FRACTURE-SEPARATION OF THE
DISTAL HUMERAL EPIPHYSIS

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We have reviewed 12 cases of fracture-separation of the distal humeral epiphysis, three of which were initially misdiagnosed as fractures of the lateral condyle and one as an elbow dislocation.

Cubitus varus deformity is as common after this fracture-separation as it is following supracondylar fracture, and is most common in children under two years of age. Closed reduction and simple immobilisation is adequate for the older child, but we recommend for those under two years of age that closed reduction should be followed by percutaneous pinning, so that the carrying angle can be assessed immediately after reduction. If the elbow is then in varus the wires should be removed, reduction repeated and treatment by straight lateral traction used to maintain a valgus carrying angle.

Fracture-separation of the distal humeral epiphysis is rare, the largest series of 16 patients being that reported by DeLee et al (1980). At Red Cross Children’s Hospital, Cape Town, we see two or three cases per year, as compared with about 20 fractures of the lateral condyle of the humerus and 60 displaced supracondylar fractures. Diagnosis may be difficult and arthrography is sometimes helpful. We have reviewed 12 consecutive cases, seen over five years.

MATERIALS AND METHODS

Twelve patients with fracture-separation of the distal humeral epiphysis were treated from 1984 to 1989, their ages ranging from birth to four years eight months. The left humerus was fractured in eight and the right in four. The cause of injury was a fall in seven, child abuse in three, a motor vehicle accident in one and a birth injury in one. One child-abuse case and the birth injury both presented after a delay of more than a week and one patient, initially treated elsewhere, was seen three months after injury.

In four cases the initial diagnosis was wrong: the injury was thought to be fracture of the lateral condyle in three and an elbow dislocation in one. Displacement was posteromedial in 11 and anterior in one. No patient had any neurovascular damage.

A metaphyseal fragment (Salter–Harris type II) was present in seven cases; the other five, with Salter–Harris type I injuries, were all under two years of age. Two of the child-abuse cases had other healing fractures (Fig. 1). The child who was involved in a motor vehicle accident also had flexor tendon injuries at the same wrist, and presented to us with a stiff elbow after three months.

Treatment was by closed reduction and immobilisation in pronation for three weeks in three cases, and by open reduction and Kirschner wire fixation through a lateral approach in four, three of which had the mistaken diagnosis of lateral condylar fracture. The other five had no reduction; two were only slightly displaced and three had presented too late.

We reviewed 10 patients at six to 31 months (average 13), assessing symptoms, carrying angle, and the ranges of flexion-extension, pronation and supination. Full length radiographs of both arms in extension and supination allowed measurement of the carrying angle,

Fracture-separation of the distal humerus may be caused by child abuse.
RESULTS

Carrying angle. There was cubitus varus of 5° to 15° in three of the 10 patients who had radiographic measurements (Table I). Two of these patients had had closed reduction and one had open reduction and fixation with Kirschner wires; all three were under two years of age.

Range of movement. In five patients elbow flexion-extension was limited by less than 25°, which did not interfere with function. The untreated patient, seen three months after injury and, who also had forearm tendon repairs, had a flexion deformity of 55°. All 10 patients had full pronation and supination.

DISCUSSION

The diagnosis of fracture-separation of the distal humeral epiphysis must distinguish the injury from a fracture of the lateral condyle in the older child, and from elbow dislocation in the younger child.

Over one to two years. After the appearance of the capitellar ossification centre, its displacement can be seen to be posteromedial (Fig. 2) and not anterolateral as in lateral condylar fracture (Fig. 3). (A very rare exception would be a flexion type of fracture-separation, with anterior displacement.) The displacement of the capitellum can be estimated in relation to the line of the anterior cortex of the humeral shaft on the lateral radiograph.

Table I. Reported carrying angles after treatment for separation of the distal humeral epiphysis in six series of cases of separation of the distal humeral epiphysis

<table>
<thead>
<tr>
<th></th>
<th>Cubitus varus</th>
<th>Cubitus valgus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Decreased</td>
<td>Normal</td>
</tr>
<tr>
<td>DeLee et al 1980</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Holda, Manoli and LaMont 1980</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>McIntyre, Wiley and Charette 1984</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Mizuno et al 1979</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Siffert 1963</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>de Jager and Hoffman 1991</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>All series</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

*fixed flexion deformity
which normally bisects the middle third of the ossification centre. Posterior displacement may be the only radiographic feature of a Salter–Harris type I injury.

The midline of the radial shaft (Stüren 1958) passes through the capitellar ossification centre on all views after fracture-separation (Fig. 2a), because the epiphysis is displaced with the radius and ulna. However, after a displaced lateral condylar fracture the capitellum is displaced in relation to the radial shaft line (Fig. 3a). **Under one to two years.** Before the appearance of the capitellar ossification centre, at between one and 26 months (Wilkins 1984), accurate diagnosis of an elbow injury is very difficult. On standard radiographs the only helpful feature is the decreased gap between the radial metaphysis and the anterior humeral line in comparison to a similar view of the normal elbow (Fig. 4). Posterior displacement of the proximal radius and ulna should not be confused with a posterior dislocation of the elbow:
elbow dislocation has not been reported before the age of four years (Wilkins 1984). If there is any doubt about the diagnosis an arthrogram will give the answer (Fig. 5, Mizuno, Hirohata and Kashiwagi 1979; Akbarnia et al 1986; Yates and Sullivan 1987). The use of ultrasound in this diagnosis has been reported (Dias, Lamont and Jones 1988).

**Minimally displaced fractures.** Fractures with minimal displacement are the most difficult to diagnose accurately. If the fragment is hinged on one side, then the side of the hinge can distinguish between a fracture-separation and a lateral condylar fracture: fracture-separation is an extension injury, hinges posteriorly, and opens anteriorly (Fig. 2b); a lateral condylar fracture hinges anteroinferiorly and opens posteriorly (Fig. 3b). However, arthrography can help to confirm the diagnosis (Fig. 5).

**Cubitus varus.** Cubitus varus is the most common complication and can be cosmetically unacceptable. In

Table 11. Patients grouped by age (range 0 to 13 years 9 months) from six series of cases of separation of the distal humeral epiphysis

<table>
<thead>
<tr>
<th></th>
<th>Under 2 years</th>
<th>Over 2 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeLee et al 1980</td>
<td>11*</td>
<td>5*</td>
</tr>
<tr>
<td>Holda, Manoli and LaMont 1980</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>McIntyre, Wiley and Charette 1984</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Mizuno et al 1979</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Siffert 1963</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>de Jager and Hoffman 1991</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td><strong>All series</strong></td>
<td><strong>31 (55%)</strong></td>
<td><strong>25 (45%)</strong></td>
</tr>
<tr>
<td>*under or over 2.5 years</td>
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</table>

The decreased gap between the radial metaphysis and the anterior humeral line is the only diagnostic feature before appearance of the capitellar ossification centre. Left, displaced; right, normal side.

Arthrogram showing the articular cartilage in a case of fracture-separation of the distal humeral epiphysis.
six reported series, including ours (Table I), cubitus varus of 5° to 15° occurred in 12 of 48 patients, making it as common as it is after supracondylar fractures, where it occurs in about 30% (Labelle et al 1982). Ten of these 12 cases of cubitus varus were in patients younger than two years, although the injury is only slightly more common in this age group (Table II). Open reduction and Kirschner wire fixation did not prevent cubitus varus in the combined series. The deformity, as in supracondylar fractures, is due to medial tilt of the distal fragment. No cases have been reported of increasing deformity due to growth plate damage.

The surface area of the fracture is greater at the epiphysis than at supracondylar level, so that a more stable reduction could be expected, without rotation or medial tilt. Cubitus varus is relatively more common before the age of two years, probably because of inadequate reduction with medial tilt. Baumann’s angle cannot be used to check the reduction in these cases because the separation is at the level where one would draw one of the lines, and in the young patients the secondary ossification centre of the capitellum is not clearly visible. Before the age of two years, the injury is usually a Salter–Harris type I, so there is no metaphyseal fragment to make an inadequate reduction obvious.

That cubitus varus followed open reduction in three cases in the combined series is more difficult to explain, but it also is probably due to inadequate reduction. In all three the pre-operative diagnosis was fracture of the lateral condyle, and it is impossible to adequately visualise the medial cortex from a lateral approach.

We therefore recommend that in children under two years old, closed reduction is followed by percutaneous pin fixation with image intensifier control. The elbow can then be extended and the carrying angle assessed clinically. If the elbow is still in varus, the wires can be removed, and further reduction attempted. The patient may then be managed in straight lateral traction (Piggott, Graham and McCoy 1986) to maintain a valgus carrying angle. We do not recommend open reduction.

In children over the age of two years, fracture-separations are best managed as supracondylar fractures, by closed reduction with immobilisation in pronation and 100° flexion, and held in a plaster backslab for three weeks.

**Conclusions.** Fracture-separation of the distal humeral epiphysis is difficult to diagnose; cubitus varus is as common after it as after supracondylar fracture, especially in children under two years of age. Accurate reduction is essential.

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**REFERENCES**


