Seven children with a post-traumatic cubitus varus deformity were treated using the Ilizarov technique of distraction osteogenesis. The outcome was rated as excellent in each case and all were satisfied with the cosmetic appearance. No complications had been encountered by the latest follow-up at a mean of 66.7 months. This technique seems reliable for the treatment of such deformities, provided that it achieves full correction by gradual distraction. Nerve palsy and unsightly scars are avoided, and the range of movement of adjacent joints is preserved.

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Cubitus varus is a common complication of supracondylar fractures of the humerus in children.1-7 The reported incidence (9% to 58%) varies with the type of treatment.8 Several techniques for corrective osteotomy of the distal humerus have been described, including a lateral closing wedge, a rotational dome procedure, an oblique medial opening wedge and a step-cut lateral closing wedge, with various devices being used for internal and external fixation.1-16 King and Secor,11 Levine et al5 and Usui et al16 used a unilateral external fixator to stabilise the fragments after wedge osteotomy. Song et al14 have reported using the Ilizarov external fixator with a lateral closing wedge osteotomy in adults. We describe seven children with a cubitus varus deformity who were treated by Ilizarov’s distraction osteogenesis.

Patients and Methods

Between 1990 and 1996, seven patients (three boys and four girls) were treated using this procedure (Table I).17 The deformity had occurred after supracondylar fractures of the humerus (Fig. 1) in all patients and had been treated by closed reduction and fixation by percutaneous wires. The mean age at the time of injury was six years (4 to 9) and at corrective surgery 11 years (6 to 15). A varus angle at the elbow of more than 10° as measured on radiographs was an indication for surgery.

Operative technique. All patients were prepared under general anaesthesia without the use of a tourniquet. Two Kirschner wires were inserted into the condylar area parallel to the joint line in anterolateral and posterolateral directions. If the apex of the deformity was more than 5 cm above the joint line a third wire was also inserted. Two further Kirschner wires were placed at least 4 cm above the apex of the deformity at an angle of 90° and a third was inserted in an anteroposterior direction at the same level. Proximally, two wires crossing each other were introduced.

Fig. 1
Case 1. A preoperative radiograph of the elbow of a 15-year-old girl at full extension.
5 cm above the second level. All wires were connected under tension using three full frames and three rods. A stab incision was then made just over the apex of the deformity and corticotomy was carried out.

Distraction was begun after five days, moving only the medial rods very slowly through a distance of 1 mm each day until the deformity was corrected (Fig. 2). The frames were left in situ until there was radiological evidence of union. During the distraction period, adjustments were made to correct rotational deformity. All calculations for the correction of the deformity were made using the rule of similar triangles, advocated by Herzenberg and Waanders. The patients were encouraged to exercise the elbow and shoulder actively during the lengthening procedure (Fig. 3).

The results were graded as excellent, good or poor based on a protocol from Bellemore et al. An excellent result was one in which the loss of carrying angle was 5° or less and the loss of flexion and extension was 10° or less. A good result had a loss of carrying angle between 6° and 10° and loss of flexion and extension of 20° or less and a poor result showed a difference in carrying angle of over 10° or limitation of the range of flexion and extension by more than 20°.

### Results

The details of the patients are shown in Table I. The mean duration of external fixation until union was secure and the frame removed was 13.4 weeks (10 to 16). The mean period of follow-up after removal of the frames (Fig. 4) was 66.7 months (34 to 98). All patients were rated excellent at the latest follow-up and were satisfied with the cosmetic appearance of the elbow.

No damage to nerves or blood vessels occurred during the operative or follow-up periods. There was a minor pin-track infection in two patients (cases 3 and 7); both responded to local wound care and antibiotics within a week. No refracture occurred after removal of the frames.

### Discussion

The use of Ilizarov distraction osteogenesis for the treatment of post-traumatic cubitus varus deformity has several advantages. The technique allows controlled correction of the deformity, whereas all other techniques which provide immediate correction give no opportunity for later adjustment, if required. Hernandez and Roach reported that two of their ten patients had poor results because of inadequate

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**Table I.** Details of the seven patients treated for post-traumatic cubitus varus deformity using Ilizarov’s technique of distraction osteogenesis

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (yr)</th>
<th>Gender</th>
<th>Varus angle (degrees) Preop</th>
<th>Flexion (degrees) Preop</th>
<th>Time to union (wk)</th>
<th>Follow-up (mth)</th>
<th>Complications</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>F</td>
<td>24</td>
<td>19 to 121</td>
<td>16</td>
<td>98</td>
<td></td>
<td>Excellent</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>M</td>
<td>15</td>
<td>10 to 135</td>
<td>14</td>
<td>88</td>
<td></td>
<td>Excellent</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>F</td>
<td>16</td>
<td>9 to 129</td>
<td>12</td>
<td>75</td>
<td>Pin-track infection</td>
<td>Excellent</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>F</td>
<td>11</td>
<td>0 to 135</td>
<td>12</td>
<td>65</td>
<td></td>
<td>Excellent</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>M</td>
<td>17</td>
<td>6 to 127</td>
<td>16</td>
<td>59</td>
<td></td>
<td>Excellent</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>M</td>
<td>12</td>
<td>14 to 145</td>
<td>14</td>
<td>48</td>
<td></td>
<td>Excellent</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>F</td>
<td>11</td>
<td>1 to 134</td>
<td>10</td>
<td>34</td>
<td>Pin-track infection</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

* carrying angles of the opposite uninjured side are in parentheses
intraoperative correction. Up to 30% of poor results reported in the literature are due to loss of or inadequate correction. Hernandez and Roach noted that unstable internal fixation with staples allowed the distal fragment to angulate into varus again in some of their patients. They recommended more rigid fixation and an additional percutaneous pin inserted medially to increase the stability. This problem is avoided using the Ilizarov apparatus; since angulation occurs during the distraction period, the frame allows for correction.

The Ilizarov technique allows for correction of the deformity in three planes. There is an occasional problem with the use of a prebent lateral plate and screws because the distal fragment is short, especially when rotational correction is required. This reduces the area of contact between the surfaces of the osteotomy, which are often unevenly curved. According to Uchida et al. and Usui et al. if the rotational deformity is left untreated, complete correction of the varus deformity is not achieved.

Another complication of correction of the varus deformity is stretching of the radial or ulnar nerves with corresponding palsies. This problem has been reported after correction by opening or closing wedge osteotomies. This occurred in two of the 24 patients of Ippolito et al., five of the 45 treated by Oppenheim et al., and three of the 15 described by both King and Secor and Labella et al. Gradual lengthening avoids this problem. We detected no nerve palsy; had any symptoms or signs of nerve damage been encountered distraction could have been decelerated or temporarily reversed.

According to Song et al., the maintenance of movement during treatment is important in order to obtain a good functional result. This problem is usually encountered when the fragments are fixed internally and the limb is immobilised. The literature contains only two reports describing immediate postoperative movement and both had used techniques of external fixation. In our series, the patients were encouraged to exercise both the elbow and shoulder on the day after surgery. Not only was the active range of movement maintained but it increased during the recovery period (Table I).

Apart from the range of movement, the cosmetic appear-
Unsightly postoperative scars have been reported in several studies.\(^1\) The Ilizarov technique avoids this problem, requiring only a stab incision for each wire.

In this small series we have found the method to be reliable, flexible and fully controllable. There have been no neurovascular complications or unsightly scars. Early movement has led to an increase in range and no patient has complained of discomfort when carrying the external cage.

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


