■ UPPER LIMB

Surgical treatment of physeal injuries of the lateral aspect of the clavicle

A CASE SERIES

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Lateral clavicular physeal injuries in adolescents are frequently misinterpreted as acromioclavicular dislocations. There are currently no clear guidelines for the management of these relatively rare injuries. Non-operative treatment can result in a cosmetic deformity, warranting resection of the non-remodelled original lateral clavicle. However, fixation with Kirschner (K)-wires may be associated with infection and/or prominent metalwork. We report our experience with a small series of such cases.

Between October 2008 and October 2011 five patients with lateral clavicular physeal fractures (types III, IV and V) presented to our unit. There were four boys and one girl with a mean age of 12.8 years (9 to 14). Four fractures were significantly displaced and treated operatively using a tension band suture technique. One grade III fracture was treated conservatively. The mean follow-up was 26 months (6 to 42).

All patients made an uncomplicated recovery. The mean time to discharge was three months. The QuickDASH score at follow-up was 0 for each patient. No patient developed subsequent growth disturbances.

We advocate the surgical treatment of significantly displaced Grade IV and V fractures to avoid cosmetic deformity. A tension band suture technique avoids the problems of retained metalwork and the need for a secondary procedure. Excellent clinical and radiological results were seen in all our patients.

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Injuries of the lateral aspect of the clavicle are rare in children, accounting for about 10% of paediatric clavicular fractures.[1] They are commonly misinterpreted as dislocations of the acromioclavicular joint (ACJ), although they are in fact Salter–Harris type 2[2] fractures of the lateral clavicular physis. The coracoclavicular ligaments remain intact, unlike following a dislocation of the ACJ, allowing the periosteal sleeve to maintain its relationship with the ACJ. Instead, the metaphysis displaces through the periosteal sleeve, akin to a banana slipping out of its skin; this has been described as a 'pseudo dislocation' (Fig. 1).[3,4] Dameron and Rockwood[5] classified these injuries in a similar manner to dislocations of the ACJ, based on the disruption of the periosteal tube and the consequent metaphyseal displacement (Fig. 2). Type I injuries involve a mild sprain without disruption of the periosteal tube. Type II injuries involve partial disruption of the dorsal periosteal tube with slight widening of the lateral clavicular physis. Type III injuries involve a complete dorsal disruption of the periosteal tube with < 100% superior displacement of the metaphysis. Type IV injuries involve disruption of the periosteal tube with superior and posterior displacement of the metaphysis. Type V injuries involve disruption of the periosteal tube with > 100% superior displacement of the metaphysis. Type VI injuries theoretically involve a subcoracoid displacement of the metaphysis, although there are no reports of this injury in the literature.

Owing to the rarity of these injuries, there are no clear guidelines for their treatment. What little material there is in the literature suggests that treatment should be determined by the degree of displacement of the metaphysis,[3] with a preference for conservative management, given the potential for remodelling in children. The periosteal sleeve is thought to be osteogenic and fills the gap between the periosteum and metaphysis. However, there are reports of the formation of a bifid or Y-shaped lateral clavicle in conservatively treated patients.[3,6] Although there are no reports of functional limitation associated with this deformity, some patients have undergone resection of the lateral clavicle because of local discomfort or cosmetic concerns.[4,7] The incidence of cosmetic deformity varies from 6.7%

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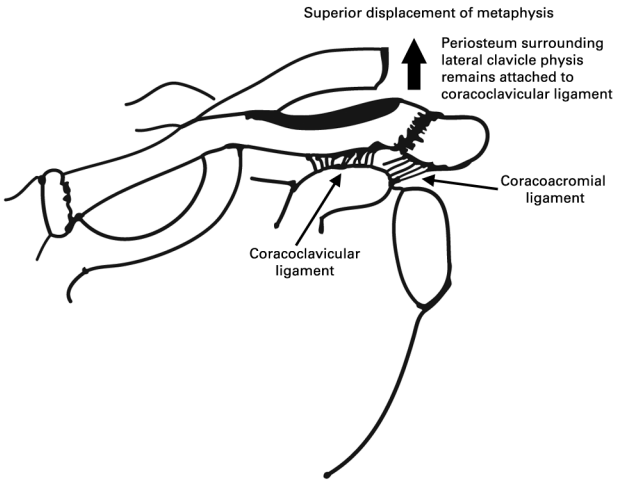

Fig. 1

Diagram showing the metaphysis slipping out of the dorsally torn periosteum and displacing superiorly.

Fig. 3

Intra-operative photograph showing the polydioxanone suture (PDS) passed in a figure-of-eight configuration.

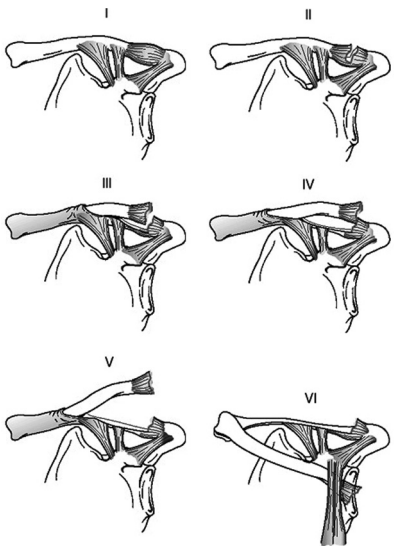

Fig. 2

Diagrams showing the Dameron and Rockwood classification[5] of lateral clavicular physeal injuries.

to 70.0%.[7-9] Furthermore, there seems to be a reduced potential for metaphyseal remodelling in this region, which may allow the deformity to persist into adulthood.[8] Some authors have therefore suggested intramedullary Kirschner (K)-wire fixation for displaced physeal injuries of the lateral aspect of the clavicle, despite possible complications such as infection, wire migration or prominent metalwork necessitating a second operation.[4,8,9] Falstie-Jensen and Mikkelsen[4] recommended reduction of the fracture and closure of the periosteal sleeve in order to avoid the problems of fixation with metalwork.

The aim of this study was to present our experience with the treatment of these injuries.

Patients and Methods

All children presenting to our institution between October 2008 and October 2011 with injuries to the shoulder were seen by the senior author (MT) and his registrars. There were five with type III, IV and V injuries; four boys and one girl, with a mean age of 12.8 years (9 to 14). The four patients with type IV and V injuries were advised to undergo surgical treatment. All operations were performed by the senior author (MT).

Operative technique. With the patient in the beach chair position, the fracture is approached through a bra-strap incision. The displaced metaphyseal fragment is replaced in the periosteal tube and held temporarily with a K-wire. A 2 mm hole is then drilled in an anteroposterior direction through the metaphysis. A heavy polydioxanone suture (PDS; Ethicon, West Somerville, New Jersey) is passed free-hand through the hole and then transosseously through the epiphyseal fragment, or through the ACJ if the epiphyseal fragment is too small for secure fixation. The suture is tied in a figure-of-eight configuration (Figs 3 and 4) to hold the reduction, and the K-wire is removed. A second suture of a similar configuration may also be used for added security. The periosteal and trapeziodeltoid sleeves are repaired over the clavicle and the wound is closed. The patient is immobilised in a polysling and gentle mobilisation started two weeks post-operatively (Fig. 5).

They were reviewed regularly, post-operatively and, after obtaining formal ethical approval for the study, they were contacted and completed Quick-DASH (Disabilities of the Arm Shoulder and Hand) questionnaires,[10] which were completed retrospectively and returned. The QuickDASH is a shortened version of the DASH Outcome Measure that

Fig. 4

Pre-operative radiograph showing a type IV injury in a 14-year-old male patient.

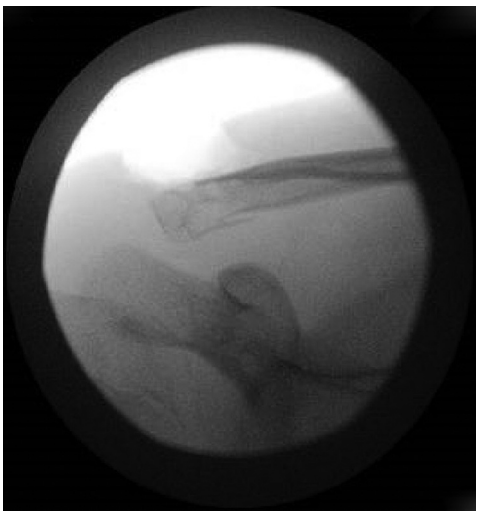

Fig. 5

Intra-operative fluoroscopic image of the same patient as in Figure 4 showing reduction.

measures physical function and symptoms in people with any or multiple musculoskeletal disorders of the upper limb.

Results

All patients were discharged from the clinic at three months (by which time all had radiological union and full functional recovery), and the mean follow-up was 26 months (6 to 42), at which time the Quick-DASH score was 0 for all patients. All had a full active range of movement of the shoulder without evidence of disturbance of growth requiring further treatment.

Discussion

The acromioclavicular ligaments attach to the perichondrium of the lateral clavicular epiphysis and then blend into the periosteum, making the physeal–metaphyseal area the biomechanically weakest region of the interface. The deforming forces will therefore result in a fracture at either lateral clavicular physis or the midshaft of the clavicle, rather than an ACJ dislocation.[3,4,11] Depending on the magnitude of the force, the injury can range from variable stripping of the periosteum in mild cases to dorsal displacement of the clavicle through a tear in the thick periosteal tube. The periosteum attached to the distal epiphysis, the ACJ and the coracoclavicular ligaments remain intact. As the distal epiphysis retains a cartilaginous cap into the mid-20s, this injury may occur in young adults and must be distinguished from true ACJ dislocation. The oldest patient described in the literature sustaining a physeal injury was 21 years old.[4]

Plain radiographs are usually sufficient to evaluate the injury. An anteroposterior radiograph with a 20° cephalad tilt will show the superior displacement. When there is minimal disruption of the periosteal sleeve, the acromial process is in its normal position relative to the lateral apsect of the clavicle, whereas disruption of the periosteal sleeve leads to discontinuity between the acromion and the clavicle. As the end of the clavicle and the acromion are incompletely ossified, the normal cartilage space may be misinterpreted as widening of the ACJ instead of a fracture of the lateral aspect of the clavicle. An axillary/lateral radiograph will demonstrate anteroposterior displacement, but the majority of patients are in too much pain to manoeuvre the arm in the correct position for this view.

Ogden[3] treated 14 patients ranging from infancy to 15 years of age with this type of injury, five of whom were treated operatively with a combination of open and closed pin fixation; displacement was cited as the rationale for surgery. There was no functional loss at a mean follow-up of ten years, although one patient who was treated conservatively subsequently underwent excision of the duplicated clavicle.[3] Havránek[9] treated ten patients ranging from nine to 15 years of age. Only one, with a displaced fracture causing protraction of the shoulder girdle, was treated surgically with pin fixation and hemicirclage of the Thurston–Holland fragment.[12] All fractures united without functional sequelae. Although seven patients developed a cosmetic deformity, no mention is made of whether they received treatment for this, or the length of follow-up. In the largest series to date, Black, McPherson and Reed[7] treated 45 patients ranging from five to 16 years with these injuries, with a mean follow-up of 2.7 years; six were treated operatively, and some experienced backout of the metalwork. They reported good functional outcomes in most patients; two had discomfort that did not limit activity, and three had a cosmetic deformity.

Most fractures of the midshaft of the clavicle in children, sustained by a similar mechanism, are treated non-operatively and unite at a mean of 6.3 weeks,[13] whereas these fractures united at a mean of three months. Although there are many reports in the literature of non-operatively treated patients developing deformity after lateral clavicle fractures,[3,7,9] there does not appear to be enough follow-up to conclude whether the deformity persists into adulthood or

whether it causes late problems. Furthermore, there is insufficient follow-up to determine whether there are late growth plate disturbances that might cause deformity from lateral clavicle physeal injuries before skeletal maturity.

Like fractures of the midshaft of the clavicle fractures, minimally displaced fractures of the lateral clavicular physis (Dameron and Rockwood[5] types I to III) in children and adolescents will heal without any functional disturbance if treated non-operatively.[5,11] Given the excellent potential for spontaneous healing, some authors also advocate the non-operative treatment of significantly displaced injuries (Dameron and Rockwood types IV to VI) with good functional results,[13] although there appears to be a higher likelihood of residual cosmetic deformity.[3] Although this deformity does not cause any functional limitation, some patients may require excision of the duplicated clavicle for aching, discomfort or cosmesis. As a consequence grossly displaced injuries tend to be treated surgically with reduction and K-wire fixation, with a risk of local complications.[4,8,9] Based on this small case series we would recommend the use of an open tension band repair using absorbable sutures, to avoid cosmetic deformity while also avoiding the complications associated with K-wires.

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