Outcome of lateral humeral condylar mass fractures in children associated with elbow dislocation or olecranon fracture

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Abstract Of 2,502 elbow/humeral injuries treated at our department between 1990 and 2005, we identified a cohort of 20 lateral condylar mass (LCM) fractures of the humerus in children associated with elbow dislocation ($n=12$; mean age 8.2 years) or with olecranon fracture ($n=8$; mean age 4.1 years). Eight patients with undisplaced fracture pattern were treated conservatively yielding a satisfactory outcome. Good to excellent results were obtained in the majority (85%). Overall, the result was poor in three patients (15%; 25% of the operated cohort) due to terminal 20–30° loss of extension. There was no obvious difference in the outcome between the isolated displaced LCM fractures described in the literature and this cohort. Testing of elbow stability by examination under anaesthesia is stressed. Undisplaced fracture patterns need to be closely observed. Parents should be warned about the likelihood of some degree of unfavourable outcome in the displaced LCM fractures with associated elbow injuries.

Resume Sur les 2502 cas de traumatismes du coude traités dans notre département entre 1990 et 2005, nous avons identifié une cohorte de 20 fractures du condyle externe (LCM) associées à une luxation du coude ($n=12$, moyenne d'âge: 8,2 ans) ou avec une fracture de l'olécrane ($n=8$, moyenne d'âge 4,1 ans). 8 patients présentant une fracture non déplacée ont été traités orthopédiquement avec un très bon résultat obtenu dans la majorité des cas (85%). Cependant, les résultats ont été médiocres chez 3 patients

(15%; 25%) du fait d'une perte d'extension. Il n'y a pas de différence évolutive entre ces patients présentant une fracture isolée du condyle externe comparés aux patients relevant d'une étude de la littérature. Le groupe de patients avec fractures déplacées doit être averti de la possibilité de résultats moins favorables, notamment s'il existe des lésions associées du coude.

Introduction

Lateral condylar mass (LCM) fractures of the distal humerus comprise 17% of distal humeral fractures and are the second most common injury around the elbow in the paediatric population, after supracondylar fractures [8, 9]. Most LCM fractures occur as an isolated injury. Whilst an undisplaced LCM fracture can be treated conservatively with close observation, the available evidence recommends open reduction and internal fixation for displaced fractures [2–4, 17, 20]. There is a paucity of literature describing LCM fractures of the elbow in children, which occur concurrently with olecranon fracture or elbow dislocation. A few isolated case reports or small case series of five or less have reported LCM fractures in association with elbow dislocation [11, 17, 21] and olecranon fractures [15].

We describe the first and largest series of LCM fractures occurring concurrently with olecranon fracture ($n=8$) or dislocation of the elbow ($n=12$) with the aim of elucidating the management, outcome, and complication rate.

Materials and methods

Between January 1990 and June 2005, we identified 2,502 elbow/humeral injuries in the departmental database. There

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were 20 LCM fractures in this unique group with concurrent olecranon fracture ($n=8$) or dislocation of the elbow ($n=12$). A retrospective case record review was performed to elucidate demographic data, the mechanism of injury, diagnosis, and treatment of the LCM fractures and associated injury. Information was collected from theatre charts, case notes, and radiographs. Postoperative radiographs were taken at three and six weeks and were assessed for union. All patients with complete bony union and full functional recovery at three months were subsequently clinically examined in the clinic, while radiographs were only made at the time of the final follow-up in clinically symptomatic patients at six months, one year, and annually thereafter. All patients were followed-up to full recovery or until their condition ceased to progress. Further follow-up in patients with full union and a full range of motion was considered inappropriate as the condition of these patients would not have led to delayed union, nonunion, cubitus valgus deformity, or tardy ulnar palsy. The mean follow-up was 15.9 months (range, 6 months to 4 years).

LCM fractures have been classified in relation to the degree of displacement and rotation of the fracture fragment [10]. Stage I fractures have less than 2 mm displacement and an intact articular surface. Stage II fractures have 2–4 mm displacement with moderate displacement of the articular surface. Stage III fractures are widely displaced and rotated. Milch's classification [12], which is based on the anatomical position of the fracture line, was not used because it is less helpful for management and prognosis. Milch type II LCM fractures with apparent subluxation of the elbow were excluded.

The stability of the elbow was assessed at the beginning of the procedure and after treating the associated injury. A lateral approach was used to reduce the LCM fracture, with fixation by 2 K-wires or a solitary screw, according to the surgeon's preference. Undisplaced LCM fractures were managed nonoperatively. After plaster immobilisation for 3–5 weeks, K-wires were usually removed (mean 3.7 weeks, range 3–5 weeks) in the pin clinic without any anaesthesia. Screws were removed by 3–6 months (mean 3.8 months) from insertion under general anaesthesia.

The outcome assessment included measurement of the carrying angle, range of elbow motion, and any complications. Final clinical results were evaluated according to Flynn's criteria [3]. Loss of motion of more than 15° or loss of the carrying angle of more than 15° of valgus or more than 5° of varus was considered unsatisfactory.

Results

The patient demography, mode of treatment, and outcome are summarised in Table 1. LCM fracture associated with

Table 1 Patient demography, fracture pattern, treatment, and outcome of lateral condyle mass (LCM) fractures in children associated with elbow dislocation or olecranon fracture

LCM fracture with associated elbow dislocation

Mean age: 8.2 (5–12 years)
Gender ratio: 12 male : 0 female
Laterality: 11 right : 1 left
LCM fracture displacement: 3 undisplaced, 9 displaced
Treatment: 9 operative, 3 nonoperative
Complications: Terminal 20–30° loss of extension in three
Outcome: 9 excellent, 3 poor (all three operated cases)

LCM fracture with associated olecranon fracture

Mean age: 4.1 (3–7 years)
Gender ratio: 5 male : 3 female
LCM Fracture displacement: 5 undisplaced, 3 displaced
Olecranon fracture displacement: 7 undisplaced, 1 displaced
Treatment: 3 operative (3 LCM, 1 Olecranon), 5 nonoperative
Complications: terminal 10° loss of extension in 1
Outcome: 7 excellent, 1 good

elbow dislocation was identified in 12 cases. The mean age was 8.2 years (range, 5–12 years). All were male patients, and 11 out of 12 were right-sided. Seven were posterolateral elbow dislocations, four were posterior, and one was lateral. Three patients also sustained medial epicondylar fractures, which were treated without fixation in two and with 2 K-wires in one patient. One of the complex fracture dislocations was further complicated by the presence of a cubitus varus deformity following a previous supracondylar fracture in the same arm. One patient had transient ulnar paraesthesia. None of them had a vascular injury.

Testing of elbow stability by examination under anaesthesia is stressed. Intraoperative stress radiographs are taken to confirm displacement of LCM fracture and direction of elbow dislocation (Fig. 1). The elbow dislocation was first managed by closed reduction followed by open K-wiring ($n=3$), screw

Fig. 1 Testing of elbow stability by examination under anaesthesia is stressed. Intraoperative stress radiograph confirmed LCM fracture and dislocation of elbow

fixation ($n=6$), or conservative treatment ($n=3$) of the LCM fracture. Three patients had an unsatisfactory outcome with 20–30° loss of extension at final follow-up. One patient had breakage of a K-wire. The embedded end was left in situ with no deleterious effect.

LCM fracture associated with an olecranon fracture was found in eight cases. The mean age was 4.1 years (range, 3–7 years). There were five boys and three girls. Six of eight were left-sided. Seven of the olecranon fractures were undisplaced and were managed without fixation (Figs. 2, 3, 4, 5), though two required fixation of the associated LCM fracture. The other five LCM fractures were stable and were managed conservatively. All had a satisfactory outcome after 3–4 weeks in plaster. The remaining case, with displaced LCM and displaced olecranon fractures, was treated by open reduction and K-wire fixation of both fractures through a posterolateral approach. This patient presented four days after sustaining the injury and the final outcome was good with only minor loss of the terminal 10° of extension. The remaining seven patients had excellent results.

Fig. 2 Preoperative anteroposterior radiograph of the elbow revealing slightly displaced LCM fracture and an undisplaced olecranon fracture of elbow

Fig. 3 Preoperative lateral radiograph of the elbow revealing slightly displaced LCM fracture and an undisplaced olecranon fracture of elbow

Discussion

This report highlights the need to be aware of other injuries which can occur in association with LCM fractures in children. The complex elbow anatomy, with multiple growth centres appearing at different ages in the skeletally immature population, can pose a diagnostic dilemma. Careful evaluation of these unusual injuries is crucial as accurate preoperative diagnosis allows appropriate management. There is a paucity of literature on LCM fractures which occur in association with elbow dislocation or olecranon fracture. This series of 20 cases is the largest. None of the injuries were missed and 17 of 20 had a good or excellent outcome.

LCM fractures occur most commonly between 5 and 10 years of age. The lateral condyle is fractured by a valgus stress applied to the condyle by the radial head. In addition, the force can fracture the radial neck, dislocate the elbow, or break the olecranon, which is fixed in the trochlea while the forearm continues into the valgus. Alternatively, the leverage of the olecranon may fracture the medial condyle though medial epicondylar fractures are probably avulsion

Fig. 4 Postoperative anteroposterior radiograph of the elbow after internal fixation of the lateral condyle fracture. The olecranon was treated nonoperatively

injuries through pull of the medial collateral ligament. Applying Jakob's classification [10] to this series, eight were type I and were managed nonoperatively. The six type II and six type III cases were treated operatively. Good to excellent results were obtained in the majority (85%). Overall, the result was poor in three patients (15%; 25% of the operated cohort) due to terminal 20–30° loss of extension. All these patients had returned to school, gym, or recreational activities fully without any symptoms or growth abnormalities in the elbow.

We agree with Flynn [3], Foster et al. [4], and Mintzer et al. [13] that minimally displaced fractures can be treated with casting and close observation. There were eight patients in this series (40%) with undisplaced LCM fractures treated conservatively. All had excellent to good result because of the potential for remodelling in young children.

For displaced fractures, anatomical reduction and fixation of the LCM is essential since this is a Salter Harris type IV injury. Both the growth plate and articular surface should be anatomically aligned. A missed or inadequately treated LCM fracture can lead to nonunion, malunion, recurrent dislocation,

abnormalities in the carrying angle, prominence of the lateral humeral condyle, progressive cubitus valgus deformity, and tardy ulnar palsy [8–10, 12].

Isolated traumatic dislocation of the elbow is uncommon in children, comprising 3–6% of all elbow injuries. The peak incidence occurs between 13 and 14 years of age [13–19]. Dislocation of the elbow is classified by the direction of the dislocation of the ulna. Elbow dislocations rarely occur with lateral condyle fractures. More commonly, there is a medial epicondyle pull-off fracture through traction from the medial collateral ligament.

Murnaghan et al. [14] and Rovinsky et al. [16] described a Milch Type I lateral condyle fracture–dislocation, and Van Haaren et al. [21] reported a paediatric posterior elbow dislocation with an associated Milch Type II lateral condyle fracture. These authors recommended stress films to aid in diagnosis. If a dislocated elbow is associated with a fracture, it is essential to reduce the dislocation first, and then reassess the fracture on the postreduction films. The fracture can be treated as if the dislocation had not occurred. Similarly, in a case report by Sharma et al. [17], the elbow dislocation was reduced by closed manipulation. Subsequently, elbow stability was assessed under general anaesthesia. Open reduction and internal fixation of the lateral condyle fracture was achieved with two Kirschner wires. This patient made a full recovery with no loss of motion, no alteration in the carrying angle, and no symptoms. In three patients, examination under anaesthesia after closed reduction of the elbow dislocation revealed a stable LCM fracture. These were treated by casting and close observation. Open K-wiring ($n=3$) or screw fixation ($n=6$) was carried out in the remaining nine patients. Three had an unsatisfactory outcome in the form of limitation of terminal 20–30° elbow extension.

Olecranon fractures in children may be epiphyseal or metaphyseal. They make up 1.6% of fractures around the

Fig. 5 Postoperative lateral radiograph of the elbow after internal fixation of the lateral condyle fracture

elbow. Pure epiphyseal fractures of the olecranon are rare. The physis closes at about the age of 14. Salter-Harris pattern types I and II are described. Metaphyseal fractures occur from either a direct blow or resisted extension or an extension injury, which is usually associated with a valgus component [7, 22]. Graves and Canale [7] recommended that surgical intervention be limited to those patients with >5 mm of displacement and also concluded that displaced fractures rarely occur before 10–12 years of age. Because the cartilaginous portion is not visible on radiographs, some authors recommended an arbitrary limit of 3 mm rather than 5 mm. Wilkins [22] recommended assessing the stability of the fracture by direct palpation and flexion of the elbow. If either manoeuvre causes separation of the fragment, open reduction and internal fixation is required.

In the English literature there is only one report published of combined olecranon and LCM fractures [15]. Although, concomitant LCM–olecranon fractures have been documented previously without further details by Gicquel et al. [6] (1 of 26), by Caterini et al. [1] (4 of 63), and by Gaddy et al. [5] (1 of 35). In our series, five undisplaced LCM and undisplaced olecranon fractures were successfully treated nonoperatively. There were two cases with a displaced LCM associated with an undisplaced olecranon fracture. Both LCM fractures were treated by open reduction and K-wire (=1) or screw fixation (=1). Only one case, with displaced LCM and displaced olecranon fractures, required operative intervention for both fractures.

In both these groups in our study, there was a significant difference in the ages at injury (4 for olecranon and 8 for elbow dislocation). It is possible that the olecranon is weaker in the younger child and fails next after the LCM. In the older child the ligaments, particularly the medial collateral, are probably the next weakest link after the LCM.

One weakness of the study is lack of radiological assessment in clinically asymptomatic patients. We believe that further radiographic assessment in clinically asymptomatic patients with normal carrying angle is entirely inappropriate. First, if the fracture is healed, it is highly unlikely that the fracture would lead to complications. Second, excess bone overgrowth and minor degree of malunion seen in the majority of these radiographs with clinical nonrelevance do not influence decision making of management planning.

There was no obvious difference in the outcome between the isolated displaced and undisplaced LCM fractures described in the literature [8–10, 12, 17] and the complex LCM group reported in this series. There were no cases of nonunion, mal-union, avascular necrosis, cubitus valgus, or tardy ulnar palsy in this series during our follow-up period. None of the injuries were missed.

LCM and associated elbow dislocation or olecranon fractures are uncommon. Their management can be technically demanding. Concomitant elbow dislocation should be managed by closed reduction followed by open K-wiring or screw fixation of the lateral condyle fracture. Once the elbow is reduced, LCM fracture should be assessed for stability. Postoperatively, a close clinico–radiological follow-up helps to diagnose early any loss of reduction, especially in conservatively treated nondisplaced groups. Patients with a dislocated elbow need good quality radiographs post reduction to exclude a concomitant fracture. If there is doubt, an examination and fluoroscopic screening of elbow stability under anaesthetic is recommended. The undisplaced LCM cohort with associated olecranon fracture can be treated nonoperatively without assessment of stability under general anaesthesia. Displaced LCM–Olecranon cohort should be managed by open reduction internal fixation.

This report highlights the need to be aware of other injuries which may be associated with LCM fractures in children. Careful evaluation of these unusual injuries is crucial to enable appropriate management. We believe that these patients, especially LCM fractures with associated elbow dislocation, are better assessed under general anaesthesia. Parents should be warned about the likelihood of some degree of unfavourable outcome in the displaced fracture pattern associated with elbow dislocation.

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