Intramedullary fixation using multiple Kirschner wires for forearm fractures: a developing country perspective

A Abalo, A Dossim, A Assiobo, A Walla, A Ouderaogo
Department of Orthopaedics, Tokoin Teaching Hospital, Lome, Togo

ABSTRACT

Purpose. To evaluate treatment results of intramedullary fixation using multiple Kirschner wires for diaphyseal forearm fractures.

Methods. Between January 2001 and January 2004, 184 patients (122 men and 62 women) with 288 displaced diaphyseal forearm fractures underwent intramedullary fixation using multiple Kirschner wires. The wires were inserted by opening the fracture site because radiographic facility for closed pinning was unavailable. The time to union, functional recovery, and the complication rates were assessed.

Results. 11 patients were lost to follow-up, leaving 173 whose data was analysed. In 167 (97%) of the patients the fractures united, and in 14 (8%) of them union was delayed. The mean time to union for closed fractures was 13 (range, 7–16) weeks and for open fractures it was 15 (range, 12–22) weeks. The mean time in cast was 6 (range, 3–14) weeks. In all, 34/173 (20%) had complications: superficial infection (n=13), deep infection (n=4), cross-union between bones (n=4), open fracture ‘needing’ a skin graft (n=2), radial nerve palsy (n=3), paraesthesia (n=1), and non-union (n=7). Among the 173 analysed patients, the infection rate was 10% and the non-union rate was 4%. 130 (75%) of the patients had the wires removed; no re-fracture occurred after wire removal. Based on the Anderson criteria, 47 (27%) of the patients attained excellent, 78 (45%) satisfactory, and 39 (23%) unsatisfactory results. In 9 (5%) of the patients, union failed (7 plain non-union and 2 due to chronic osteomyelitis).

Conclusion. Kirschner wires are much cheaper than plates and screws, and require minimal expertise for insertion and removal. They remain acceptable for stabilising displaced diaphyseal forearm fractures in developing countries.

Key words: bone wires; forearm injuries; fracture fixation, intramedullary

INTRODUCTION

The treatment goal for diaphyseal forearm fractures is to regain axial and rotational stability. Inadequacy of devices is associated with high complication rates. Plate osteosynthesis has been shown to achieve high union rates. Intramedullary techniques have the advantage of closed insertion.

In Togo, west Africa, intramedullary fixation with multiple Kirschner wires remains an acceptable...
treatment method for forearm fractures, because of financial constraints. The wires were inserted by opening the fracture site, because radiographic facility for closed pinning was unavailable. Long-term follow-up was lacking. We aimed to describe our treatment results with intramedullary fixation using multiple Kirschner wires.

**MATERIALS AND METHODS**

Records of patients who underwent intramedullary fixation of the radius, ulna, or both between January 2001 and January 2004 were reviewed. Patients aged under 15 years or those with fractures treated conservatively or with plates and screws or external fixation were excluded.

Records of 184 patients (122 men and 62 women) aged 15 to 67 (mean, 36) years fulfilled the criteria, of which 49 had fractured the radius, 11 the ulna, and 124 both; 104 had injured the right forearm and 80 the left. The mechanisms of injury were motor vehicle accident (n=98), industrial accident (n=20), and fall (n=66).

According to the AO classification,7 60 fractures were type A, 96 type B, and 28 type C. The fractures were open in 34 patients. According to the Gustilo criteria,8 19 fractures were grade I, 10 grade II, and 5 grade III. 26 patients were poly-traumatised. Surgery was performed on the day of admission for patient with open fractures; all other fractures were stabilised within 24 days of injury.

General anaesthesia was used in 125 patients and regional anaesthesia in 59. The arm was placed on a side table or across the chest. Wires were inserted by opening the fracture site as emergency radiographic facility for closed pinning was unavailable. For ulnar fractures, 2 to 3 Kirschner wires were inserted into the medullary canal from the olecranon along the subcutaneous border. For radial fractures, the wires were inserted through the radial styloid exposed by a dorsal/dorsolateral incision. The wires were threaded across the fracture site under direct vision. The wires were bent against the outer cortex at the insertion and cut off (Figs. 1 and 2). A splint extending from the hand to the upper humerus was applied. The forearm was immobilised in the cast until satisfactorily radiographic union. Physiotherapy involved active flexion, extension, pronation, and supination exercises. Kirschner wires were kept in situ until formation of bridging periosteal callus.

Clinical union was defined as no tenderness at the fracture site. Radiographic union was defined as extension of trabeculae across the fracture, the presence of bridging callus, and obliteration of the fracture line. A forearm goniometer was used to measure the flexion or extension of the wrist or elbow, and the rotation of the forearm with the elbow flexed.
90°. Time to union was defined as the time between surgery and radiographic union. The Anderson criteria were used to evaluate the functional results (Table 1).

**RESULTS**

11 of 184 patients were lost to follow-up. In the accessible 173 patients whose data was analysed, the mean follow-up duration was 26 (range, 17–51) months. 167 (97%) of these patients achieved bone union, in 14 (8%) of them union was delayed. The mean time to union for closed fractures was 13 (range, 7–16) weeks and for open fractures was 15 (range, 12–22) weeks. The mean operating time was 63 (range, 34–129) minutes. The mean time in cast was 6 (range, 3–14) weeks.

Based on the Anderson classification, 47 (27%) of patients attained excellent, 78 (45%) satisfactory, 39 (23%) unsatisfactory results. In 9 (5%) there was failure of union (2 due to chronic osteomyelitis). The success rate (excellent and satisfactory results) was 72%. The extent of mean pronation was 70° (range, 0°–97°) and the extent of mean supination was 83° (range, 0°–114°). Compared to the normal arm, the mean rotation loss was 28° (range, 5°–160°).

In these patients, 34 (20%) encountered complications: superficial infection (n=13), deep infection (n=4) [giving a 10% infection rate], cross-union between bones (n=4), open fracture ‘needing’ a skin graft (n=2), radial nerve palsy (n=3), paraesthesia (n=1) [both resolved spontaneously], and non-union (n=7, 4%). 15 of the infections resolved with debridement and antibiotics. There were no compartment syndromes, nor mechanical irritations at the distal radius or olecranon. 130 (75%) patients had the wires removed as an out-patient procedure under local anaesthesia 6 to >24 months later (Table 2). There were no re-fractures after pin removal.

**DISCUSSION**

Forearm fractures are best treated by open reduction and internal fixation to minimise the incidence of mal-union and non-union. The treatment of choice is plate fixation, which reported a 98% union rate, and 2.3% infection rate. Axial pinning of the forearm began before nailing of the larger bones. Intramedullary fixation has the advantage of closed insertion with less soft-tissue disruption and preservation of extramedullary vascular supply. A variety of medullary nails have been developed: Kirschner wire, Steinmann pin, Lottes forearm medullary nail, and forearm interlocking intramedullary nail.

Intramedullary fixation using multiple Kirschner wires is cost-effective (one Kirschner wire costs US$10 versus a plate with 6 screws cost US$300

---

**Figure 2** A 56-year-old man sustained a grade-II open fracture in a traffic accident: (a) preoperative anteroposterior and lateral radiographs of the forearm showing a fracture of the middle one third of the radial shaft and a ulnar segmental diaphyseal fracture. (b) Radiograph 15 weeks after surgery.

<table>
<thead>
<tr>
<th>Results</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>Fracture union</td>
</tr>
<tr>
<td></td>
<td>Loss of flexion/extension of &lt;10°</td>
</tr>
<tr>
<td></td>
<td>Loss of pronation/supination of &lt;25%</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>Fracture union</td>
</tr>
<tr>
<td></td>
<td>Loss of flexion/extension of &lt;20°</td>
</tr>
<tr>
<td></td>
<td>Loss of pronation/supination of &lt;50%</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>Fracture union</td>
</tr>
<tr>
<td></td>
<td>Loss of flexion/extension of &gt;20°</td>
</tr>
<tr>
<td></td>
<td>Loss of pronation/supination of &gt;50%</td>
</tr>
<tr>
<td>Failure</td>
<td>Fracture non-union</td>
</tr>
<tr>
<td></td>
<td>Unresolved chronic osteomyelitis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Time between surgery and pin removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>No. of patients</td>
</tr>
<tr>
<td>&lt;6 months</td>
<td>0</td>
</tr>
<tr>
<td>6–12 months</td>
<td>81</td>
</tr>
<tr>
<td>13–24 months</td>
<td>23</td>
</tr>
<tr>
<td>&gt;24 months</td>
<td>26</td>
</tr>
</tbody>
</table>
and requires minimal expertise for insertion and removal. Because radiographic facility for closed pinning was unavailable, wires were inserted by opening the fracture site, as recommended by the AO group. This approach, especially to the distal radius, avoids injury to the superficial terminal branch of the radial nerve, and is easy to perform with less risk of neurovascular injury. Except for the severely comminuted or double fracture, the incision was not longer than 6 cm, and much smaller than that required for plating. Although our complication rate of 20% is high, the 97% union rate and 72% excellent or satisfactory results were comparable to other series of intramedullary pinning, which also described 90 to 100% union rates, and 72 to 85% excellent or satisfactory results. 75% of our patients had the wires removed in an out-patient setting under local anaesthesia. No recovery time in hospital was needed, and patients resumed work the following day. For plate removal, in one series the mean recovery time in hospital was 40 hours and the mean off-work time was 3.4 weeks and the mean time for full recovery was 2.5 weeks. Nonetheless, plates and screws should be removed only when clinically indicated. There were no re-fractures after wire removal. Re-fracture is the commonest complication reported after plate removal; 7 re-fractures were reported in 23 patients after plate removal. Kirschner wires can maintain linear alignment but not rotational deformity. No rotational deformity was noted in our study. This may be due to the use of an above-elbow plaster until satisfactorily radiographic union.

CONCLUSION

Intramedullary fixation using multiple Kirschner wires can achieve good outcome. The wires are cheaper than plates and screws, require minimal expertise to insert, and can be removed under local anaesthesia as an out-patient procedure. This method is therefore a valid alternative to the types of fixation for forearm fractures used in developing countries.

REFERENCES