrogen peroxide. With the patient in the beach chair, semiupright position, the fracture was reduced under direct vision. An 8-hole LCP precontoured clavicle locking plate (Synthes) was used as an external fixator to achieve fracture site stability while the local infection was treated. Given the potential risk of injury to neurovascular structures that lie in close proximity, particular attention to screw length was paramount in this situation.⁶ Two equipment sets were used in the case in order to allow the use of four locking drill guides. Two millimetre K-wires were inserted unicortically through two of the locking guides, allowing the plate position to be adjusted and held while accurate screw length could be achieved by drilling through and measuring from the other two guides. The screws were each introduced percutaneously through small separate skin incisions. The wound was partially closed and a negative pressure dressing was applied ([figures 1 and 4](#)).

OUTCOME AND FOLLOW-UP

The patient returned to theatre at 48 hours for repeat washout, secondary dressing and closed wound negative pressure

Figure 4 Postoperative plain film X-ray.

Figure 5 Six-month plain film X-ray.

reapplication. The negative pressure therapy was discontinued on the fifth postoperative day. Prior to discharge, he received counselling regarding the management and maintenance of the external fixation device. He completed a further course of 6 weeks of oral antibiotics. At 6 weeks, the plate and screws were removed under general anaesthetic. Physiotherapy with shoulder range of motion exercises continued throughout the duration the plate remained in situ. All wounds healed well, without further complication.

Radiographs at 6 months postfixation revealed successful union of the fracture fragments and an acceptable alignment of the clavicle ([figure 5](#)). At that stage, the patient had regained full functional use of the limb, with a shoulder range of motion that was equal to the contralateral side.

DISCUSSION

Infection in clavicle fractures is well described. Duncan *et al*⁷ presented a case series of infections in clavicle fractures. Five of the six cases presented after previous clavicle surgery. One of the cases involved an infection in a conservatively managed fracture in a diabetic patient, which developed following break down of the overlying skin at the fracture site. All cases described were treated with debridement and removal of hardware where applicable and this was later followed by internal fixation in some cases. This represents a commonly adopted treatment strategy for these types of cases. Unfortunately, the risk of non-union remains high. Two of the six cases described in this series ultimately resulted in a non-union. In each of the cases, the causative organism was identified as *S. aureus*, *propionibacterium acnes* or both organisms. Similarly, the samples from the patient in our report cultured *S. aureus*. This is consistent with possible inoculation of skin commensals at the fracture site.

What makes this case very unusual is that the infection in the clavicle fracture did not present until 5 weeks postinjury. Furthermore, the skin had remained intact throughout this time.

This is not a presentation that has previously been described for a closed clavicle fracture.

The use of external fixation for the treatment of clavicle fractures has previously been described.^{2–5 8 9} Schuind *et al*³ described a case series of clavicle external fixators, employed for a variety of different indications. In the authors' series, seven of the cases had involved an open fracture or a fracture in which the overlying skin was considered to be at high risk of necrosis. The authors describe a mean duration of external fixation of 51 days. From their findings, they advocate consideration of external fixation in open clavicle fractures or infected non-unions. Another case reported by Strauss *et al*⁴ involved a lateral clavicle fracture compromised by *S. aureus* and *Streptococcus pyogenes* infection. This was successfully treated with external fixation using a conventional external fixation device. The patient had initially presented with a closed injury but had developed ulceration of the skin over the fracture site between 5 and 7 days postinjury. Bonneville *et al*² described a case of bilateral clavicle fractures treated with external fixation. As with our case, the fractures were closed injuries and were initially treated conservatively. At 2 weeks postinjury, they reported significant inflammation bilaterally with bullous formation at the fracture site on one side. The decision was made at that point to debride and apply external fixation. Culture samples were positive for *Propionibacterium acnes*.

A recent systematic review examining the use of external fixators illustrates their value as a suitable alternative in the treatment of clavicle fractures.⁵ The authors however make the suggestion that in the setting of an atrophic non-union, their role may be limited. They also drew attention to the poor patient tolerance of conventional external fixation devices when applied to a clavicle. Given the size and appearance of the device and its proximity to the patient's face, it may prove to be a significant source of inconvenience and psychological stress for the duration that it remains in situ.

Locking plates serve as constructs by which stability at a fracture site is achieved. Although the surface of the plate does not necessarily need to be in direct contact with the bone to achieve this, they are usually implanted as an internal fixation device, flat on the bone and deep to skin and soft tissues. The use of locking plates as a device for achieving external fixation is not a new concept. A number of authors have described the use of this method for the treatment of tibia fractures.⁸ The technique has been referred to as 'supercutaneous plating'. It has been suggested that this method may offer a number of advantages over conventional external fixation methods.^{8 9} The locking screw head mechanism provides an additional degree of stability to the construct, particular in its resistance of angular forces. This may result in a greater ability to resist loosening. The locking plate is arguably easier to apply than conventional external fixators. Another supposed advantage is that the locking plate with its uniform shape, smooth edges and low profile is likely to be much better tolerated by the patient.

To the authors' knowledge, there have only been only two previous cases described in the literature that used a locking plate as an external fixation device for the treatment of a clavicle fracture. Kloen⁸ described a series of four cases, three involving tibia fractures and one case involving the treatment of a midshaft clavicle fracture. The latter case was a woman aged 44 years with an infected non-union of a clavicle fracture following internal fixation. At 16 weeks, she underwent a debridement and placement of a 3.5 mm 10-hole locking compression plate superficial to the skin. This was subsequently removed at 2 months and an open reduction and internal fixation was

performed resulting in successful fracture healing. Another case report by Sirisreerux *et al*⁹ describes the use of a 9-hole 3.5 mm LCP reconstruction plate used as an external fixation device to treat an open clavicle fracture resulting from a gunshot wound. The plate was removed after 8 weeks in situ and resulted in successful fracture union. The authors raised concerns in their discussion that a 3.5 mm locking plate may not be strong enough to provide adequate stability when used in as an external fixator. They suggest that a 4.5 mm plate could also be considered. However, despite their concerns, the authors do present a satisfactory outcome with a 3.5 mm plate, which was similar to our own experience in the management of the case reported above.

Johnson *et al*¹⁰ describe the case of a delayed presentation of skin ulceration 14 months following open reduction internal fixation of a clavicle fracture. This was treated successfully with the removal of hardware, application of a conventional spanning external fixator and a modified Lautenbach technique. The Lautenbach technique involved application of a closed double-lumen suction irrigation system, which facilitated ongoing intermittent local administration of antibiotic. Although in the case described in our report, a double-lumen suction irrigation system was not used, a conventional negative pressure dressing was applied to good effect. It was found that given the compact shape of the locking plate, negative pressure dressing placement and maintenance were easily facilitated. In order to achieve an adequate seal, an adherent film drape was simply placed on top to envelope the entire construct, a technique that may not have been possible with a conventional external fixation device.

Learning points

- ▶ Infection can present as a complication in a closed, conservatively managed clavicle fracture.
- ▶ External fixation is an effective method of definitive fixation for infected midshaft clavicle fractures.
- ▶ Low profile locking plates serve as an alternative method of providing external fixation of fractures.
- ▶ Locking plate external fixation facilitates easy negative pressure dressing application and is well tolerated by patients.

Competing interests None declared.

Patient consent Obtained.

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