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5 authors, including:

Jorge Orbay
Miami Hand & Upper Extremity Institute, Miami, …

Igor Indriago
CENTRO SALUD CARACAS

Alejandro Badia
Badia Hand to Shoulder Center, Miami, FL USA

Roger Khouri
Miami Breast Center

Percutaneous Fixation of Metacarpal Fractures

Jorge L. Orbay, MD, Igor Indriago, MD, Eduardo Gonzalez, MD, Alejandro Badia, MD, and Roger Khouri, MD

Metacarpal shaft fractures are common but consensus on the best mode of treatment has not been established. Open reduction and internal fixation with plates or screws has been performed for severely displaced fractures. Unfortunately, extensor tendon adhesions and/or unsightly scars frequently follow this form of treatment. Percutaneous flexible intramedulary nailing of metacarpal fractures provides an alternative method that minimizes these problems. The technique is simple and provides the ability to lock the nails to control length and rotation. The nails are inserted using a manually operated slotted awl and usually in an anterograde direction to prevent soft tissue irritation around the metacarpo-phalangeal joints. This method utilizes flexible nails (1.5 and 1.0 mm.) and closed fluoroscopically assisted reduction. Rotationally unstable or fractures with a tendency to shorten can be locked proximally using a captured transverse pin which effectively controls length and rotation. Metacarpo-phalangeal flexion block splinting can be used postoperatively and the nails are routinely removed after fracture healing. Experience with this technique has been favorable as it avoids exposure of the fracture, dissection around the extensor mechanism, and scar problems. It has provided excellent functional results and has presented a low complication rate.

The Metacarpal bones are frequently injured, they account for 36% of hand and wrist fractures.[1,2] Because their peak incidence occurs between 20 and 40 years of age, these fractures result in significant economic impact. The hand tolerates these injuries well and serious residual functional deficits are rare, therefore these injuries are often considered trivial and treated lightly. On the other hand, metacarpal fractures can sometimes cause significant morbidity and patient dissatisfaction. Rotational malalignment and stiffness will produce a serious functional deficit and angular malunion can result in a cosmetic defect poorly tolerated by some patients.

The optimal management of these injuries is still the subject of controversy. Nonoperative treatment requires prolonged splinting and frequently fails to correct deformity, while surgical treatment involves a tradeoff between restoration of bony anatomy and the consequences of soft tissue irritation and scar formation. Many techniques of surgical treatment also require exposure of the fracture site, a maneuver which has well-recognized disadvantages. Intramedullary fixation of metacarpal fractures was introduced as an attempt to provide stable fixation while minimizing the drawbacks of operative treatment. Lord[3] and later Pfeiffer[4] (1976) advocated close retrograde pinning of metacarpal fractures by inserting the pins through the flexed MP joint. Foucher[5] introduced in 1975 the "bouquet" technique of close anterograde nailing of these injuries using multiple small pre-bent k-wires. This technique avoided both opening the fracture site and injury to the MP joint. Its drawback was the need for a proximal surgical incision and its relative technical difficulty. More recently other authors, Gonzalez et al.[6] (1995), Gonzalez and Hall[7] (1996), and Manueddu and Della Santa[8] (1996) have reported success with variations of this last technique. Recently, we have developed a system to allow percutaneous insertion of these nails and a new method for locking them to enhance fixation and expand their indications.

From the Miami Hand Center, Florida.

Address correspondence and reprint requests to Dr. Jorge L. Orbay, Miami Hand Center, 8905 SW 87th Avenue Suite # 100, Miami, Florida. 33176.

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Biomechanical Considerations

In clinical practice, metacarpal shaft fractures present three levels of instability. These can all be treated with percutaneous intramedullary fixation.

1. *Simple transverse fractures*, where the main issue is the prevention of angulatory deformity. Here, a single intramedullary nail will stabilize angulation. The intermetacarpal ligaments will control rotation (Fig 1).
2. *Fractures with rotational instability*, either two nails inserted through different portals or a locked nail will stabilize angulation and rotation (Fig 2).
3. *Fractures with rotational instability and a tendency to shorten*, such as long spiral or comminuted fractures. These will require locked nails to stabilize fracture angulation, rotation, and length (Fig 3).

Flexible intramedullary nails provide fixation through several mechanisms. Most important, they function as intramedullary splints, controlling angulation and displacement by "filling up" the canal and producing an interference fit. They can give added angular support by carefully bending them to provide 3-point fixation. Distal rotatory stability is provided by driving a flat and/or curved end into the distal metaphyseal bone. Proximal rotatory stability can be obtained by using a transverse locking sleeve. Rotational stability can also be provided by the use of multiple curved nails inserted through separate portals.

Experimental evidence suggests that intramedullary fixation of oblique metacarpal fractures is as strong as dorsal plate fixation and superior to crossed k-wires and lagg screws.[9]

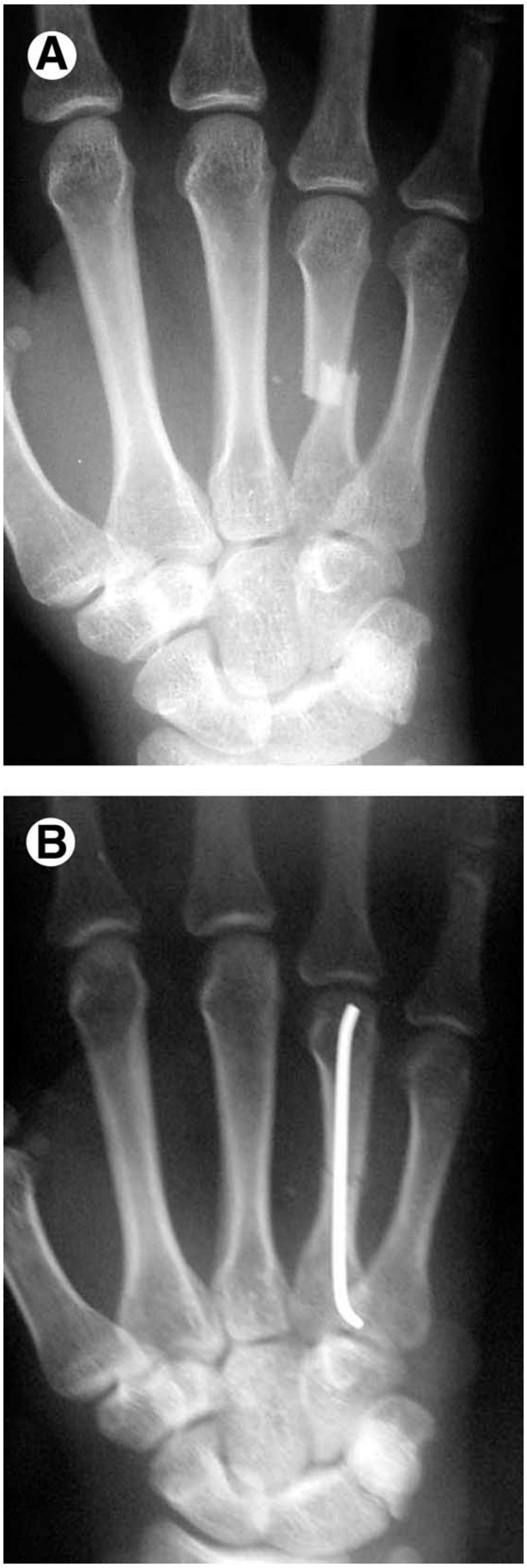

Fig 1. (A) Preop and (B) postop radiographs of a simple flexible intramedulary nail fixing an isolated transverse fracture. In this situation the intermetacarpal ligaments usually provide sufficient rotational stability.

Technique

Flexible intramedulary metacarpal nails are inserted through a percutaneous approach (<1 cm) and under manual power. A special device, consisting of a nail-handle assembly that fits inside a slotted awl (Fig 4), has been designed for this purpose. The awl is utilized to perforate the thin cortex of the proximal metaphysis and to deliver the nail into the medullary canal. Nail insertion is usually done in an anterograde direction, to prevent injury to the MP joint and the periarticular soft tissues.

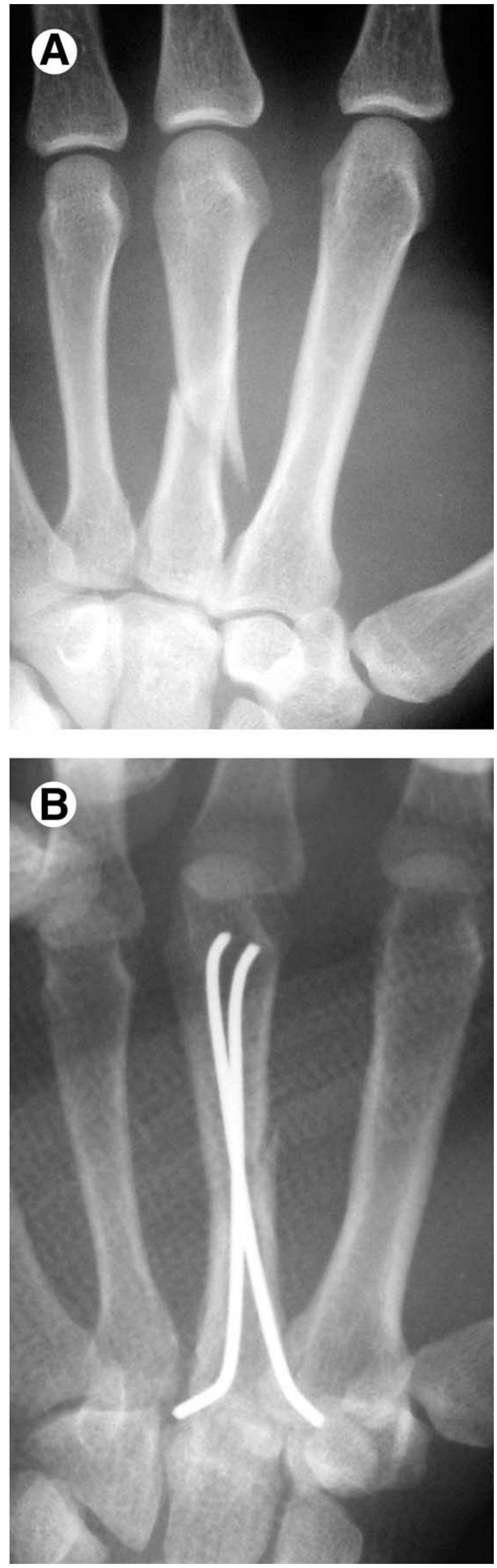

Fig 2. (A) Preop and (B) Postop radiographs. Two nails can control angulation and rotation in a short spiral fracture.

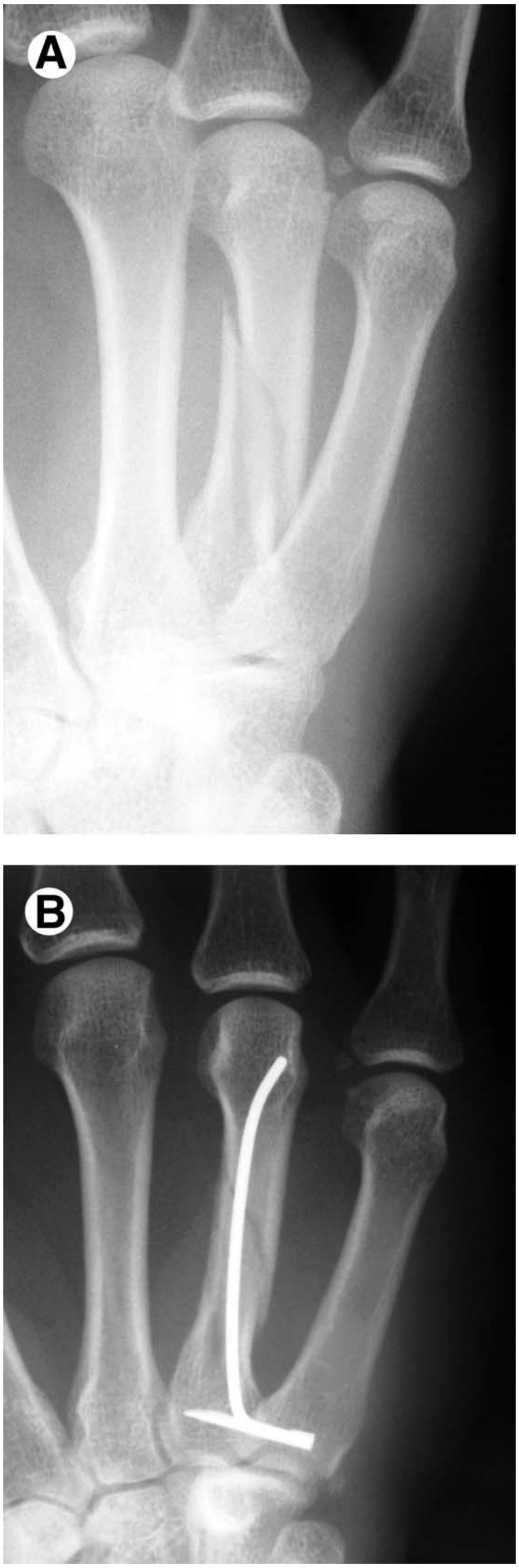

Fig 3. (A) Preop radiograph. (B) Postop radiograph. A locked intramedulary nail can control length, angulation, and rotation in a long spiral fracture.

The procedure is performed under fluoroscopic guidance. Most cases are done under local anesthesia and sedation. First, it is confirmed that the fracture can be reduced close. A small stab incision is then placed over the base of the metacarpal. Blunt soft tissue dissection is carried down to the bone surface. Careful spreading of the soft tissues is particularly important in the case of the 3rd and 4th metacarpal where the extensor tendons are in close proximity to the nail insertion site. After the metaphyseal cortex is perforated (Fig 5), the nail is deployed and separated from the awl. The nail is then advanced to the fracture site. The fracture is reduced under flouroscopic guidance and the nail is passed into the distal fragment (Fig 6). The nail is finally advanced into the metacarpal head. If it is necessary, the nail can be removed during the procedure and its curvature modified while maintaining access to the medullary canal. This is possible with the use of an accessory tool designed for this purpose. Once satisfied with reduction and nail placement the surgeon decides if proximal locking is desirable. This step greatly enhances rotatory and longitudinal stability allowing the stabilization of spiral and comminuted fractures (Fig 7). If locking is unnecessary, as in the case of transverse metacarpal shaft fractures, the surgeon simply cuts the handle off the nail, bends the proximal end to facilitate retrieval and recuts it above or below the skin as preferred. Locking is desirable in the case of oblique, spiral, or comminuted fractures. The nail handle is first cut off and the proximal end of the nail is then bend 70 to 90° by using the accessory tool. A locking sleeve is introduced over the cut end of the nail; it is driven down through the entrance portal and into the metaphyseal bone by manual action. Fluoroscopy will greatly facilitate this step. When strong resistance is finally felt, a few sharp blows from a mallet helps to fully seat the device. A ratchet mechanism prevents component disengagement during rehabilitation. In most metacarpal fractures, only one 1.5 mm nail is necessary. Multiple nails can be used when required by severe fracture instability.

Postoperative Management

A bulky postoperative dressing is applied in the operating room. It should support the hand in an intrinsic plus position while allowing full interphalangeal motion. The patients are told to commence immediate finger motion in the recovery room. They are next seen approximately 1 week after surgery, when the dressing is removed. Rehabilitation is now individualized to each patient's circumstances. It is important to consider fracture location and stability, patient compliance, and the actual digital motion present before deciding on a rehabilitation plan. Stable fractures, especially those on metacarpals 2 and 5, may just require encouraging the patient to perform

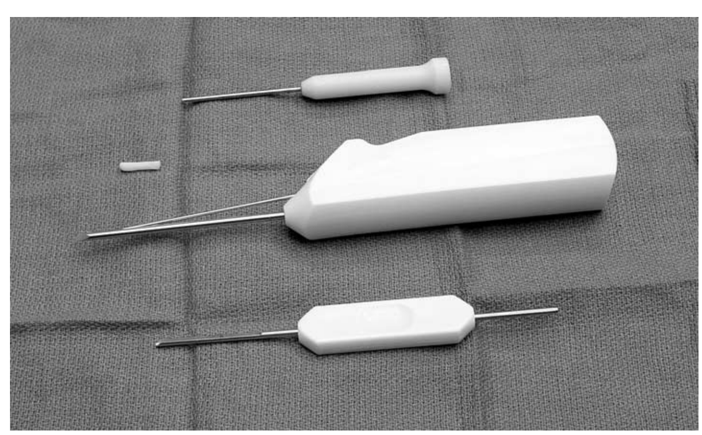

Fig 4. The "slotted awl" (center) is used for manual nail introduction. The nail is attached to its handle and resides inside the awl. The nail locking sleeve is on the top and the accessory tool for nail exchange or bending is on the bottom.

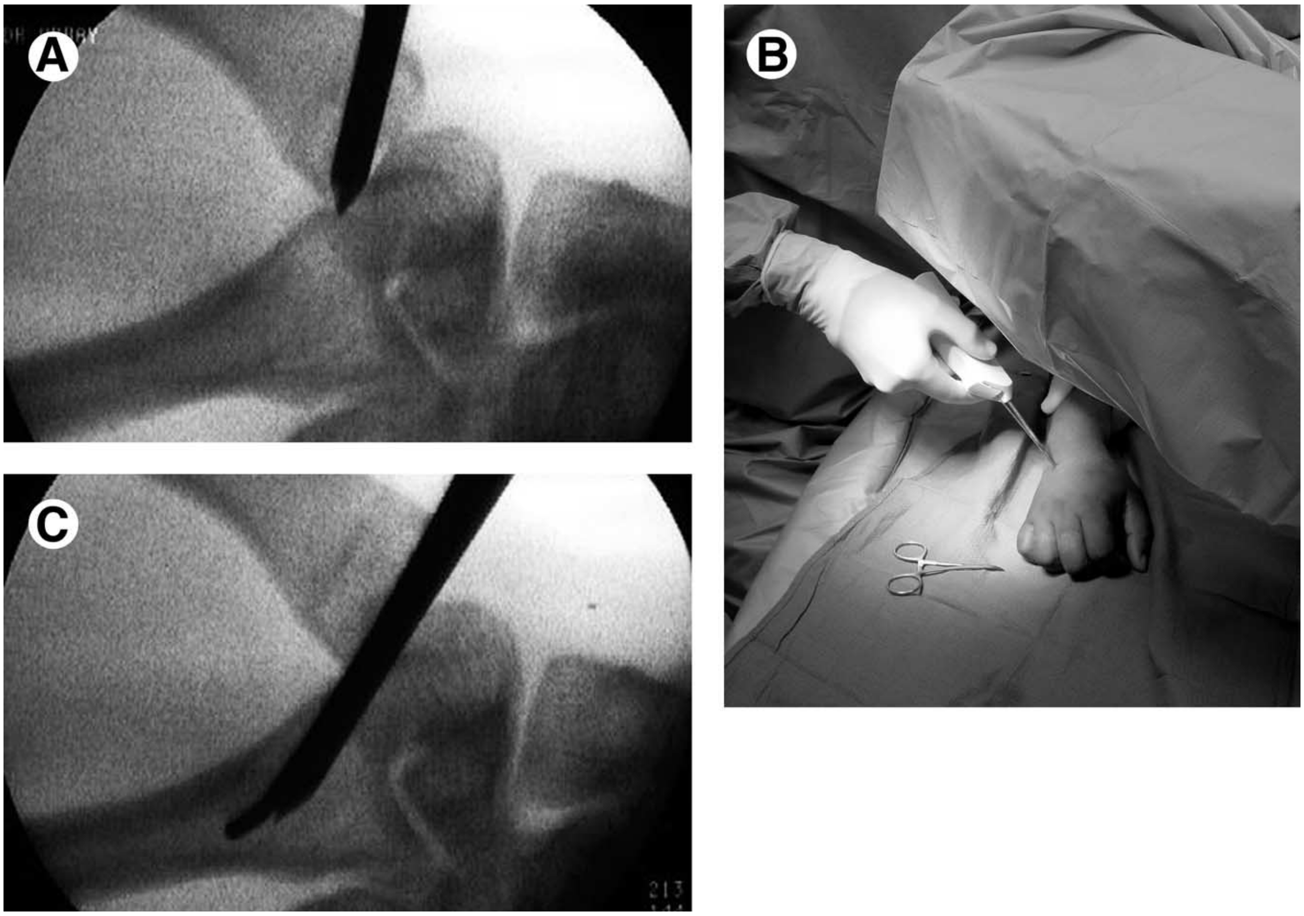

Fig 5. The metaphyseal cortex is perforated manually utilizing the slotted awl and the nail advanced into the medullary canal.

motion exercises. A buddy splint or no splinting at all might be necessary. Unstable fractures may benefit from an MP flexion block splint. The use of this device will not only support fixation but also prevent rotational malalignment and avoid the development of an MP joint extension contracture. Furthermore, by limiting extensor tendon excursion, MP block splinting prevents the problem of extensor tendon irritation by the proximal end of the nail of metacarpals 3 and 4. This problem does not happen with metacarpals 2 and 5 as the proximal part of the nail is well separated from the tendons. The nails are routinely removed after fracture healing. This usually occurs between the 4th and the 8th post-op week.

Discussion

The ideal method of metacarpal fracture treatment should obtain stable fixation and allow early recovery of function while minimizing the risk of soft tissue damage and scar formation. It should also be reliable, simple, and easy to perform.

Treatment options for these injuries have included: no reduction and early motion, close management with casts or splints, percutaneous pinning with k-wires, external fixation, open reduction and internal fixation with plates, screws, or tension bands, and intramedullary flexible nail fixation. All these alternatives have advantages and disadvantages.

Early motion without reduction produces good functional results in stable minimally displaced fractures but it is inappropriate in those cases where the original displacement cannot be accepted. Closed treatment with cast or splints is simple but frequently fails to maintain reduction in unstable fractures. Percutaneous cross pinning with k-wires avoids opening the fracture but it is frequently difficult to perform and the pins can transfix the extensor tendons, extensor hood, or the collateral ligaments causing postoperative stiffness. Open reduction and internal fixation with plates, screws, or tension bands provide rigid internal fixation and allow the management of complex fracture situations, but these techniques necessitate exposure of the fracture site and are associated with tendon and scar problems. External fixation facilitates management of soft tissue wounds but is cumbersome, induces stiffness and is rarely indicated.

Flexible anterograde intramedullary fixation preserves the soft tissues and does not expose the fracture. This technique was originally described by Foucher using multiple small pins through an open approach to the metacarpal base. It was best indicated in transverse metacarpal shaft and neck fractures. In the presence of severe comminution or spiral fracture patterns, the technique tends to produce shortening.

Percutaneous insertion of flexible intramedulary nails to treat extra-articular fractures of the metacarpals minimizes scar formation and soft tissue trauma. It also facilitates and expedites the surgical procedure. The nails can be locked on their proximal aspect to enhance fixation in spiral and comminuted fractures, in this manner preventing shortening and controlling rotation. Therefore, the indications for flexible intramedullary fixation can now be extended to most unstable extraarticular metacarpal fractures. Flexible intramedullary fixation is versatile; single or multiple locked or unlocked nails can be used to treat different clinical situations. Most metacarpal fractures are best treated with anterograde nails, in this way preventing injury to the soft tissues around the metacarpo-phalangeal joints.

In the case of a proximal metaphyseal thumb or small finger metacarpal fracture, retrograde nails can sometimes be used advantageously. Very distal or boxer's type fractures are easily treated but care has to be given to prevent penetration of the metacarpal head. This occurs occasionally in osteoporotic bone. Placing the curvature at end of the nail against the dorsal cortex and the use of two nails for better load distribution are useful techniques. Transverse metacarpal fractures are ideal for this technique provided that the surgeon is careful to impact the fragments together to prevent over-distraction. Spiral fractures require attention to rotational alignment, the use of proximally locked nails and careful support with MP block splints and/or buddy splints is necessary. Comminuted fractures tend to shorten; therefore they too should be treated with locked nails. In the case of metacarpal fractures of the long or ring fingers, the proximal end of the nail lies close to their extensor tendons, raising the danger of tendon irritation. Here, the use of an MP flexion block splint is recommended to minimize the excursion of the extrinsic extensors and therefore the likelihood of tendon injury during rehabilitation. Nails should be removed soon after fracture healing; this can be done as an office procedure or in a more formal operating room.

Percutaneous flexible intramedullary nailing of metacarpal fractures is easy to perform, saves operating room time, minimizes soft tissue dissection, and produces an insignificant scar.

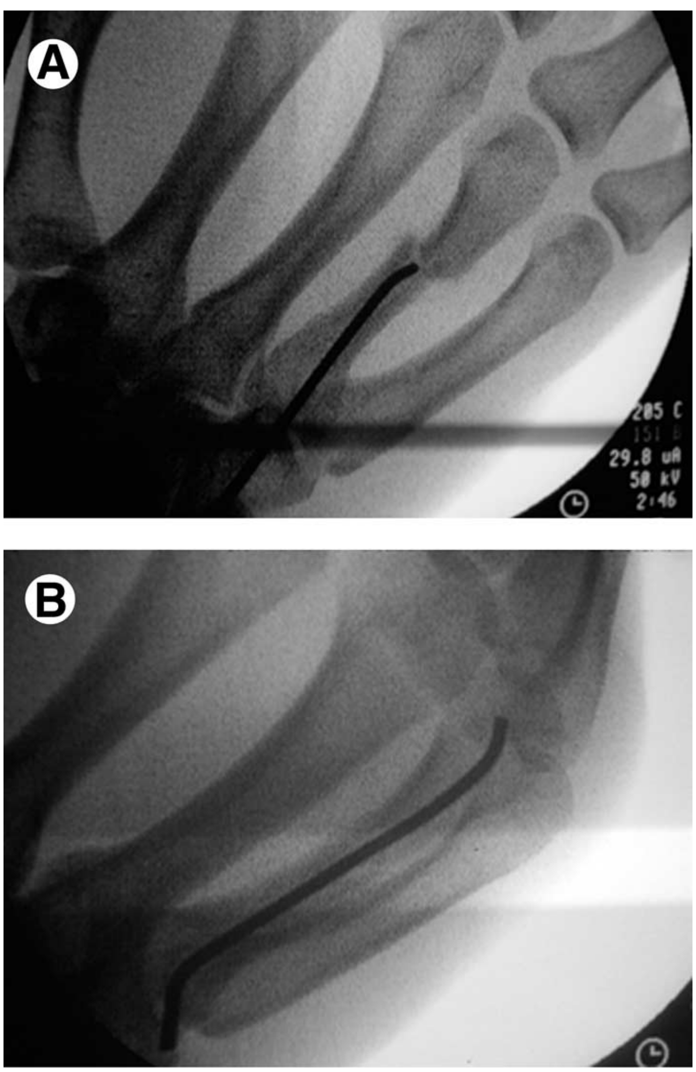

Fig 6. The fracture is reduced and the nail is advanced into the distal fragment

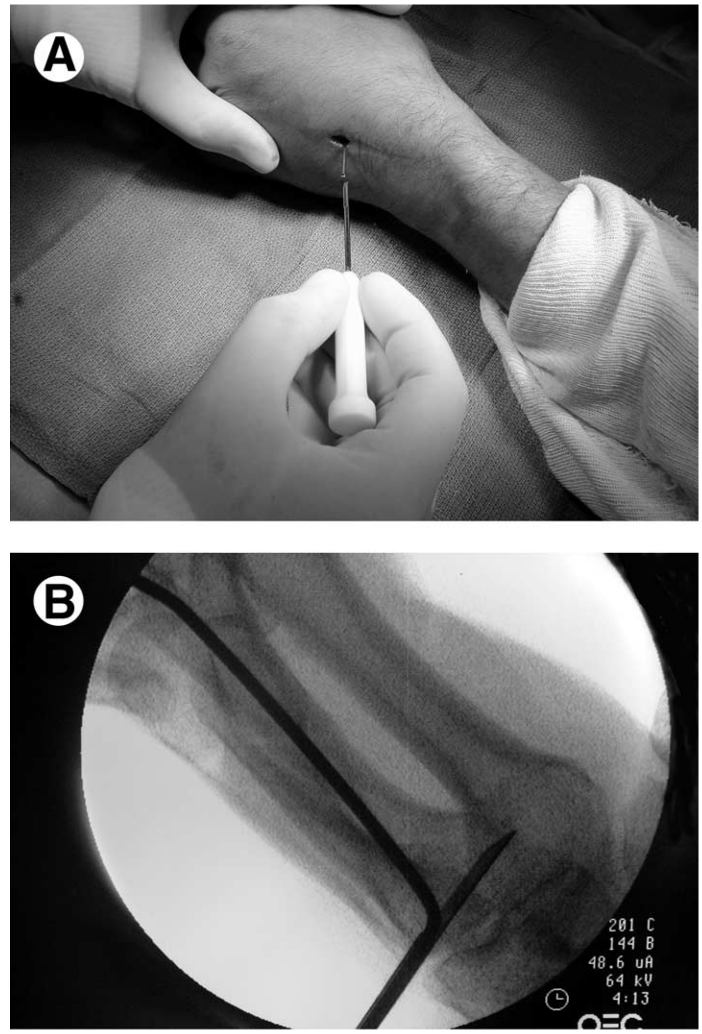

Fig 7. For optimal rotational stability, the nail is locked proximally using the locking sleeve. This device is applied by first sliding it over the bent end of the nail and then impacting it into the proximal metaphyseal bone. The sleeve and the nail are then cut below the skin.

It is cost-effective when compared with plate and screws and obtains high patient satisfaction.

References

1. Wolfe SW, Elliott AJ: Metacarpal and Carpometacarpal Trauma, In: Peimer CA (ed): Surgery of the Hand and Upper Extremity. McGraw-Hill Companies, Inc. 1996, pp 883-920
2. Greene TL: Metacarpal Fractures. In: American Society for the Surgery of the Hand (ed): Hand Surgery Update. Am Acad Orthopaedic Surg 11-15, 1996
3. Lord RE: Intramedullary fixation of metacarpal fractures. J Amer Med Assoc 164:1746-1749, 1957
4. Pfeiffer KM: Advances in osteosynthesis of hand fractures. Hand Chirurgie 8(1):17-22, 1976
5. Foucher G: "Bouquet" osteosynthesis in metacarpal neck fractures: A series of 66 patients. J Hand Surg 20A(Supp):S86-S89, 1995
6. Gonzalez MH, Igram CM, Hall RF: Flexible intramedullary nailing for metacarpal fractures. J Hand Surg 20A:382-387, 1995
7. Gonzalez MH, Hall RF Jr: Intramedullary fixation of metacarpal and proximal phalangeal fractures of the hand. Clin Orthop Rel Res 327: 47-54, 1996
8. Manueddu CA, Della Santa D: Fasciculated intramedullary pinning of metacarpal fractures. J Hand Surg 21B:230-36, 1996
9. Firoozbakhsh KK, Moneim MS, Doherty W, Naraghi F: Internal fixation of oblique metacarpal fractures. Clin Orthop Rel Res 325:296-301, 1996