EXTERNAL FIXATION OF COLLES' FRACTURES
AN ANATOMICAL STUDY

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In a prospective, controlled study 58 patients aged under 60 years with Colles' fractures were treated either by a forearm plaster or by the application of an external fixator. In 94% of those treated by a fixator it was possible to insert the distal pins of the frame into the fracture fragment, the fixation obtained being sufficient to forgo additional splintage. The external fixator proved more effective at holding the manipulated position, and the radiological loss of position during fracture union was minimal compared with that seen in patients treated in plaster.

Although it is usually possible to achieve a satisfactory manipulative reduction of Colles' fracture, holding the reduced position in plaster is known to be ineffective (Gartland and Werley 1951; Pool 1973; Stewart, Innes and Burke 1985), and recent reports of attempts at improving the anatomical results have been concerned with external fixation (Cooney 1983; Jonsson 1983; D'Anca et al. 1984). In a retrospective study D'Anca et al. found that external fixation was more effective than other methods of treatment, but there have been no controlled studies to substantiate this view. We have done a prospective, randomised and controlled study to compare the anatomical results of treating Colles' fractures either by external fixation or by plaster.

PATIENTS AND METHODS
Patients under 60 years of age with a displaced Colles' fracture requiring manipulation were randomly allocated by date of birth to one of two groups treated either by plaster or by external fixation. The trial was limited to patients under 60 for two reasons. First, and most importantly, a prospective study of patients with Colles' fractures presenting at the Cardiff Royal Infirmary had revealed that 40% of these injuries occurred in patients under 60 and 30% in patients less than 50; it was felt that these younger patients merited particular study, especially in view of the potential consequences of a poor result. Secondly, it was thought prudent to avoid the possibility of the fixator pin loosening in porotic bone, and for this reason any patient aged under 60 with radiographic evidence of gross osteoporosis was also excluded.

Fifty-eight patients, aged 17 to 59 years, were entered into the study; 26 were treated in plaster (although two were later eliminated from the trial because of early loss of position requiring remanipulation) and 32 were treated by external fixation.

Treatment. Plaster. The fracture was manipulated into a satisfactory position under sedation, and a dorsal forearm plaster slab was applied. The patient was allowed home after a radiographic check, and was seen the following day for a plaster check. On this occasion instructions to mobilise the fingers and shoulder were repeated.

External fixator. Patients were admitted to hospital and an AO/ASIF mini-fixator applied after reduction of the fracture; this was done under appropriate anaesthesia and radiographic control. In the first two cases the distal Kirschner wires were inserted into the second metacarpal in the manner described by Jakob (1984). However, it seemed unnecessary to cross the wrist joint with the frame if a satisfactory hold could be obtained in the distal fracture fragments, and so, in the majority of cases (30), the distal Kirschner wires were inserted into these fragments as described by Forgon and Mammel (1981). The arm was elevated overnight and the patient discharged home the following day after instructions to mobilise the fingers and shoulder. Active movement of the wrist was encouraged in those patients in whom the fixator did not cross the joint. However, no patient in either group had any physiotherapy at this stage. In the latter part of the study it proved possible to manage a number of patients as day cases.
Follow-up. Patients in both groups were followed up at one, four, eight and 16 weeks in a special fracture clinic staffed by one of the authors (usually NHJ). At one and four weeks anteroposterior and lateral radiographs were taken, and at the four-week visit the radiographs of the contralateral normal wrist were taken for comparison. The protocol stipulated that if a fracture had slipped to an unacceptable position at the first follow-up visit, it would be remanipulated and the patient excluded from the trial; this occurred in two cases.

If the position remained satisfactory at one week, the casts of those patients treated by plaster were completed; patients were reviewed three weeks later with their casts off. A clinical assessment of union was made and, if the fracture was sound, it was managed in a crépe bandage and the patient given instructions on mobilisation by a physiotherapist. If the fracture remained too tender or painful, a further week in plaster was advised, after which mobilisation progressed as before.

In patients treated with the fixator the pin sites were dressed at weekly intervals by the nursing staff who referred any infection to the medical staff. At four weeks the frame was dismantled and the fracture tested clinically for union. The protocol allowed for a further week of fixator splintage but no patient required it.

Radiographic assessment was performed on three different occasions: at the time of injury, again after reduction of the fracture, and finally at the time of fracture union. The dorsal angle, the radial angle and the radial length were determined from the radiographs (Fig. 1). These measurements were scored and then graded, using the method described by Stewart et al. (1985) derived from Lidström (1959) and Sarmiento, Zagorski and Sinclair (1980). Table I shows the scoring system employed. The severity of the initial injury was reflected in the original position of the fracture fragments and their displacement compared with the uninjured wrist. A fracture of minimal severity had no displacement in any of the three parameters: loss of radial length, loss of radial angle, and dorsal angulation. These measurements progressively increased in more severe injuries.

The quality of reduction was, of course, reflected in the position of the fracture fragments on the first post-reduction film. The loss of position in a fracture was determined by comparing the scores of post-reduction films with those derived from radiographs taken at fracture union. Student’s t-test was used to compare the severity of the injury, the position of the fracture after manipulation, and the loss of position during fracture union in the two treatment groups.

RESULTS

Both the severity of the initial injury (Table II) and the quality of the reduction (Table III) were comparable between the two groups, and there was no statistical difference between any of the pairs of parameters.

<table>
<thead>
<tr>
<th>Group</th>
<th>Dorsal angle (degrees)</th>
<th>Loss of radial angle (mm)</th>
<th>Loss of radial length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plaster</td>
<td>-2.6° (±8.7°)</td>
<td>1.1° (±4.6°)</td>
<td>0.2 (±2.3)</td>
</tr>
<tr>
<td>Fixator</td>
<td>-3.1° (±13.3°)</td>
<td>2.6° (±5.6°)</td>
<td>0.9 (±2.5)</td>
</tr>
</tbody>
</table>

Table II. Severity of injury (mean and standard deviation) as determined by comparison with the uninjured wrist

<table>
<thead>
<tr>
<th>Group</th>
<th>Score for each measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsal angle (degrees)</td>
<td>0</td>
</tr>
<tr>
<td>Loss of radial angle (degrees)</td>
<td>0</td>
</tr>
<tr>
<td>Loss of radial length (mm)</td>
<td>0</td>
</tr>
</tbody>
</table>

The losses of radial angle and length refer to a comparison with the uninjured wrist and are therefore an expression of the quality of the anatomical position. They do not refer to a loss of position occurring during union.
Table IV. The loss of position between the time of reduction and the time of union (mean and standard deviation)

<table>
<thead>
<tr>
<th>Group</th>
<th>Dorsal angle</th>
<th>Radial angle</th>
<th>Radial length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plaster</td>
<td>10.5° (±10.1°)</td>
<td>6.5° (±5.2°)</td>
<td>3.7 (±2.8)</td>
</tr>
<tr>
<td>Fixator</td>
<td>0.1° (±5.6°)</td>
<td>0.7° (±3.9°)</td>
<td>0.3 (±1.8)</td>
</tr>
<tr>
<td>p</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

The mean loss of position in each group is compared in Table IV; the difference in outcome for each parameter was significant (p<0.01). In the fixator-treated group, the mean loss of position was less than 1° or 1 mm, the limit of accuracy of the measurements made.

The method by which the fractures were graded is illustrated in Table I; these grades are useful in that they show the degree to which position is maintained or lost for individual fractures. In the fixator group there were eight patients with grade changes: four patients moved down one grade, whilst four improved by one grade. The net result was that 13 patients had an excellent reduction, and 13 had the same result at union; similarly, 17 patients had a good position after manipulation, and 17 had the same result at union (Table V). It is likely that the apparently anomalous improvements in grade reflect errors of measurement as much as variations in the actual outcome for individual fractures. In short, the external fixator was highly effective in holding the reduced position of Colles' fractures. A typical case is illustrated in Figures 2 to 7.

In the plaster-treated group, however, the differences between the reduced position and the final position at union were quite obvious (Table V): none of the excellent reductions were maintained, and only one of seven good reductions was held. Of the 22 patients whose position was lost, 15 lost one grade, five lost two grades and two lost three grades and fell from excellent to poor.

Pin-track infections occurred in nine patients at nine pin sites. All infections were superficial and responded to treatment by cleansing and antibiotics.

Table V. Changes in positional grade for both groups (56 patients*) between fracture reduction and union

<table>
<thead>
<tr>
<th>Group</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plaster</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-manipulation</td>
<td>15</td>
<td>7</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Union</td>
<td>0</td>
<td>12</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td><strong>Fixator</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-manipulation</td>
<td>13</td>
<td>17</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Union</td>
<td>13</td>
<td>17</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

* Two patients treated by plaster were eliminated from the trial due to early loss of position.

Figures 2 to 7 - Sequential anteroposterior and lateral radiographs of a 17-year-old gymnast who sustained a severe left-sided Colles' fracture in a 10-foot fall. The fracture was treated by external fixation and a secure hold was obtained in the distal fragment despite comminution and an apparent deficiency of bone stock.
There was no joint infection, no osteomyelitis, no pin loosening, nor did any frame require premature removal. Six fixator-treated patients developed sensory changes in the distribution of the superficial radial nerve; five recovered within six weeks, but in one patient the change persisted after five months. No patient in a frame developed reflex sympathetic dystrophy (Sudeck’s atrophy). In marked contrast, two plaster-treated patients developed Sudeck’s atrophy with an accompanying severe shoulder–hand syndrome that required many months of physiotherapy.

**DISCUSSION**

Stewart et al. (1985) have shown that loss of position after manipulation is almost inevitable during the conventional treatment of Colles’ fractures by forearm plaster; recent results have also shown that supination casts, above-elbow plasters in various degrees of rotation (Pool 1973; Wilson and Venner 1984) and functional bracing (Stewart, Innes and Burke 1984) have all been found wanting as methods of controlling this loss of position. The incorporation of transfixing Kirschner wires within the plaster (Cole and Obletz 1966) was followed by the use of external fixation (Cooney 1983; Jonsson 1983), a method found to be effective by D’Anca et al. (1984).

Jakob and Fernandez (1982) reported good results after treating severe distal radial injuries by fixation; other authors have reported their results according to qualitative assessments (Grana and Kopta 1979; Forgon and Mammel 1981; Cooney 1983; Jonsson 1983).

Most studies of the external fixation of wrist fractures have addressed themselves to either the “redisplaced” or the “unstable” fracture, the latter being defined by the more severe Frykman grades (1967) (Cooney, Linscheid and Dobyns 1979; Forgon and Mammel 1981; Cooney 1983; D’Anca et al. 1984; Schuind, Donkerwolcke and Burny 1984). However, as Stewart et al. (1985) have shown that the potential of a fracture to slip is related to its initial displacement, any fracture that was displaced sufficiently to require manipulative reduction, whether or not it was intra-articular or comminuted, could be considered potentially unstable. In the relatively young population we studied there was a preponderance of high-energy injuries that caused both types of fracture. Our results showed that no loss of fracture position occurred when a fixator was applied after manipulative reduction, whereas in the plaster-treated group only one fracture maintained its position and a further single fracture improved one grade spontaneously. The remaining 22 plaster-treated fractures lost position; 15 lost one grade, five lost two grades and two lost three grades. The documented loss of position in the fixator-treated group compares favourably with that reported by Cooney et al. (1979) with less variation.

Our fixator-treated group of patients suffered a numerically higher incidence of complications than did the plaster-treated group. However, none of the pin-site infections were serious, all responded to treatment, none necessitated early removal of the fixator and there were no infective sequelae. The six cases of radial nerve sensory impairment occurred relatively early in the trial and, being an “operator-related” complication, could have been avoided by careful attention to pin-site placement (Schuind et al. 1984). In contrast, the two cases of reflex sympathetic dystrophy occurring in the plaster-treated group were associated with extreme morbidity and required intensive outpatient treatment.

Conventionally an external fixator at the wrist is applied so that the fixation crosses and immobilises both the fracture and the wrist joint. Such fixation may be associated with finger stiffness, metacarpal fracture or even reflex sympathetic dystrophy (D’Anca et al. 1984; Schuind et al. 1984; Vaughan et al. 1985). There have been reports of distal wires being inserted into the fracture fragment, thus avoiding wrist immobilisation (Cooney 1980; Forgon and Mammel 1981; Jakob (1984), however, suggested that this form of fixation was insecure and recommended additional plaster splintage, thus negating the potential advantages of this more proximal pin placement. We employed the conventional method in the first two cases but changed to direct fixation of the distal fracture fragment in the remaining 30 cases (94%) and never found the need to supplement the fixation with plaster in spite of severe comminution.

Previous reports of fixator treatment in Colles’ fractures have had a stipulated period of fixator splintage (often several months) sometimes followed by additional plaster splintage (Jakob 1984). Schuind et al. (1984) required radiological evidence of healing before discontinuing fixation, but this practice seems questionable when one considers that the macroscopic callus of healing cortical bone (McKibbin 1978) is not found in cancellous bone. In our study fracture union, regardless of the method of treatment, was assessed solely on a clinical basis; no frame was left on longer than four weeks and only one plaster was maintained for five weeks.

**Conclusion.** The aims of treatment in Colles’ fracture are to allow early functional recovery of the limb, to improve the long-term function of the wrist, and to prevent cosmetic deformity. It remains unknown whether an improvement in the anatomical result can influence the long-term function of the wrist as well as contributing to a normal appearance. There is no doubt, however, that the external fixator effectively maintains the reduced position whereas treatment by plaster does not. Distal fixation of the pins into the fracture fragment is not difficult, is safe and allows immediate recovery of function of the wrist and hand. Whilst the long-term functional results of this study are still being evaluated, it does appear that improved anatomical results combined with early rehabilitation of wrist function produce very favourable functional results.
REFERENCES


