Intramedullary Fixation Of Unstable Metacarpal Fractures

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Displaced fractures of the metacarpal shafts and necks can be treated with a variety of techniques, ranging from early mobilization with no attempt at fracture reduction to open reduction and internal fixation.

The functional outcomes of fractures of the ring and little finger metacarpal shaft and neck that unite with severe malunion are usually good, but severe malunion does cause cosmetic deformity, particularly if the fracture is in the shaft rather than at the neck. Thus controversy exists regarding indications for fixation, particularly of little finger metacarpal neck fractures, which are the most commonly encountered in hand fracture clinics. Debate centers around the degree of angular malunion that is acceptable at the metacarpal neck. Ford and colleagues [1] studied 62 fractures of the little finger metacarpal neck and concluded that palmar angulation up to 70° resulted in good outcomes when the fracture was, in essence, ignored and the hand was simply mobilized. Other authors have expressed similar views [2,3], but Eichenholtz and coworkers [4] considered that palmar angulation of more than 40° required correction. Others recommend operative intervention if there is angulation of 30° [5], but no study has prospectively compared the outcomes of reduction and stabilization or simple early mobilization without intervention of these fractures. Patient wishes and expectations, together with a balanced view of the advantages and disadvantages of alternative management philosophies, should guide the hand surgeon.

In contrast to the controversy regarding ring and little metacarpal neck fractures, most surgeons would agree that angulation and shortening of index and middle finger metacarpal fractures are less well-tolerated and require correction, probably because the carpometacarpal articulations of these radial rays are less mobile. Thus intramedullary stabilization and other operative techniques are more generally accepted for these fractures.

All the possible treatment options have advantages and disadvantages, and there is no one treatment that is always the best. Intramedullary Kirschner wiring (Fig. 1) is one option which a hand surgeon should be able to offer patients who have metacarpal shaft and neck fractures, but the decision as to whether to use this technique of fracture management or another will depend both on characteristics of the fracture and the patient, who frequently has sustained the injury in a fight or by hitting a wall in frustration. Patients who have these mechanisms of injury who we see in our clinics are usually not interested in complex treatments, and frequently prefer to accept a cosmetic deformity rather than undergo operative treatment. Even if treated by closed reduction and plaster immobilization, many do not attend follow-up appointments and presumably remove their casts themselves. Another consideration for patients who sustain fractures of the ring and little finger metacarpal shafts and necks through fighting is whether they are at risk of sustaining further similar injuries in the future.

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Intramedullary wiring of metacarpal fractures

Intramedullary stabilization of tubular bone fractures is a widespread and established technique. Intramedullary fixation of metacarpal fractures using cow horn was reported as early as 1936 [6], and Rush and Rush [7] reported fixation of metacarpal fractures with miniature versions of their pins in 1949. Various techniques have subsequently been described, with some inserting the wires retrogradely through a window in the metacarpal neck/head, and others inserting them orthogradely through a window in the base of the metacarpal. Some leave the tips of the wires percutaneous, others bury them in the soft tissues, and still others bury the wires completely in the medullary cavity of the metacarpal, so that they cannot irritate the surrounding soft tissues and need not be removed at a later date. In addition, some surgeons use a single large (1.6 mm) wire [8,9], whereas others use multiple small (0.8–1 mm) intramedullary wires [10–12], and although most use Kirschner wires, some use special implants [12,13].

In 1976, Foucher [10] described a technique of using multiple (three, occasionally two) fine (0.8 mm) blunt-ended Kirchner wires to stabilize fractures of the metacarpal neck in the French literature. He subsequently reported the results of a series of 68 fractures with good results. Fracture reduction was achieved using the Jahss technique of applying a dorsal force to the distal fragment with the metacarpophalangeal and proximal interphalangeal joints flexed [14], and he then inserted the wires through a small incision at the base of the metacarpal, leaving the fracture hematoma undisturbed. The divergent tips of the wires in the metacarpal head resemble the stems of flowers, and thus the term “bouquet” osteosynthesis was coined for this technique. The wires were thought to provide enough stability to allow early mobilization without splintage, and were left slightly raised from the bone to allow removal at 6 to 8 weeks. A variety of modifications of Foucher’s technique have been published with successful outcomes, but follow-up of patients who have these fractures is difficult, and thus one cannot be certain that all unite in good alignment.

Intramedullary techniques have also been used successfully for metacarpal shaft fractures [9,11,12]. The most commonly accepted technique is to insert one or more wires through an incision over the base of the fractured metacarpal. The fracture hematoma is not disturbed if at all possible, with obvious advantages with regard to fracture healing. Details regarding aspects of the technique used vary between authors (Table 1) [18,19], but in general outcomes are reported as good regardless of the details of technique. Again the indications for intervention are debated, though most authors agree that angulation of greater than 30° in the little finger metacarpal shaft can lead to significant cosmetic deformity, if not functional disability. The technique is ideal for two-part transverse fractures, but is also suitable for short oblique fractures (see Fig. 1) and fractures with a butterfly fragment, because axial stability is provided and metacarpal length is preserved by the “intact” opposite cortices of the two main fracture fragments (Fig. 2). Such fractures with complete translation (step-off) of the fracture fragments, which may cause unacceptable shortening and significant cosmetic deformity, are particularly good candidates for intramedullary...
<table>
<thead>
<tr>
<th>Study</th>
<th>Fractures</th>
<th>Shaft or neck</th>
<th>Wire size</th>
<th>Number of wires</th>
<th>Technique</th>
<th>Postoperative immobilization</th>
<th>Follow-up (average)</th>
<th>Malunion</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foucher 1995 [10]</td>
<td>68</td>
<td>neck</td>
<td>0.8 mm</td>
<td>3</td>
<td>Orth/bs</td>
<td>None</td>
<td>4 years</td>
<td>Not stated</td>
<td>RSD/ulnar nerve neuritis</td>
</tr>
<tr>
<td>Gonzalez et al 1995 [12]</td>
<td>98</td>
<td>both</td>
<td>0.8 mm</td>
<td>4–5</td>
<td>Orth/bs</td>
<td>4 weeks</td>
<td>9 months</td>
<td>1° average</td>
<td>Metalwork prominence/ refraction</td>
</tr>
<tr>
<td>Calder et al 2000 [8]</td>
<td>6</td>
<td>neck</td>
<td>1.6 mm</td>
<td>1</td>
<td>Orth/bs</td>
<td>None</td>
<td>9 months</td>
<td>4° average</td>
<td>Pin site sloughing</td>
</tr>
<tr>
<td>Manueddu et al 1996 [5]</td>
<td>23</td>
<td>neck</td>
<td>0.8 mm</td>
<td>2–5</td>
<td>Orth/bs</td>
<td>“a few days”</td>
<td>5 years</td>
<td>17/4mm shortening</td>
<td>RSD/ulnar nerven neuritis</td>
</tr>
<tr>
<td>Faraj &amp; Davis 1999 [11]</td>
<td>22</td>
<td>shaft</td>
<td>0.9 mm</td>
<td>1–3</td>
<td>Orth/bb</td>
<td>None</td>
<td>6 weeks minimum</td>
<td>Not stated</td>
<td>Refracture</td>
</tr>
<tr>
<td>Wong et al 2005 [17]</td>
<td>30</td>
<td>neck</td>
<td>Not stated</td>
<td>2</td>
<td>Orth/bs</td>
<td>2 weeks</td>
<td>24 months</td>
<td>Not stated</td>
<td>Wire migration/distal perforation</td>
</tr>
<tr>
<td>Moutet 1987 [18]</td>
<td>104</td>
<td>both</td>
<td>Not stated</td>
<td>3</td>
<td>Orth/bs</td>
<td>Not stated</td>
<td>Not stated</td>
<td>Not stated</td>
<td>Not stated</td>
</tr>
<tr>
<td>Mockford et al 2003 [9]</td>
<td>20</td>
<td>shaft</td>
<td>1.6 mm</td>
<td>1</td>
<td>Orth/pc</td>
<td>Not stated</td>
<td>Not stated</td>
<td>4°</td>
<td>Superficial infection</td>
</tr>
<tr>
<td>Kelsch 2004 [19]</td>
<td>35</td>
<td>neck</td>
<td>1.2–1.4 mm</td>
<td>1–3</td>
<td>Orth/bs</td>
<td>4 weeks</td>
<td>1 year</td>
<td>Not stated</td>
<td>Not stated</td>
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*Abbreviations:* bb, wires buried in metacarpal; bs, wires buried in soft tissues; orth, orthograde insertion; pc, wires left percutaneous; ret, retrograde insertion.
fixation [11]. Long spiral fractures and fractures of the proximal shaft and base (proximal to the isthmus of the bone) are less suitable for intramedullary fixation because acceptable stabilization of the fracture is unlikely to be achieved. In addition, severely comminuted fractures with no axial stability should probably be treated with other techniques because of the risks of unacceptable shortening or significant bending of the intramedullary wires causing angular malunion. Although rare, metacarpal fractures with significant true rotation deformities, as opposed to apparent rotation caused by swelling [15], should be treated with operative fixation. Although some consider that the splayed ends of the wires in the metacarpal head will control rotation [12], the authors feel that intramedullary wires provide insufficient rotational control of the fracture, unless supplemented with a transverse Kirschner wire that transfixes the heads of the fractured and an adjacent (intact) metacarpals.

A number of published studies have demonstrated successful use of intramedullary techniques for both shaft and neck fractures, and several are shown in Table 1. Details of technique, including the diameter of implant and the postoperative splintage and immobilization regimens, vary between studies, but in general good outcomes are reported, possibly reflecting the tolerant nature of these fractures. The use of single large (1.6 mm) [8,9] or multiple small (0.8–1 mm) [5,10–12] intramedullary wires does not appear to have an influence on outcome; however, the use of a single large (1.6 mm) wire [8,9] may provide less rotational control when compared with bouquet techniques. Recently use of a larger diameter wire with simple introduction system (Small Bone Fixation System, Hand Innovations, Miami, Florida) has been proposed, with the added theoretical advantage of the ability to lock the wire for rotational control [13]. Use of this implant requires later implant removal. The authors have no personal experience in the use of this system and await comparative studies with the use of simple Kirchner wires bent (as detailed below) to facilitate introduction.

As Table 1 shows, there is wide variation in individual practices with regard to mobilization, but it appears that immediate mobilization is an accepted and safe management principle; however, although patients can resume office based and even manual work shortly after intramedullary fixation if the Kirchner wires are buried in the metacarpal bone and do not irritate the soft tissues, they do not provide rigid fixation, and may bend with heavy hand usage, allowing recurrent flexion of the fracture (see Fig. 2).

The need or desire to remove the implants also varies among the published studies. The authors generally bury the wires within the bone with no intention to remove them at a later date, and have found this practice safe and satisfactory, provided the window for their insertion is distal to, and does not encroach on, the carpometacarpal joint [11]. The retained wires may, however, cause management problems if the patient subsequently
refractures the metacarpal in another fight. This is because the Kirschner wires may bend markedly at the time of refracture, so that their distal tips come out of the medullary canal and lie on the dorsal surface of the flexed distal fracture fragment, thus preventing a closed reduction (Fig. 3). This is an argument for routine removal, although this has significant negative cost implications, and the authors suspect that our patients would not reliably reattend for planned wire removal.

Assessment of the various studies published using intramedullary stabilization techniques for metacarpal fractures indicates that, in general, the technique is well-tolerated and associated with few complications. Attention to surgical technique and avoidance of superficial ulnar nerve branches reduces the incidence of complications. Burying the wires reduces the risk of pin site sepsis and extensor tendon irritation. In the authors’ view, reflex sympathetic dystrophy (RSD) rather than the fracture stabilization technique is a potential complication of the injury, although early mobilization may be relatively protective against this complication.

Authors’ technique

The indications for intramedullary Kirschner wire fixation are inevitably molded by the health resources available for treatment of these injuries, and the authors’ indications have therefore been influenced by the large numbers of ring and little finger metacarpal fractures that we see, and the shortage of operating theater time/access to treat hand fractures. The authors’ indications for intramedullary Kirschner wire fixation include displaced ring and little finger metacarpal shaft fractures in which a closed reduction cannot be maintained in a hand cast [16] in patients who wish a good cosmetic result. We feel that the technique is particularly valuable for displaced metacarpal shaft fractures with complete step-off of the two fracture fragments. Such step-off may cause significant shortening and cosmetic deformity, and although intramedullary wires may bend in the postoperative phase, resulting in some recurrent palmar angular deformity, they will not allow recurrent step-off to occur. The authors do not routinely use this technique for ring and little finger metacarpal neck fractures, because most patients who have such injuries are not bothered about the cosmetic outcome, and in our experience the functional outcome is almost invariably excellent, even if a major malunion occurs. Also we believe, possibly erroneously, that the wide medullary canal at the metacarpal neck level reduces the effectiveness of the technique and increases the risk of redisplacement of the fracture after fixation, particularly if the fracture fixation is not protected by a splint or plaster cast postoperatively. Finally, although the authors have limited experience of such injuries, we do not favor intramedullary fixation for multiple metacarpal fractures in association with severe soft-tissue crush injuries, because we believe that

Fig. 3. This man had undergone intramedullary fixation of a metacarpal shaft fracture 1 year previously. He then punched a wall and returned with a metacarpal neck fracture that was markedly flexed. The intramedullary wires had bent at the fracture site and one protruded through the metacarpal head while the tip of the other lay dorsal to the metacarpal head. The wires were removed and the fracture was manipulated and immobilized in a hand cast.
other techniques of fixation provide better stability.

The authors’ present technique of percutaneous intramedullary fixation for metacarpal shaft fractures is a modification of that described by Faraj and Davis in 1999 [11]. The blunt rounded ends of three or four single-ended 1-mm Kirschner wires are bent to an angle of approximately 30°, 5 mm proximal to the tip, so that they resemble the guide wire for a femoral intramedullary nail. The sharp tip at the other end of the Kirschner wire is removed, and it is bent to a right angle 2 cm from its end to produce a handle. The bends at each end of the Kirschner wire should be made in the same plane, so that the surgeon can determine the alignment of the tip of the Kirschner wire in the intramedullary canal by looking at the position of the handle. The midportion of the Kirschner wires are then bent into gentle curves (Fig. 4).

The surgery is performed under general or regional anesthetic under image intensification, preferably with a tourniquet on the upper arm. First a 1- to 2-cm skin incision is made over the base of the fractured metacarpal. For the little finger this incision is made on the ulnar aspect of the metacarpal base, whereas for the middle and ring fingers it is made on the dorso-ulnar aspect, and for the index finger it is made dorso-radially. An awl is then placed on the surface of the metacarpal base, approximately 1 cm distal to the carpometacarpal joint, using the image intensifier for guidance. The awl is used to create a window in the cortex of the metaphysis, and is passed into the medullary cavity of the bone (Fig. 5). The window created by the awl is then enlarged using burrs, which are introduced obliquely, first in a distal direction so as to encourage the Kirschner wires to run up the shaft of the metacarpal bone, and then proximally to create a void in the base of the metacarpal in which the tips of the Kirschner wires are buried at the end of the procedure (Fig. 6). It is important that this cortical window does not encroach on the carpometacarpal joint, because otherwise the inserted and retained Kirschner wires may migrate into this joint, causing pain. Once a 5-mm diameter window has been made in the metacarpal base, the first Kirschner wire is introduced into the window, and the fracture is reduced by the assistant applying a distraction force with extension. The Kirschner wire is then manually advanced up the medullary cavity and across the fracture by gently rotating it, using the handle to rotate the tip into the correct alignment to engage in the medullary canal of the distal fragment (Fig. 7). It is then manually advanced as far into the neck/head of the metacarpal as possible. It is not always easy to pass the Kirschner wire up the shaft and across the fracture, but this is made easier by using the rounded end of a single ended Kirschner wire rather than the sharp tip of the Kirschner wire or the rough end of a Kirschner wire whose tip has been cut off with
a pair of pliers. It is not uncommon for the Kirschner wire to miss the medullary canal of the distal fragment and pass into the soft tissues, but with thoughtful perseverance, the Kirschner wire can usually be passed across the fracture and into the metacarpal neck. If, however, this proves impossible, as is sometimes the case in patients who have particularly narrow medullary cavities (the ring finger metacarpal sometimes has a particularly narrow medullary canal), then the skin incision can be extended and retracted distally to expose the fracture, which can then be reduced under direct vision, thus allowing passage of the Kirschner wire.

A second and third Kirschner wire, and sometimes a fourth, are then usually inserted in a similar fashion, and these are usually easier to introduce than the first. The medullary canal of the ring finger is frequently narrow, however, so that only one or two Kirchner wires can be introduced. This is occasionally the case for the little finger metacarpal, and can be predicted preoperatively from the radiographs. Once the required number of Kirschner wires have been

![Fig. 6.](image1.png)

**Fig. 6.** A burr is used to widen the cortical window in a distal oblique direction (*A*), and create a void in the base of the metacarpal (*B*).

![Fig. 7.](image2.png)

**Fig. 7.** The prebent Kirschner wires are introduced into the medullary canal. This is often easier if the wire is held with a needle holder (*A*), but can be done by hand (*B*).
inserted as far into the metacarpal as possible, the position of the wires and the fracture are checked on the image intensifier. Each Kirschner wire in turn is then withdrawn approximately 5 mm and is cut (with a pair of pliers) right up against the window in the base of the metacarpal bone. Each Kirschner wire is then pushed back into the medullary cavity with a mosquito clip, and its proximal end is then pushed proximally into the metacarpal base, so that it lies proximal to the cortical window and cannot migrate out of it later (Fig. 8).

Once all the Kirschner wires have been cut and buried in the metacarpal base, axial compression is applied across the fracture to ensure that it is not held in distraction by the wires and that there is no gap between the two fracture fragments. The skin wound is closed and the hand is rested in a soft bandage.

If the patient wishes to achieve the best possible cosmetic result, then a palmar slab is applied and worn for 3 to 4 weeks to protect the reduction and allow the fracture to unite in as good alignment as possible. If the patient is keen to mobilize the hand and accepts that the Kirschner wires may bend during fracture healing, causing some recurrent flexion deformity if the hand is used for heavy work, then all that is required is a soft bandage. The patient can be encouraged to mobilize the hand immediately.

**Summary**

Intramedullary stabilization of metacarpal shaft and neck fractures is a relatively simple, cost-effective, and safe technique with good published outcomes (Fig. 9); however definite

![Fig. 8](image1.png)  ![Fig. 9](image2.png)

Fig. 8. The Kirschner wires are withdrawn slightly, cut flush with the cortical window, and then one by one, their tips are pushed back into the medullary canal and pushed proximally into the void in the metacarpal base with mosquito forceps, so that they are trapped in the medullary canal (A–D).

Fig. 9. A fracture of the shaft of the little finger metacarpal with palmar angular displacement. This was reduced and stabilized with three Kirschner wires. Note that the tips of the wires in the metacarpal head are not rounded but sharp. This might have made their insertion more difficult by allowing the tips to catch on the rough walls of the intramedullary canal.
advantages over other techniques of fracture stabilization, or indeed simple early mobilization in some instances, have not been clearly demonstrated. A recent publication does suggest that the technique is comparable to percutaneous transverse fixation in the context of fifth metacarpal neck fractures [17].

References