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ORIGINAL STUDY

Single retrograde intramedullary wire fixation of metacarpal shaft fractures

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From 1993 to present day, 110 metacarpal fractures in 89 patients were stabilised using a method of inserting a percutaneous intramedullary wire. This allowed for early unimpeded movement in wrist and hand together with ease of wire removal in clinic.
Reduction was maintained in all patients until fracture healing, and there were no malunions. One was re-done owing to inadequate reduction intra-operatively, which thereafter united. One re-fractured and was subsequently treated non-operatively. There were two superficial infections. One patient was lost to follow-up at 4 weeks ; the rest regained a full range of pain-free movement. In a final assessment of 62 patients, the mean DASH score was 4.6.
We recommend this technique for metacarpal fractures that are : transverse and off-ended ; angulated transverse or short oblique ; multiple transverse or short oblique. We do not recommend this technique for long oblique or rotationally malaligned fractures.

Keywords : metacarpal shaft fracture ; intramedullary fixation.

INTRODUCTION

Unstable displaced fractures of the metacarpal shaft are treated in many different ways, each with its own merits. The ideal technique would hold the fracture in a perfect position while allowing full unimpeded movement of the fingers. Percutaneous Kirschner wire fixation techniques generally share the advantage of minimising operative soft tissue damage. In some techniques wires left protruding through the skin can limit joint movement, while in others buried wires can be difficult to remove. We describe a simple technique for percutaneous intramedullary wiring of unstable metacarpal fractures in which joint movement is unimpeded but the wires are left percutaneous for ease of removal in the clinic.

Black *et al* in a cadaveric study, compared the strength of five different fixation methods following a transverse metacarpal osteotomy (*1*). In this rather unusual fracture configuration, a lag screw and dorsal plate was stronger than plate alone or diagonal Kirschner wire, with or without a wire box suture. Intramedullary wires were not considered.

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Vanik *et al* did a similar cadaveric study, but again did not test a longitudinal intramedullary wire (*13*). They found that the best intraosseous loop configuration was as strong as a dorsal plate, but did not try supplementing this with an interfragmentary screw.

Firoozbakhsh *et al* cyclically loaded an oblique osteotomy in cadaveric metacarpals fixed in five different ways (*2*). A dorsal plate and interfragmentary screw was the strongest. Stacks of two or five intramedullary Kirschner wires were deemed as failing when "excessive relative movement between the rod and the bone" was observed. Excessive relative movement was not defined but no intramedullary Kirschner wires broke. None of these studies addressed how strong the fixation of a metacarpal fracture needs to be, and whether there is an optimum stiffness of fixation beyond which fracture healing is slowed or inhibited.

Stern *et al* retrospectively reviewed 258 patients who had undergone internal fixation of metacarpal and phalangeal fractures in Cincinatti (*11*). A metacarpal fracture had been fixed with a plate in only 29 of these patients. In two patients there was some permanent stiffness, and three developed nonunions. They described an overall complication rate of 29% in the plated acute metacarpal fractures. On the other hand, Ford *et al* achieved uniformly satisfactory results in 26 unstable or displaced metacarpal fractures treated by open reduction and internal fixation with AO minifragment screws and plates (*3*).

Mennen described the use of his own clamp-on plate in 15 metacarpal fractures reporting an operating time between 10 and 15 minutes and a perfect result in all cases (*9*).

Smith and Peimer suggested open reduction of all unstable metacarpal fractures and fixation with plates and screws or crossed Kirschner wires. They did not consider intramedullary wiring (*10*).

Suman described nine fractures in five patients treated by running a Kirschner wire transversely across adjacent metacarpal necks and then inserting longitudinal single intramedullary wires (*12*). He did not explain whether the intramedullary wire was introduced from the proximal or distal end of the metacarpal, and the diagram showed an improbable bone with a convex articular surface at each end. He did say that all the wires were left percutaneous and removed three weeks later, but it is not clear which end of the intramedullary wire was left protruding. Transverse wires could cause problems by transfixing the interosseous muscle mechanism.

Lord pointed out that transverse wires had been found to "affect the efficiency of the intrinsic muscle mechanism" but stated that plaster treatment as advocated originally by Bunnell resulted in "hand stiffness, malunion, necrotic skin areas and great economic loss" (*7*). Lister described in 1978 the use of intraosseous wiring supplemented by a single Kirschner wire (*6*). He emphasized that fixation should be rigid – this was at a time when the original AO principles still held sway – and stated that a single Kirschner wire on its own is not rigid enough while two may hold the fracture ends apart.

Hall developed 0.8 mm pre-curved rods with which he treated 70 metacarpal and 21 phalangeal fractures (*5*). Depending on the position of the fracture, the rods were introduced through proximal or distal portals on the dorsal aspect of the metacarpal shaft using a 1 cm incision. The rods were cut 1-2 mm from the bone and were apparently not removed. He stated that there were no malunions, but did not give his definition of malunion.

Varela and Carr described "a slight modification of Hall's technique" also using 0.8 mm intramedullary rods through proximal or distal ports (*14*). The distal port was extra-articular, 1 cm proximal to the distal articular surface. They pointed out that the diameter of the metacarpal canal increases from index to little finger, accepting from two to five rods. They did not give detailed results nor did they say how many cases were treated. No wires were removed.

Manueddo and Della Santa treated 23 metacarpal fractures in a similar way with fasciculated pinning, inserting multiple flexible 0.8 mm Kirschner wires through a hole made in the dorsum of the proximal end of the metacarpal (*8*). The wires were buried and left in place permanently. They reported that all the patients were "subjectively satisfied" at 5 years with only one patient having a reduced range of motion.

Gonzales and Hall also used stacks of three to five 0.8 mm Kirschner wires to treat 98 closed

unstable metacarpal fractures (*4*). The wires were buried and left in place permanently. Fifteen patients were lost to follow-up but of the rest only two had a malunion greater than 5° and one had a 20° rotational malunion. All but two regained a full range of movement.

Vom Saal had described in 1952 the use of a single intramedullary wire, treating three metacarpal fractures in two patients with a wire inserted from the metacarpal head and left protruding distally at the metacarpophalangeal joint (*15*). He did not comment on the limitation to movement that this would impose.

Lord treated 30 patients with an intramedullary wire inserted through the metacarpal head which was left to protrude distally and was removed "in most cases" at three weeks. He admitted that metacarpophalangeal joint movement was limited while the wire was in place, but stated that it returned to normal shortly after removal of the wire. He also stated that "entry into the carpometacarpal joint seems to cause no ill effects".

PATIENTS AND METHODS

One hundred and ten metacarpal fractures in 89 patients were treated over a 17 year period. All patients were followed to radiological union of the fractures. In a final telephone questionnaire, the satisfaction of 62 patients was assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) Score.

Operative Technique

Under a general anaesthetic without tourniquet and using image intensifier control a single Kirschner wire is inserted into each fractured metacarpal (fig 1). A long 0.8 mm Kirschner wire with one pointed and one rounded end is selected. With the metacarpophalangeal joint flexed to 90° the pointed end of the Kirschner wire, mounted in a wire driver drill, is run into the distal end of the metacarpal, through the distal articular surface and in the line of the intramedullary cavity. The fracture is reduced by closed manipulation and the wire is passed across the fracture into the medullary cavity of the proximal fragment. The wire is advanced to the proximal end of

Fig. 1. — Preoperative AP and Lateral radiographs showing a severely angulated fracture of the midshaft of the fifth metacarpal.

the metacarpal, and the wrist is then put into a fully flexed position. The wire is then advanced using a manual wire holder, rotating it about a third of a revolution in each direction to prevent any soft tissues becoming wound around it. The wire is advanced further until it begins to tent the skin on the dorsum of the wrist. It should reach the skin approximately 1 cm proximal to the proximal end of the metacarpal. A small exit incision is made. The wire is advanced again and the manual driver is now removed from the distal end and placed on the proximal end of the wire. It is then withdrawn proximally until the image intensifier picture confirms that its distal end is just within the metacarpal head, clear of the articular surface. An incision is made from the proximal exit point distally towards the base of the metacarpal. The incision is usually around 1.5 cm in length. The wire is bent back distally through this incision, the point of bending being where the wire emerges from the metacarpal. This bend takes the wire clear of the wrist joint. The wrist is then extended fully to check that the wire does not limit dorsiflexion. The bend also prevents the wire from subsequently migrating distally into the metacarpophalangeal joint. The incision is closed leaving the wire protruding from its distal end. A plaster of Paris volar slab is applied to support the palm with the wrist in 10° of extension. Hand therapy to regain full finger movement begins the following day. The slab and sutures are removed after 8 days. Full wrist and finger movement is then encouraged. At 5 weeks, or when there are radiological signs of healing, the wire is removed by drawing it proximally out of the metacarpal in the clinic.

RESULTS

One hundred and ten fractures were treated in 89 patients (80 male, 9 female). All fractures were closed but displaced transverse or short oblique without rotatory malalignment. All were considered to be unstable during manipulation under a general anaesthetic.

Thirty-nine patients had a fracture of the 5th metacarpal, 14 had a fracture of the 4th metacarpal, 11 had a fracture of the 1st metacarpal ; 46 had multiple fractured metacarpals.

The median operating time, taken from the anaesthetic record, was 20 minutes (range : 15-40).

The mean patient age was 24.2 years (range : 16-77).

The median preoperative worst fracture angle on radiographs was 41° (range : 20°-70°).

The median postoperative worst fracture angle on radiographs was 2° (range : 0°-10°).

The median time to final follow-up was 16 months (range : 5-28).

We attempted to contact all the patients by telephone to assess the longevity and functional outcome of their treatment. Of the 62 patients successfully contacted, 8 were not working and 16 were students who only missed a few days of study. The other 38 returned to work after a mean of 5 weeks (range : 3-8).

One patient sustained a refracture in a second injury 6 weeks after the first. The second fracture was minimally displaced and was treated conservatively. Two patients developed a wound infection described as superficial. It settled with oral antibiotic treatment.

The sixty-two patients successfully contacted by telephone were assessed according to the DASH scoresheet :

– Ranging from 0 (best possible score) to 100 (worst possible score).
– Comprising 30 components, with no more than three items missing to be considered a valid score. Focuses on severity of symptoms including pain, stiffness, weakness and tingling and activities of daily living including opening a jar ; turning a key ; writing ; pushing a door ; washing ; dressing and household chores.

Mean score was 4.6 (range : 0-6.9)

No patient described any pain, deformity, loss of range of movement, or interference with work or hobbies following hand therapy at time of discharge. One patient described a small lump at the fracture site. Seven patients described the result as “good” while the other fifty-five described it as “excellent”.

DISCUSSION

Many isolated metacarpal fractures can be treated conservatively provided that they are stable enough to allow mobilisation of the fingers to begin within a few days of the injury. If they are angulat-

ed, rotated or shortened, or especially if they are multiple, they will require fixation of some sort. Most metacarpal fractures that require manipulation will need to be fixed. Fixation allows earlier mobilisation of hands presenting with multiple or complex injuries. Very unstable fractures, such as those that are comminuted or those that are malrotated on presentation, usually require fixation with screws or plates.

We do not recommend the use of crossed Kirschner wires. Inserted by a closed technique they must transfix the interosseous muscles, and we agree with Lister's opinion (*6*) that they tend to hold fractures apart. An intraosseous wire loop or box suture is only of any use in holding transverse fractures or osteotomies, and an open technique must be used. Transverse fractures are better and more easily fixed with intramedullary Kirschner wires. We agree with Lord's view (*7*) that transverse Kirschner wires, as later used by Suman (*12*), may damage the interosseous muscles or their tendons, and we do not find any need to use this technique. Although multiple intramedullary wires have been recommended by Hall (*5*), Verala *et al* (*14*), Manueddo *et al* (*8*) and Gonzales *et al* (*4*), we find that a single intramedullary wire is sufficient. None of the wires became bent at the fracture site, indicating that a single 0.8 mm wire is strong enough. Although insertion of the wire through the articular surface of the metacarpal head might be expected to cause problems in the metacarpophalangeal joint, we agree with the observation of Lord (*7*) that this is not the case, and we did not detect any such problems in our patients.

The technique that we have described is simple, reliable and effective when used for unstable metacarpal fractures that are (Fig 2 & 3) :

1. transverse and off-ended.
2. angulated transverse or short oblique.
3. multiple transverse or short oblique.

It is not recommended in metacarpal fractures that are :

1. long oblique.
2. rotationally malaligned.

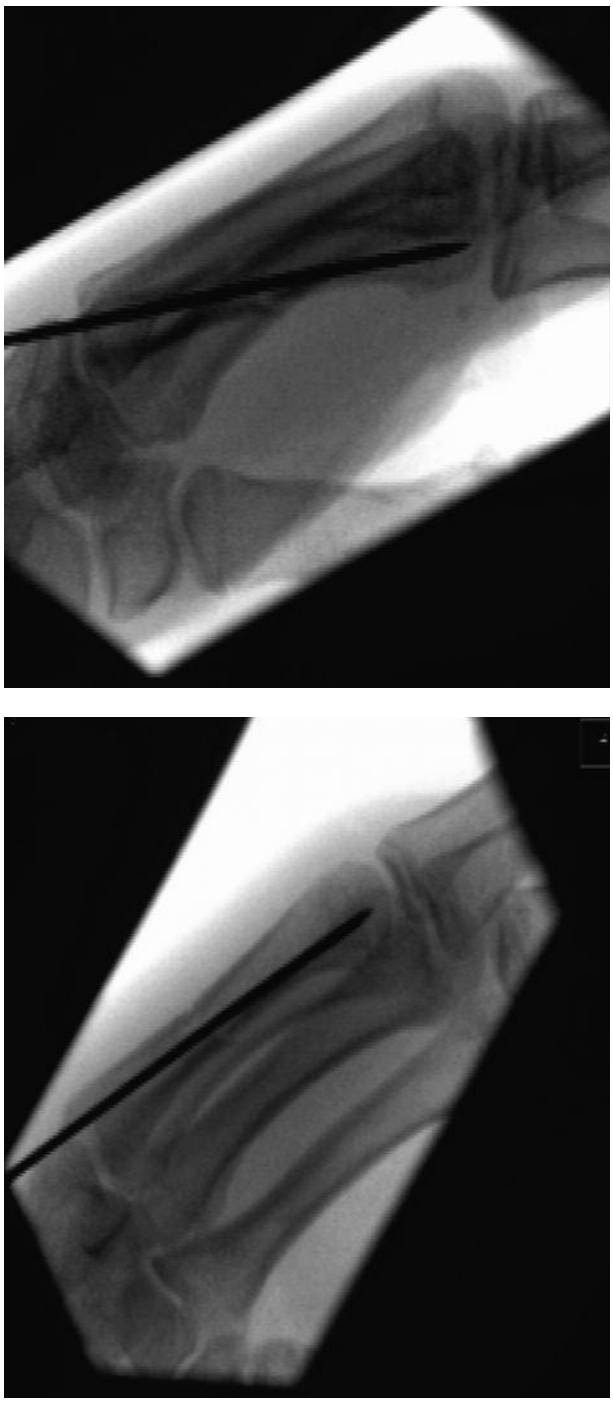

Fig. 2. — The intraoperative position of the Kirschner wire is checked under image intensifier control.

Fig. 3 a-c. — AP, Oblique and Lateral films confirming radiological union prior to removal of the wire in clinic.

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