Second fracture of the distal humerus after varus malunion of a supracondylar fracture in children

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Nine children sustained a second fracture of the distal humerus after union of an ipsilateral supracondylar fracture which had healed with cubitus varus. There were eight boys and one girl with a mean age of five years (1 to 8) at the time of the second fracture which occurred at a mean of 1.5 years after the first. In all patients, the second fracture was an epiphyseal injury of the distal humerus, either associated with a fracture of the lateral metaphysis below the site of the previous supracondylar fracture, or a fracture-separation of the entire distal humeral epiphysis. This suggests that the physis and epiphysis tend to be more subject to injury than the metaphysis of the distal humerus in children who have had a previous supracondylar fracture with varus malunion.

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Little is known about second fractures which may occur in children who have had supracondylar fractures that have healed with cubitus varus. Herring and Fitch reported a child who sustained a lateral condylar fracture after a supracondylar fracture, but they did not comment on the relationship between the fractures. Davids et al first described the relationship between post-traumatic cubitus varus and a subsequent lateral condylar fracture. They reviewed the medical records of 100 cases of lateral condylar fractures and identified six fractures which occurred after post-traumatic cubitus varus. They suggested that this residual deformity may predispose a child to subsequent lateral condylar fracture. Although Wilkins accepted that lateral condylar fracture was a late complication of cubitus varus, it is not known whether other types of fracture occur in children. We have therefore studied second fractures of the distal humerus in children after union of an ipsilateral supracondylar fracture.

Patients and Methods

Between 1987 and 1996, we treated nine children with a second fracture of the distal humerus after an ipsilateral supracondylar fracture. There were eight boys and one girl with a mean age of 3.5 years (1 to 5) at the time of the supracondylar fracture. The right distal humerus was affected in two and the left in seven. Eight fractures were treated conservatively and one had percutaneous pinning. All fractures resulted in varus malunion. The mean carrying angle and angle of Baumann of the nine affected elbows after the treatment were –11.7° (–25 to 0) and 2.2° (–6 to 12), respectively (Table I). Each child sustained a second fracture of the ipsilateral distal humerus as a result of a fall when aged between one and eight years (mean five). The mean interval from the supracondylar fracture to the second fracture was 1.5 years (0.3 to 3.6).

We examined the fracture line, the initial displacement of the distal fragment and the relationship of the capitellum to the radius on the radiographs of the second fracture. An initial radiological diagnosis of the fracture type was made according to accepted criteria. A conclusive diagnosis was made after the fracture line had been identified macroscopically in those patients who had an open reduction. The outcome after the treatment was examined radiologically. The mean period between the first fracture and the last follow-up examination was 4.2 years (1.8 to 10).

Results

The radiographs of the second fracture showed features which were common to all patients. There was malunion of the first fracture in the supracondylar region. The second
fracture line was seen only in the lateral metaphysis just above the distal humeral physis, with a gap between it and the level of the first fracture. There was varus displacement of the distal fragment and the relationship of the capitellum to the radius was maintained. The severity of the initial displacement of the distal fragment was different in each patient. It was minimal in four, moderate in four, and severe in one (Fig. 1). One patient (case 9) with a severely displaced fracture had a fracture-separation of the entire distal humeral epiphysis. The remaining eight patients had a lateral condylar fracture.

Six of the second fractures were immobilised using a plastic cast, one was treated by percutaneous pinning alone and two by open reduction combined with percutaneous pinning. In two patients (cases 8 and 9) who had open reduction the fracture line was identified macroscopically. In one of these (case 9) it passed medially along the entire distal humeral physis as initially diagnosed. In the other (case 8) the definitive diagnosis was fracture-separation of the entire distal humeral epiphysis because the fracture line passed medially between the trochlea and the medial epicondyle. We did not obtain conclusive diagnoses in the remaining seven patients because they did not have open reduction or arthrography. No immediate major complications were noted. All fractures united within a few months. The mean carrying angle and angle of Baumann at follow-

Radiographs of second fractures of the distal humerus after varus malunion of a supracondylar fracture. The fracture lines (arrows) were identified only in the lateral metaphysis just above the distal humeral physis. The fractures showed minimal displacement of the distal fragment (a and b), moderate displacement of the distal fragment (c and d), or severe displacement of the distal fragment accompanied by the radial head and proximal ulna (e and f).
### Table 1. Clinical and radiological details of the nine children with second fracture of the distal humerus after varus malunion of a supracondylar fracture

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (yr)</th>
<th>Treatment*</th>
<th>Carrying Angle (degrees)</th>
<th>Angle of Baumann (degrees)</th>
<th>Carrying Angle (degrees)</th>
<th>Angle of Baumann (degrees)</th>
<th>Radiograph at fracture</th>
<th>Definitive diagnosis†</th>
<th>Treatment*</th>
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<tr>
<td>1</td>
<td>4</td>
<td>CR, cast</td>
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<td>-6</td>
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<td>Minimum LCF</td>
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<td>CR, cast</td>
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<td>3</td>
<td>Minimum LCF</td>
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<tr>
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<td>5</td>
<td>CR, cast</td>
<td>-3</td>
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<td>8</td>
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<td>-</td>
<td>CR, cast</td>
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<td>Traction</td>
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<td>12</td>
<td>3</td>
<td>Severe FSE</td>
<td>FSE</td>
<td>OR, PP</td>
<td>-17</td>
</tr>
</tbody>
</table>

* CR, closed reduction; OR, open reduction; PP, percutaneous pinning
† initial radiological diagnosis; LCF, lateral condylar fracture; FSE, fracture-separation of the entire distal humeral epiphysis
‡ definitive diagnosis was obtained macroscopically; FSE, fracture-separation of the entire distal humeral epiphysis; -, no definite diagnosis

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![Fig. 2a](image1.png)  
![Fig. 2b](image2.png)  
![Fig. 2c](image3.png)  
![Fig. 2d](image4.png)

Case 4. Anteroposterior radiographs of the left elbow showing a supracondylar fracture at the age of four years (a), varus malunion after conservative treatment (b), a second fracture (black arrowheads) and evidence of the united supracondylar fracture (white arrow) one year and 10 months after the supracondylar fracture (c) and an increased varus deformity after conservative treatment (d).
up examination were \(-21.4^\circ\) (\(-35\) to \(-15\)) and \(-5.7^\circ\) (\(-13\) to 4\), respectively (Table I). The mean decrease in the carrying angle at the follow-up examination compared with that just before the second fracture, was \(9.7^\circ\) (2 to 17) and the mean decrease in the angle of Baumann was \(7.9^\circ\) (2 to 21). Radiological examination after treatment showed an increased varus deformity of the elbow in all children. One patient (case 5) had irregularity of the distal humeral metaphysis seen radiologically at the follow-up examination. During follow-up, two patients (cases 7 and 9) sustained a third fracture of the ipsilateral distal humerus. In order to have an acceptable cosmetic appearance, five patients needed a corrective osteotomy at a mean of 3.8 years (1 to 9) after the last fracture.

Illustrative case reports

Case 4. A four-year-old girl fell from a bicycle and suffered a supracondylar fracture of the left distal humerus (Fig. 2a). This was treated by a splint and healed in varus (Fig. 2b). One year and ten months after the fracture, she fell on the floor and sustained a lateral condylar fracture of the ipsi-
lateral distal humerus (Fig. 2c). The fracture was again treated by a splint and healed with an increased varus deformity (Fig. 2d).

**Case 9.** A three-year-old boy sustained a displaced supracondylar fracture as a result of a fall (Fig. 3a). Straight alignment of his left elbow was obtained after treatment by traction (Fig. 3b). Four months later, he fell from a height of about 1 m and suffered a fracture-separation of the entire distal humeral epiphysis (Fig. 3c). Although he had open reduction and pinning, anatomical reduction was not obtained. A radiograph taken one year after the operation showed varus malunion (Fig. 3d). One year and seven
months after the second fracture, he again sustained a fracture-separation of the entire distal humeral epiphysis as a result of a fall (Fig. 3e) and was treated by percutaneous pinning.

**Case 5.** A one-year-old boy sustained a supracondylar fracture as a result of a fall (Fig. 4a) and was treated by a splint. The fracture healed with slight varus malunion (Fig. 4b). Five months later, he suffered a lateral condylar fracture (Fig. 4c) and was again treated by a splint. A radiograph taken at a follow-up examination showed severe varus deformity of the distal humerus and irregularity of the distal metaphysis (Fig. 4d).

**Discussion**

There have been many studies of the complications of supracondylar fractures including neurovascular involvement, ischaemic contracture, cubitus varus, internal rotation, and hypertenosion deformities, myositis ossificans, loss of movement, and nonunion. Recent studies have reported late complications associated with cubitus varus after a supracondylar fracture, such as tardy ulnar nerve palsy, avascular necrosis of the distal humeral epiphysis, posterolateral rotatory instability of the elbow, and lateral condylar fracture of the humerus. In all of our patients the second fracture was an epiphyseal injury of the distal humerus associated with a fracture involving the lateral metaphysis below the supracondylar fracture. The diagnosis was either lateral condylar fracture or fracture-separation of the entire distal humeral epiphysis. In addition, two patients had a third fracture of the ipsilateral distal humerus after union of the second fracture. These also involved the distal humeral physis. Our results suggest that the physis and epiphysis tend to be more subject to injury than the metaphysis of the distal humerus in children after a supracondylar fracture.

In one patient (case 9) the fracture had the characteristic radiological appearance of a fracture-separation of the entire distal humeral epiphysis. In another (case 8) the operative findings showed that the injury was a fracture-separation of the entire distal humeral epiphysis, although the capitellum was minimally displaced. The remaining seven children were not treated by arthrography or open reduction and therefore definite diagnoses differentiating a lateral condylar fracture from fracture-separation of the entire distal humeral epiphysis could not be made. Some authors have recommended arthrography to identify the fracture line because fracture-separations of the entire distal humeral epiphysis have often been misdiagnosed as lateral condylar fracture in children.

The second fracture was caused by a fall as was the initial supracondylar fracture. The involvement of the physis in the second fracture may depend on post-traumatic changes in the metaphysis of the distal humerus. It is thought that the healed injury leaves the metaphysis thickened, which protects the area from further injury, but the growth plate becomes vulnerable. Davids et al. studied the biomechanics of cubitus varus, and suggested that posttraumatic cubitus varus alignment could increase both the distraction and shear forces across the lateral condyle of the distal humerus generated by a routine fall on an outstretched upper arm. The eight fractures which we initially diagnosed as a lateral condylar fracture were classified as adduction avulsion fractures as described by Milch, which suggests that the cause had been predominantly a distraction rather than a compression force. When the elbow is re-injured, due to the cubitus varus, the main force is varus. The resultant injury pattern may be a total separation of the distal humeral growth plate or a fracture of the lateral condyle.

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

**References**


