TRAUMA

Management of lateral humeral condylar mass fractures in children

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Lateral condylar mass fractures; Elbow; Open reduction internal fixation; Screw; K-Wire

Summary
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. LCM fractures occur most commonly between five and ten years of age, usually as an isolated injury. Whilst an undisplaced LCM fracture can be treated conservatively with regular radiographic observation, the available evidence recommends open reduction and internal fixation for displaced fractures. Growth plate and articular surface should be aligned and restored during open reduction and internal fixation. Missed, inadequately reduced or improperly fixed lateral humeral condylar fractures can lead to stiffness, non-union, malunion, recurrent dislocation, progressive cubitus valgus deformity and tardy ulnar palsy.

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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. LCM fractures occur most commonly between five and ten years of age. 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.

There remains little evidence to decide whether pins or cancellous screws yield better outcomes.

This article provides an overview of the current evidence-based practice in the management of LCM fractures and details of perioperative care, postoperative results and complications.

Mechanism of injury
The possible mechanisms are

1. ‘push-off’ (blow to palm with elbow flexed when falling);
2. ‘pull-off’/avulsion (adduction of forearm with elbow in extension and forearm in supination during a fall);
3. direct blow to the olecranon.

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Classification

There are three main classifications, which are widely used to describe LCM fractures (Table 1).

The Milch\(^8\) classification is based on the anatomical position of the fracture line (initially described by Stimson). In Type I fractures, the fracture line courses lateral to the trochlea and passes through the capitello-trochlear groove. In the Type II injury, the fracture line extends into the apex of the trochlea. Milch described the more common Type II injury as a fracture-dislocation and the Type I injury as a simple fracture. The Milch type I could be considered as a variant of the Salter-Harris type IV physeal injury, while the Milch type II fracture is equivalent to a Salter-Harris type II physeal fracture.\(^8\)

Jakob et al.\(^9\) described lateral condyle fractures in relation to the degree of displacement and rotation of the fracture fragment. Stage I displaced fractures have less than 2 mm of displacement with an intact articular surface. In Stage II displaced fractures, there is 2–4 mm of displacement with moderate displacement of the articular surface. Stage III displaced fractures demonstrate significant displacement associated with rotation of the fragment.

Badelon et al.\(^10\) classification

This system of classification describes four different types based upon the degree of displacement of the fracture. This classification helps in fracture management.

Type 1. Undisplaced fracture line seen on single radiograph i.e. projection only.
Type 2. Undisplaced fracture line seen on both views.
Type 3. Displacement more than 2 mm on both views.
Type 4. Complete separation of fragments.

Clinico-radiological assessment

Displaced fractures usually produce diffuse swelling that distorts elbow surface anatomy. The key to diagnosis is localised swelling over the lateral aspect of the elbow and tenderness over the lateral condyle. With non-displaced or minimally displaced fractures, these signs may be subtle, leading to delay in detection. Antero-posterior and lateral radiographs of the elbow should be taken and examined for significant soft-tissue swelling of the lateral aspect of the elbow and a ‘fat-pad’ sign if a fracture is not obvious. The location of the fracture line, the degree of displacement and the relationship of the condylar ossification centre to the radial head should be noted. It is important not to miss associated injuries such as fractures of the olecranon, medial condyle, forearm bones, or elbow dislocation. Oblique views may be helpful when there is doubt, as may be arthrograms and MRI or ultrasound scanning.\(^3\)

The role of the cartilage hinge as a major factor in determining stability of the fracture has been recently stressed.\(^11\) An MRI scan may be a better tool in the diagnosis of integrity of this hinge as compared to plain radiographs. Chapman et al.\(^12\) described the role of multidetector computerised tomography (MDCT) in accurately detecting the exact degree of displacement and integrity of the lateral soft tissue hinge.

Management strategy

For practical purposes, all fractures can be grouped under two categories: undisplaced and displaced (Fig. 1). Most authors agree that fractures with displacements greater than 2 mm need open reduction. Pirker et al.\(^13\) suggested that fractures with less than 2 mm displacement can be treated non-operatively but these patients need radiographs out of plaster at 4–6 days to detect further displacement. Progressive loss of position of the fragment in the plaster cast is an indication for open reduction and internal friction and requires surgery.\(^14\) Minimally displaced fractures with an intact periosteal hinge can be managed with percutaneous pinning. The available evidence recommends open reduction and internal fixation for displaced fractures.

Surgical procedure

(A) Postero-lateral approach

This approach is considered a safe approach through the interneural interval (Kocher interval) between anconaeus and the extensor carpi ulnaris thus protecting the posterior interosseous nerve.\(^15\) This is the senior author’s preferred approach particularly if the child is placed prone when the whole of the posterior surface of the joint can be seen with ease, ensuring an accurate and anatomical fracture reduction. No muscle needs to be released from the distal fragment, thus preserving the blood supply to the physeal fragment.

(B) Lateral approach

This approach also uses an interneural interval between extensor digitorum communis and extensor carpi radialis...
brevis but because of its direct lateral nature, risk of injury
to posterior interosseous nerve is considered to be high.

The displacement and size of the fragment usually are
greater than is apparent on the radiograph because of the
large cartilaginous portion of the fragment. A single
cancellous screw can be used (Fig. 2). It should be inserted
proximal to the physis, where possible, to minimise the risk
of growth arrest. Hasler and von Laer\textsuperscript{16} in their study
concluded that screw osteosynthesis led to anatomical
union, symmetrical carrying angles and full range of move-
ment in all of their operated cases at 10 years average
follow-up. None of these patients had any growth dis-
turbances.

If K-wiring is preferred two are necessary to prevent
rotation of the fragment. The pins may be parallel or
crossed, but if crossed pins are used they should not be
crossed at the fracture site. Divergent pins (one horizontal
and one up the lateral column) also provide a sound fixation
(Fig. 3A and B). The pins can be removed at 3 to 4 weeks,
while the screw is removed between 3 and 6 months.
An algorithm for the management of LCM fractures in children is provided in Fig. 4.

**Post-operative management**

The limb is elevated and the neurovascular status is assessed. Patients are usually discharged the following day in a long arm plaster with a broad-arm sling for support. The child is reviewed in the fracture clinic 3 weeks later, at which time the pins are removed without anaesthesia, and a radiograph obtained. A further 3 weeks of immobilisation in plaster is ensured, and active mobilisation is then usually possible without the need for physiotherapy. As full extension is seldom possible on removal of the cast, a further final follow-up is arranged to assess the carrying angle, elbow ROM and return of function. Contact sports and activities likely to result in a fall are not allowed for 12 weeks after the fracture. Follow-up until skeletal maturity is carried out at some centres.

**Complications**

Complications are listed in Table 2.

1. Spur formation. Lateral condylar spur formation is the commonest complication. It can be seen in fractures which are treated operatively and non-operatively. It has no functional significance.

2. Cubitus varus. Some overgrowth of the lateral mass is common. Following conservative or operative treatment. The cause is unknown.

3. Cubitus valgus. It is less common than cubitus varus and is more commonly seen with non-unions. It is thought to be due to premature epiphysiodesis on the lateral side.

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Figure 3 (A), (B) LCM fracture treated with two K-wires.

Figure 4 Algorithm for the management of lateral humeral condylar fractures in children.
Fish tail deformity. There are two types. Firstly, a sharp angled wedge type. There is a gap between the lateral condylar physis ossification centre and medial ossification of the trochlea. The second type is a smooth gentle curve thought to be due to avascular necrosis of the lateral part of medial crista of the trochlea. Rutherford\textsuperscript{17} suggested that this deformity is caused by inadequate reduction.

Delayed union. This is seen mainly in fractures treated non-operatively, even if in satisfactory position.

Non-union. Non-union can occur with or without angulation. Flynn et al.\textsuperscript{14} defined non-union when the fracture had failed to heal by 12 weeks. Non-union with angulation is seen in Badelon type 2 and 3 fractures. Non-union can lead to cubitus valgus deformity and tardy ulnar nerve palsy. Principles of management of non-union are open reduction to achieve apposition of the fracture fragments and then compression across the fracture site.

Miscellaneous. Physeal arrest, malunion, myositis ossificans and avascular necrosis (usually iatrogenic secondary to excessive dissection).

In summary, closed treatment results in a satisfactory outcome if the initial radiographic displacement does not exceed 2 mm. This requires close follow-up for detection of displacement. Most authors agree that fractures with displacement beyond 2 mm need open reduction.

### Table 2 Complications related to LCM fracture and its management.

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<tr>
<th>Immediate</th>
<th>Short term complications</th>
<th>Long term complications</th>
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<tr>
<td>Infection</td>
<td>Metal related problems</td>
<td>Non-union</td>
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<tr>
<td>Neurovascular problems</td>
<td>Prominence of lateral condyle</td>
<td>Malunion</td>
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### Practice points

1. Second most common injury around the elbow in the paediatric population, after supracondylar fractures
2. Open reduction and internal fixation are recommended for even minimally displaced fractures
3. Missed, inadequately reduced, or improperly fixed lateral humeral condylar fractures lead to a poor outcome and the place for late fixation or reconstruction is controversial

### Research directions

1. RCT for screw versus K-wire fixation
2. Use of bio-absorbable screw fixation
3. Role of magnetic resonance imaging to assess stability

### References