Dislocations of the elbow in children

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A total of 33 children were treated for acute traumatic dislocation of the elbow between 1994 and 2002; 30 dislocations were posterior and three anterior. Eight children had a pure dislocation and 25 had an associated fracture of the elbow. Two had compound injuries. Two children had injury to the ulnar nerve, one to the radial nerve and one to the median nerve together with injury to the brachial artery. Twenty required open reduction. Complications included pseudarthrosis of the medial epicondyle in one child and loss of flexion and rotation of between 10˚ and 30˚ in ten others. Meticulous clinical and radiological assessment is mandatory in children with dislocation of the elbow to exclude associated injuries.

The results were excellent to good in 22 patients, fair in ten and poor in one.

Traumatic dislocation of the elbow is rare in children with an incidence of only 3% to 6%\(^1\) of all elbow injuries and there has been only one study describing this injury exclusively in children.\(^2\) The most recent publications have been case reports of rare forms of dislocation and associated complications.\(^3\)-\(^16\)

Dislocations may be classified according to the position of the proximal radio-ulnar joint in relation to the distal humerus. Displacement of the proximal forearm can occur in four directions, either posterior, anterior, medial or lateral.\(^1\)

Pure dislocation is uncommon and radiographs must be evaluated carefully for associated avulsions and fractures around the elbow. Avulsion of the medial epicondyle is the most common associated injury.\(^1,17\)-\(^21\) Less common are injuries in the region of the coronoid process, radial head, olecranon, trochlea and lateral condyle,\(^1\) or very rarely, there may also be disruption of the proximal radio-ulnar joint (divergent type).\(^3\)-\(^10\)

The aim of this paper is to highlight the spectrum of dislocations of the elbow and to increase the awareness of the less common types seen in children. The importance of careful clinical and radiological assessment is emphasised.

Patients and Methods

The clinical records and radiographs of 33 children with acute traumatic dislocation of the elbow treated between 1994 and 2002 at a major referral centre were reviewed retrospectively. All children with displaced injuries involving the elbow are routinely admitted and reviewed by the consultant after initial assessment and treatment by orthopaedic trainees. Twenty-one children had been referred from rural hospitals. All had standard anteroposterior (AP) and lateral radiographs and in 23 radiographs were taken of the opposite elbow for comparative views. There were 24 boys and nine girls with a mean age of nine years (5 to 13). Every injury had been caused by a fall and was seen and treated within five days. Two children had compound injuries. Two had an associated injury of the ulnar nerve, one of the radial nerve and one of the median nerve with disruption of the brachial artery. Radiologically, 22 of the dislocations were postero-lateral, seven posteromedial, one posterior, two anteromedial, and one anterolateral.

Associated fractures of the elbow were seen in 25 children. In 18, the dislocation was associated with a single fracture or avulsion and in the remaining seven there were various combinations. The fracture was not recognised on the initial radiograph in eight children after initial reduction.

The various types of injury were grouped as follows:

- **Pure dislocation** (eight cases). Seven children had a closed reduction. One (Fig. 1) had a compound injury with severe soft-tissue disruption and damage to the median nerve and brachial artery. The latter was reconstructed using a...
reverse saphenous graft. The artery was subsequently ligated because of failure of the graft. There was adequate collateral circulation.

Dislocation with avulsion of the medial epicondyle (11 cases). Ten dislocations were posterolateral (Fig. 2); one was anteromedial. Seven children had a closed reduction. The medial epicondyle was trapped within the joint in two children who required open reduction and fixation with Kirschner wires (K-wire). In one of these the dislocation was compound with associated injury to the ulnar nerve. Two children with displacement of the medial epicondyle after closed reduction required open reduction and fixation with K-wires.

Dislocation with fracture of the lateral condyle (5 cases). Four fractures were Milch type II (Salter-Harris type II) and one, type I (Salter-Harris type IV). The dislocations were posteromedial in four and anteromedial in one. All underwent internal fixation with K-wires.

Dislocation with fracture and avulsion of the olecranon (one case). This injury was associated with anterolateral disloca-

Anteroposterior and lateral radiographs of the elbow showing a posterolateral dislocation. There is air in the tissues, extensive soft-tissue swelling and disruption. The patient had injury to the median nerve and brachial artery.

Radiographs showing a) posterolateral dislocation of the elbow and avulsion of the medial epicondyle (arrows) and b) asymptomatic nonunion of the medial epicondyle at follow-up at four years.
tion (Fig. 3) and was treated by open reduction and fixation with a single K-wire.  

**Posterior dislocation with fracture of the radial head.** One child had a posterior dislocation with an associated Salter-Harris type I complete epiphyseal separation and was treated by open reduction and K-wire fixation (Fig. 4).  

**Combined injuries (7 cases).** In seven children the dislocation was associated with more complex injuries of the elbow. Three with posteromedial dislocations had the following injuries: 1) fracture of the lateral condyle (Milch II) and avulsion of the medial epicondyle (Fig. 5); 2) avulsion of the radial head (Salter-Harris type II) and olecranon apophysis; and 3) avulsion of the olecranon and medial epicondyle and injury to the radial head (Salter-Harris type II).

Two children with posterolateral dislocations had the following injuries in combination: 1) avulsion of the olecranon and medial epicondyle and injury to the ulnar nerve; and 2) injury to the radial head (Salter-Harris type II) and avulsion of the medial epicondyle.

All the injuries were treated by open reduction and K-wire fixation.

**Divergent dislocations.** Two children with posterolateral displacement of the elbow had a transverse type of divergent dislocation of the proximal radius and ulna (Fig. 6). In one reduction was achieved by traction and compression of the radial head and olecranon, the other required open reduction. The latter child also had signs of injury to the radial nerve and, at surgery, the radial head was found to have buttonholed through the lateral capsule and the origin of the extensor muscles. The coronoid was avulsed and was not visible on radiographs. The annular ligament was repaired after reduction.  

**Fractures at other sites.** Two children had a fracture of the distal radius.  

**Delayed diagnosis.** The diagnosis was delayed in eight children. The associated fractures or avulsions had been overlooked. Four required surgery to fix a displaced medial or lateral condyle. Comparative radiographs showed overlap of the fragments on bone in four. All dislocations which had been reduced by closed manipulation were immobilised in a collar and cuff sling for three weeks. Those with combined injuries or who required surgery, were immobilised in a...
plaster backslab for four weeks. All had physiotherapy for two to three weeks.

**Results**

The patients were reviewed at a mean of 10 months (4 to 48). The results were graded using the criteria of Roberts as follows: excellent, no symptoms, no limitation of movement; good, mild symptoms, not >10° loss of movement; fair, moderate symptoms and 10° to 30° loss of movement; and poor, severe symptoms, >30° loss of movement. There were 22 children (67%) with excellent or good results, ten fair and one poor result (Table I). Seventeen patients (52%) had a full range of movement, and seven of these had a pure dislocation.
Figure 5a – Radiographs showing dislocation of the elbow and associated Salter-Harris type I injury of the radial head. Figure 5b – Diagrams showing fracture of the radial head (dotted lines). Figure 5c – Radiographs six months later showing healing.
Patients with closed reduction had a better outcome than those requiring open reduction. The children with injury to the ulnar and radial nerves recovered in two to four weeks. Loss of movement was greater with injury to the lateral compartment (radial head, and lateral condyle) than to the medial compartment (medial epicondyle, olecranon and coronoid). Combined and compound injuries resulted in a greater loss of movement than isolated fractures. Asymptomatic pseudarthrosis of the medial epicondyle was seen on follow-up radiographs of one patient, four years after the initial injury (Fig. 2b).

At follow-up at four months, the child with the vascular injury had a fixed flexion deformity of 30° at the elbow and rotational loss of 30°, but there was a good collateral circulation and no signs of ischaemia. The median nerve did not recover.

**Discussion**

Carlioz and Abols reported the only large series of dislocations of the elbow in children and found that 64% of children had associated fractures and avulsions. Other series included adults and children in their study (Table I).

In this study, 75% of the dislocations had an associated injury to the elbow. In 24% of cases, an accurate diagnosis was not made on the initial radiographs.

In all other studies the commonest associated injury was avulsion of the medial epicondyle by the origin of the flexor muscles and medial collateral ligament (Table II). The incidence ranged from 25% to 36% and was similar to that of this study (33%). The epicondyle is small and when displaced it is difficult to see on routine radiographs; it may be overlapped by the distal humeral metaphysis or confused with the ossification centre of the trochlea or olecranon (Fig. 2a). The management is controversial. Some authors have advocated open reduction and internal fixation in all cases to prevent instability and nonunion. Others have considered surgery for the entrapped or displaced epicondyle to restore stability to the elbow. Recurrent dislocations have been reported in adults who had injury to the medial epicondyle in childhood but asymptomatic fibrous union of the medial epicondyle has been seen in this series and others.

When avulsion of the olecranon is associated with dislocation, the displacement is usually anterior as was observed in this study. Osteochondral fragments from the
Articular surface of the olecranon have been observed occasionally to prevent reduction and such lesions may be unrecognised on plain radiographs but found on exploration. Carlioz and Abols emphasised that these lesions can cause recurrent dislocation of the elbow and that exploration is indicated when inadequate reduction is seen on radiographs.

Fracture of the coronoid is rare (<1%) and usually occurs with dislocation in older children. An unusual flap injury has been described in dislocations in which the articular surface may be flipped back into the joint and prevent congruous reduction. Grant and Miller stated that unrecognised osteochondral fragments may cause a poor result in an initially apparently uncomplicated dislocation of the elbow. If there is an indication for operative intervention, the joint should be thoroughly inspected. In well-reduced dislocations there is no need to replace the coronoid avulsion surgically.

Dislocations with unusual associated fractures of the elbow have been reported. Fracture of the medial condyle has been reported by Badelon et al and Saraf and Tuli. Dislocations have also been observed in association with osteochondral fractures of the trochlea. Grantham and Tietjen reported an unusual transcondylar fracture-dislocation in which the fracture line was intracapsular and both distal humeral condyles were displaced as a single unit with the elbow dislocated (Chutro-Posadas fracture).

Fracture of the lateral condyle occurring with dislocation is very rare. Four cases have been reported by Newman and one by Roberts. There was a higher incidence of isolated fracture of the lateral condyle in this study compared with others (Table II) and most dislocations were posterolateral.

Injury to the head and neck of the radius associated with dislocations of the elbow can occur during the process of reduction when the capitellum can damage the distal lip of the radial head. Alternatively, the radial neck may be fractured during the process of dislocation when the capitellum can damage the proximal lip of the radial head. Three such injuries were seen in this series all occurring during dislocation. Steinberg et al reviewed the literature and found 25 children with fracture of the head and neck of the radius with associated dislocation of the elbow. Some limitation of rotation usually occurs after these injuries.

In our study most of the dislocations were posterolateral (66%). The incidence of anterior dislocation is generally low (< 2%). It may occur from a direct blow to the posterior aspect of the elbow, with avulsion of the insertion of the triceps from the olecranon. The radius and ulna usually dislocate anteromedially.

Simultaneous dislocation of both the elbow and the proximal radio-ulnar joint, includes disruption of all three joints of the elbow - the radiocapitellar, ulnotrochlear and proximal radio-ulnar joints. The transverse type has been reported by other authors. The suspected mechanism of

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**Table I.** Literature review of dislocations of the elbow in children

<table>
<thead>
<tr>
<th>Author/s</th>
<th>Length of review (yrs)</th>
<th>Number of cases and age</th>
<th>Type of dislocation</th>
<th>Associated fractures</th>
<th>Complications</th>
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<tbody>
<tr>
<td>Carlioz and Abols</td>
<td>5</td>
<td>58 (&lt;15 yrs)</td>
<td>Posterior (all)</td>
<td>Medial epicondyle</td>
<td>Pulse deficit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pure</td>
<td>Olecranon</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Radial head, neck</td>
<td>3</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Lateral flakes of bone</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Coronoid</td>
<td>2</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Combined</td>
<td>2</td>
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<tr>
<td>Roberts</td>
<td>11</td>
<td>24 (&lt;14 yrs) +36 adults</td>
<td>Posterolateral (all)</td>
<td>Medial epicondyle</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pure</td>
<td>Olecranon</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Radial condyle</td>
<td>1</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Radial head neck</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Coronoid</td>
<td>1</td>
</tr>
<tr>
<td>Linscheid and Wheeler</td>
<td>15</td>
<td>12 (&lt;10 yrs) +71 adults</td>
<td>Details of injuries in children unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Josefsson and Nilsson</td>
<td>12</td>
<td>13 (&lt;20 yrs) +165 adults</td>
<td>Details of injuries in children unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neviaser and Wickstrom</td>
<td>10</td>
<td>31 (&lt;10 yrs) +45 adults</td>
<td>Details of injuries in children unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present study</td>
<td>8</td>
<td>33 (&lt;13 yrs)</td>
<td>Posterolateral (all)</td>
<td>Medial epicondyle</td>
<td>11</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Pure</td>
<td>Olecranon</td>
<td>7</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Radial condyle</td>
<td>5</td>
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<td></td>
<td></td>
<td>Coronoid</td>
<td>1</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Combined</td>
<td>8</td>
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**Table II.** Incidence (%) of associated fractures and injuries with dislocations

<table>
<thead>
<tr>
<th>Associated injury</th>
<th>Carlioz and Abols</th>
<th>Roberts</th>
<th>Present study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial epicondyle</td>
<td>36.0</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Lateral condyle</td>
<td>0.0</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>Olecranon</td>
<td>1.7</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Radial head, neck</td>
<td>5.0</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Coronoid</td>
<td>3.5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Divergent</td>
<td>0.0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Combined</td>
<td>3.5</td>
<td>0</td>
<td>20</td>
</tr>
</tbody>
</table>
injury is thought to be a combination of axial loading on the ulna and a strong pronation force causing disruption to the proximal radio-ulnar joint, the interosseous membrane and the annular ligament. Reduction is achieved by gentle traction and compression of the radial head and olecranon.\(^3\)\(^,\)\(^9\) Avulsion of the coronoid process has been reported with this injury.\(^6\)\(^,\)\(^10\) and was seen in this study. The anteroposterior type of divergent dislocation seen in adults has not been reported in children.\(^1\) Proximal radio-ulnar translocation (convergent dislocation) has been described in which the radius articulates with the trochlea and the ulna with the capitellum as the forearm is clinically pronated.\(^3\)\(^,\)\(^4\)\(^,\)\(^11\)

Delay in diagnosis occurred in eight children because of lack of interpretation of the radiographs. Most injuries were fractures of the medial epicondyle or lateral condyle. However, no serious morbidity occurred since these injuries were recognised and treated before discharge. Complications reported after dislocations of the elbow have included neurovascular injuries, loss of movement, myositis ossificans, radio-ulnar synostosis and recurrent dislocation. Injuries to nerves are not uncommon after dislocation of the elbow. The ulnar nerve is more frequently affected in dislocations with avulsion of the medial epicondyle.\(^21\) These injuries are usually transient and resolve completely. Although Linscheid and Wheeler\(^17\) suggested that anterior transposition of the ulnar nerve should be performed at the time of open reduction, others found that it was not usually necessary except when signs of nerve compression were present.\(^2\)\(^,\)\(^25\)\(^,\)\(^26\)\(^,\)\(^21\) The median nerve seems to be at greatest risk in dislocations. The nerve has been found to be trapped behind the medial epicondyle or within the joint after reduction.\(^27\)\(^-\)\(^34\) Severe pain persisting after reduction of the dislocation should alert the surgeon to entrapment of the median nerve.\(^29\) Injury to the radial nerve after dislocation has not been described in the literature. One child was seen in this series with this injury after a divergent dislocation. Vascular injury after dislocation of the elbow is unusual but well-recognised. It is usually associated with open dislocation or with an associated fracture.\(^36\)\(^,\)\(^37\) The vessel may be contused, or suffer an intimal tear, thrombosis or frank disruption.\(^17\) Rarely is the vessel injured by closed dislocation.\(^37\) Very rarely is reconstruction performed since there is usually an adequate collateral circulation.\(^35\)\(^,\)\(^36\) In one study the absent pulse reappeared after reduction in four patients. Myositis ossificans and heterotrophic ossification have been reported, mainly in adults\(^17\)\(^,\)\(^19\)\(^,\)\(^20\) and attributed to delay in treatment and vigorous early active physiotherapy. Proximal radio-ulnar synostosis has been noted to occur with an associated fracture of the radial head.\(^1\)

No case of recurrent dislocation was seen. It is rare in children and is due to a failure of the capsule and ligamentous structures to become reattached after traumatic dislocation.\(^17\)\(^,\)\(^23\) The stability of capsular structures can be assessed in the course of gentle post-reduction manipulation. A dislocation of the elbow in a child may be associated with an unrecognised additional fracture. There should be a high index of suspicion, with good clinical examination and meticulous assessment of the radiographs and systematic examination of the medial (medial epicondyly, olecranon, coronoid, medial condyle) and lateral compartments (radial head, lateral condyle) for associated fractures or avulsions. Comparative radiographs are helpful for detecting an overlap of fragments. MRI may reveal cartilaginous fragments. Dislocations in children should ideally be reduced under general anaesthesia and radiological control to avoid delay in accurate diagnosis.

No benefits in any form have been received or will be received from any commercial party related directly or indirectly to the subject of this article.

References


29. Galbraith KA, McCullough CJ. Acute nerve injury as a complication of closed fractures or dislocations of the elbow. *Injury* 1986;11:159-64.


