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TECHNIQUE

Intramedullary Nailing of Metacarpal Shaft Fractures

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ABSTRACT

Uncorrected bony deformity or stiffness resulting from a metacarpal shaft fracture can produce a significant functional or cosmetic deficit. Intramedullary fixation of metacarpal shaft fractures using small flexible rods can provide stable internal fixation while minimizing the extent of soft tissue trauma that is associated with more extensive surgical techniques such as plate or screw fixation. The flexible rod is usually introduced in a proximal to distal direction to avoid injury to the metacarpophalangeal joint and extensor mechanism. Closed reduction of the fracture and percutaneous insertion of the rod improve operative efficiency and allow what is truly a minimally invasive procedure. The use of a proximal locking pin greatly enhances fixation and has resulted in an expansion of the surgical indications to include spiral and comminuted fractures. Usually a single locked nail is used, although it is possible to insert multiple nails if necessary. A radiopaque plastic cap can be applied over the cut end of the nail to minimize irritation of the adjacent soft tissues during rehabilitation. Post-operatively, splint or cast immobilization is often unnecessary. The nails are routinely removed after the fracture has completely healed.

Keywords: metacarpal fractures, intramedulary nailing, minimally invasive

HISTORICAL PERSPECTIVE

Metacarpal shaft fractures are common, representing approximately one third of all fractures encountered by the hand surgeon.[1,2] It has been generally accepted that a severely displaced and unstable metacarpal shaft fracture requires operative treatment. This is commonly accomplished via open reduction and internal fixation with plate and screw fixation, a method that involves a trade-off between the restoration of normal bony anatomy and the consequences of exposure of the fracture site, specifically soft tissue irritation and scar formation. Intramedullary fixation of metacarpal shaft fractures has been advocated to simplify the surgical treatment of these common injuries and minimize the complications associated with more extensive surgical approaches. Lord[3] and later Pfeiffer[4] advocated closed retrograde pinning of metacarpal fractures by inserting K-wires through the flexed MP joint. This technique implied transfixing the MP joint and the extensor mechanism. In 1975, Foucher introduced the "bouquet" technique of closed anterograde nailing of metacarpal fractures using multiple small pre-bent K-wires.[5] The technique avoided both opening the fracture site and injury to the soft tissues around the MP joint. A drawback of the "bouquet" technique was the need for a proximal surgical incision and the relative technical difficulties. More recently Gonzalez et al,[6] Gonzalez and Hall,[7] and Manueddu and Della Santa[8] have reported similar success with surgical techniques that incorporate variations of the "bouquet" technique. Recently we described a technique for percutaneous insertion of small flexible locked nails using prefabricated instrumentation.[9]

INDICATIONS/ CONTRAINDICATIONS

Flexible intramedullary nailing is indicated for any displaced or unstable fracture of the metacarpal shaft or neck in which nonoperative treatment would produce an unacceptable result including symptomatic malunion (Fig. 1). The technique is also indicated when ORIF is undesirable, specifically a fracture of the fifth metacarpal with more than 60 degrees of angulation or 45 degrees for the 4th metacarpal and 30 degrees for the 3rd and 2nd metacarpals, respectively. Spiral fractures and fractures

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FIGURE 1. A good indication for using the intramedullary fixation technique is the presence of multiple metacarpal shaft fractures.

with rotational malalignment, excessive shortening (more than 5 mm), and moderate comminution defined as a single butterfly fragment are acceptable indications for this technique, but a proximal locking pin or the use of multiple nails is typically necessary. Fractures in those patients who are unwilling or unable to tolerate cast immobilization are also good candidates for the intramedullary nailing technique. Intraarticular involvement or fractures with severe diaphyseal comminution (more than 1 butterfly fragment) and those injuries with associated soft tissue loss in which the exposure for plate and screw fixation would not entail additional morbidity are not amenable to intramedullary nailing. Those patients presenting with a chronic fracture or nascent malunion may also be treated with flexible intramedullary nailing, provided that the fracture is exposed through a small incision and the callus mobilized or excised.

TECHNIQUE

Flexible, blunt, and pre-bent nails measuring 1.6 or 1.1 mm in diameter are inserted through a percutaneous approach, under manual power with the aid of a specially designed prefabricated awl (Small Bone Fixation System, Hand Innovations, LLC, Miami, FL). The procedure is performed under fluoroscopic guidance, and local anesthesia and sedation are frequently used. First, and most importantly, it is must be confirmed that the fracture can be easily reduced by closed manipulation. A small stab incision is then placed over the proximal base of the fractured metacarpal (Fig. 2). Blunt soft tissue dissection is carried down to the dorsal cortex. Careful spreading of the soft tissues is particularly important with fractures of the long and ring metacarpals because the extensor tendons are in close proximity to the nail insertion site. The dorsal metaphyseal cortex is perforated manually using the awl, and the nail is deployed into the medullary canal (Fig. 3). The nail is then advanced to the level of the fracture site (Fig. 4). The fracture is gently manipulated and reduced under fluoroscopic guidance, and the nail is then advanced across the fracture and into the distal fragment (Fig. 5). The nail is finally advanced into the subchondral bone of the metacarpal head, where additional

FIGURE 2. A small stab incision is placed directly over the base of the fractured metacarpal.

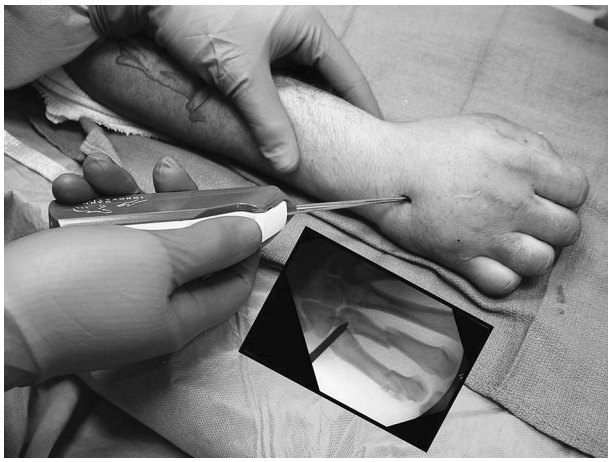

FIGURE 3. Using the awl, the surgeon perforates the dorsal cortex at the base of the metacarpal. Fluoroscopy is used to confirm the correct entry point.

FIGURE 5. The fracture is reduced by closed manipulation with the assistance of fluoroscopic imaging. The nail is then advanced across the fracture into the distal metacarpal.

careful manual rotation of the nail can assist in the final reduction. If necessary, the nail can be removed and the curvature modified as needed before reinsertion. This is usually performed to achieve greater stability of the fixation construct or to improve the final reduction. Once the surgeon is satisfied with the reduction and nail placement, the decision to lock the nail proximally is made. Locking the nail proximally greatly enhances rotational and longitudinal stability. Locking is desirable in the case of oblique, spiral, or comminuted fractures to prevent shortening and control rotation. If locking is not indicated, as in the case of a transverse or short oblique metacarpal shaft fracture, the surgeon simply cuts the handle off the nail, bends the proximal end to facilitate later retrieval, and cuts the remaining end off beneath the skin to prevent pin tract infection (Fig. 6). If locking of the nail is indicated, the nail handle is cut off, and the proximal end of the nail is bent approximately 90 degrees with the assistance of a custom device (Fig. 7). A proximal locking sleeve is introduced over the cut end of the nail and is gently driven palmarward through the entrance portal into the proximal metaphysis (Fig. 8). Fluoroscopic guidance is recommended for this step. When the locking pin engages the volar cortex, resistance is encountered, indicating that the device is appropriately seated. A ratchet mechanism engaging the locking pin to the nail prevents component disengagement during rehabilitation. The locking sleeve is kept in place by means of small teeth that engage the nail through an interference effect. Next, the prominent ends of the locking pin and nail are cut below the skin (Fig. 9), and a radiopaque plastic cap is applied (Fig. 10). This is a very important step because the cap is designed to prevent soft tissue irritation and facilitate rehabilitation while avoiding attritional injury to the extensor digitorum communis tendons. For the majority of metacarpal fractures, a single intramedullary nail is

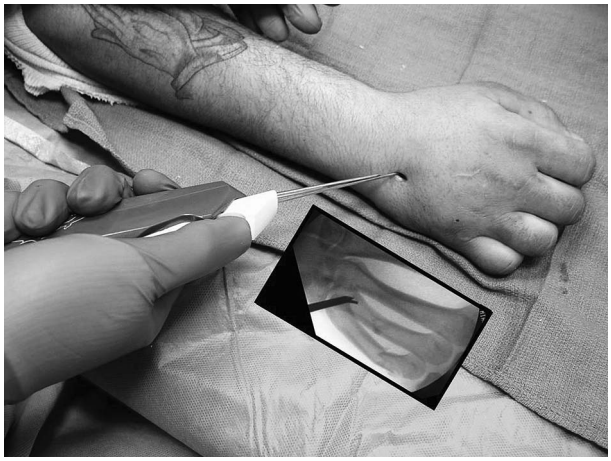

FIGURE 4. The nail is carefully introduced into the intramedullary canal before being separated from the awl.

FIGURE 6. The handle is cut off from the nail.

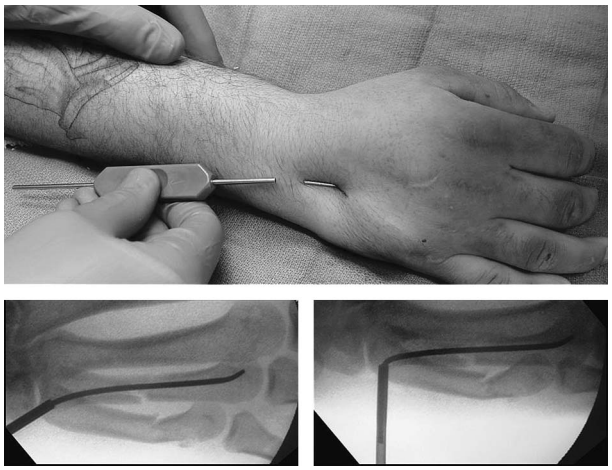

FIGURE 7. A tool is used to bend the proximal end of the intramedullary nail approximately 90 degrees.

FIGURE 9. The locking pin is cut below the skin level.

usually sufficient (Fig. 11). Multiple nails may be inserted into a single metacarpal using the identical steps just described. Multiple nails are used if persistent instability of the fracture is encountered following the insertion of a single nail or if the patient has an excessively large intramedullary canal.

REHABILITATION

A bulky postoperative dressing is applied immediately postoperatively. The dressing should support the MP joints in a flexed position while allowing unimpeded interphalangeal (IP) joint motion. The patient is instructed to begin immediate active and passive IP joint motion while in the recovery room. The patient returns to clinic at approximately 1 week after surgery, and the dressing is subsequently removed. The rehabilitation plan is individualized and is based on each patient's circumstances. It is important to consider fracture location, stability achieved, patient compliance, and the range of digital motion encountered before deciding on a plan. Stable fractures may simply require encouraging the patient to perform a home program consisting of range-of-motion exercises and edema management (Fig. 12). Unstable fractures may benefit from a dorsal hand–based splint with a MP flexion block. A well-designed splint will not only augment the fixation but will also assist in rotational alignment and the potential development of an MP joint extension contracture. The nail is routinely removed in the O/R as an outpatient procedure after complete fracture healing has been confirmed on plain radiographs. Local anesthesia augmented with intravenous sedation

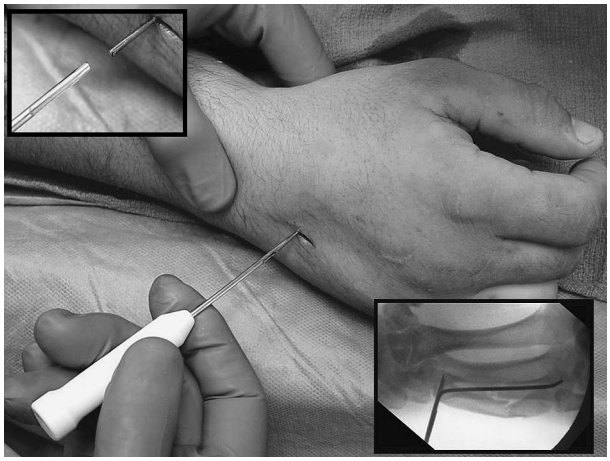

FIGURE 8. The locking pin is introduced over the cut end of the nail and driven palmarward to engage the opposite cortex.

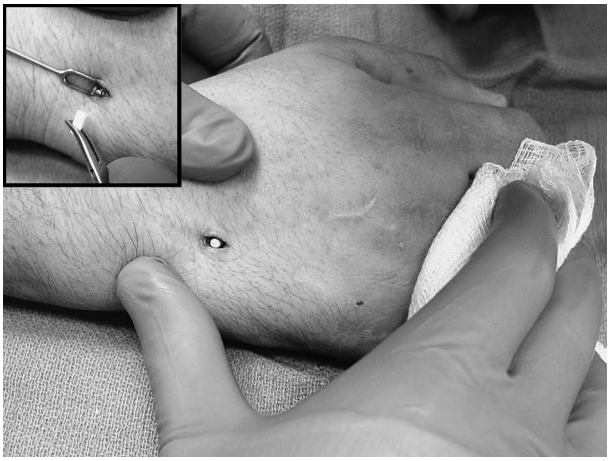

FIGURE 10. Applying the plastic soft tissue protection cap over the cut end of the locking pin prevents tendon or skin irritation during rehabilitation.

FIGURE 11. Postoperative PA and oblique radiographic views of the hand demonstrating satisfactory reduction and fixation of ring and small finger metacarpal shaft fractures.

FIGURE 12. Full digital motion is expected at the initial postoperative visit. Light functional activities are permitted, and splinting may be discontinued.

is suitable for these cases. A needle-nose pliers is used to remove the implant components. This usually occurs between 4 and 8 weeks postoperatively.

COMPLICATIONS

Penetration of the nail through the metacarpal head can occur in those fractures with small distal fragments and in patients with osteoporotic bone. Inserting the nail such that the tip is pointing down inside the metacarpal head and therefore placing the convexity of the nail against the subchondral bone or using multiple nails can help avoid this problem. Excessive distraction of the fracture can result in a delayed union. The surgeon must be careful to impact the fragments at the fracture site to prevent this problem after inserting the nail. Spiral fractures require particular attention to rotational alignment to prevent malunion. If malrotation is encountered and cannot be corrected, the surgeon must abandon the intramedullary technique. Comminuted and long oblique fractures are inherently unstable and tend to shorten. Therefore, proximal locking of the nail should be performed. In the case of a fracture of the long or ring finger metacarpal, the proximal end of the nail is located in the vicinity of the extensor tendons. Irritation can be prevented with the use of the plastic soft tissue protection cap. If the cap is not used and the patient develops tendon irritation, a custom fabricated dorsal hand splint with a MP joint flexion block can be used to minimize long extensor excursion. In our experience, there have been no tendon ruptures, infection, loosening, or migration with the use of the plastic cap. Penetration of the implant through the metacarpal head can occur in osteopenic bone, and this complication is treated by nail removal after the fracture is healed.

REFERENCES

1. Wolfe SW, Elliot AJ. Metacarpal and carpometacarpal trauma. In: Peimer CA, ed. *Surgery of the Hand and Upper Extremity*. New York: McGraw-Hill, 1996, pp 883–920.
2. Greene TL. Metacarpal fractures. In: American Society for the Surgery of the Hand, eds. *Hand Surgery Update*. Rosemont, IL: American Academy of Orthopaedic Surgery, 1996, pp 11–15.
3. Lord RE. Intramedullary fixation of metacarpal fractures. *JAMA*. 1957;164:1746–1749.
4. Pfeiffer KM. [Advances in osteosynthesis of hand fractures]. *Handchirurgie*. 1976;8:17–22.
5. Foucher G. "Bouquet" osteosynthesis in metacarpal neck fractures: a series of 66 patients. *J Hand Surg [Am]*. 1995;20:S86–S90.
6. Gonzalez MH, Igram CM, Hall RF Jr. Flexible intramedullary nailing for metacarpal fractures. *J Hand Surg [Am]*. 1995;20:382–387.
7. Gonzalez MH, Hall RF Jr. Intramedullary fixation of metacarpal and proximal phalangeal fractures of the hand. *Clin Orthop Rel Res*. 1996;Jun:47–54.
8. Manueddu CA, Della Santa SD. Fasciculated intramedullary pinning of metacarpal fractures. *J Hand Surg [Br]*. 1996;21: 230–236.
9. Orbay JL, Indriago IR, Gonzalez E, et al. Percutaneous fixation of metacarpal fractures. *Oper Tech Plast Reconstr Surg*. 2002;9:138–142.