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The Treatment of Unstable Metacarpal and Phalangeal Shaft Fractures with Flexible Nonlocking and Locking Intramedullary Nails

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The surgical management of the common extra-articular metacarpal and phalangeal fractures remains a dilemma for the hand surgeon. Although osteosynthesis with plates and screws affords excellent stability [1,2], this approach requires a significant amount of soft-tissue dissection, and can lead to extensor tendon adhesions and objectionable scarring [3,4]. The need to restore hand function while keeping surgical morbidity to a minimum encouraged the development of alternate methods of internal fixation. Closed flexible intramedullary (IM) nailing of long bone fractures of the hand was described first by Foucher and colleagues [5], followed by Gonzalez and coworkers [6,7]. Because of its inherent limitations, however, the technique was initially contraindicated for long, oblique, spiral, and comminuted fracture patterns. Later, Gonzalez and colleagues [8,9] developed a rigid intramedullary rod with proximal and distal locking screws for the management of longitudinally and rotationally unstable fractures. This large device required considerable surgical exposure, and its use was limited to those fractures presenting with a severe soft-tissue injury. To fix these unstable fractures through a minimally invasive approach, a method of locking the proximal end of flexible IM nails was developed [10,11]. Proximal locking prevents axial collapse and provides improved rotational stability over simple flexible nails. The authors' experience in the management of unstable metacarpal and phalangeal shaft fractures with the use of flexible intramedullary nails, and a comparison of the use of unlocked versus locked implants is presented next.

Patients and methods

The authors reviewed the clinical and radiological data of 150 hand fractures in 125 patients who had fractures of the long bones of the hand (metacarpals and proximal phalanxes) that had been treated with either flexible nonlocked or locked IM nails at the Miami Hand Center from January 2002 to January 2005, and who had at least 12 weeks of follow-up. The average follow-up time was 18 weeks (range 12 to 68 weeks). Locking sleeves became available some time after flexible nails; they were used for most cases and for all fracture types after their introduction. All patients were treated in an ambulatory setting with closed reduction and under fluoroscopic visualization. Indications for these procedures were significantly displaced and unstable metaphyseal or diaphyseal fractures of the metacarpals or proximal phalanxes. These include fractures with 100% displacement, rotational deformity, angulation of the fifth metacarpal of more than 60°, of the fourth with more than 45°, and of the second and third with more than 30°. Patients who had articular involvement, tendon injury, open fractures with severe soft-tissue loss, and pathological fractures were excluded from the study. Fractures were classified by site and configuration. Rotatory displacement was clinically assessed preoperatively and during follow-up examinations.

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Surgical technique

Following closed manipulation of the fracture, a small 0.5-cm stab incision was placed over the base of the fractured metacarpal. Flexible nails measuring 1.6 or 1.1 mm in diameter were inserted through a percutaneous approach, and usually in an antegrade direction. This was done under manual power and with the aid of a specially designed awl (Small Bone Fixation System, Hand Innovations, Miami, Florida) (Fig. 1). When necessary, extensor tendons were mobilized with a hemostat. The metaphyseal cortex was perforated using the awl, and the nail was then deployed into the medullary canal. The nail was first advanced to the level of the fracture site, the fracture reduced, and the nail driven into the distal fragment (Fig. 2). If necessary, the curvature of the nail was modified to achieve three-point fixation or to negotiate the fracture. If nonlocking technique was used, the surgeon simply cut the proximal end of the nail and left it under the skin for later retrieval. If locking technique was used, a proximal locking sleeve was introduced over the bent end of the nail and driven transversely into the metaphysis (Fig. 3). Often, the prominent end of the locking pin was protected with an implantable radiopaque plastic cap to prevent soft-tissue irritation. For the majority of rotationally stable fractures, either a single locked or an unlocked intramedullary nail was used (Fig. 4A, B). In the face of significant rotational instability, either a locked nail or multiple nails were inserted (Fig. 5A, B).

Postoperative management

Patients returned to the clinic at approximately 1 week after surgery to remove their postoperative dressing. For the metacarpal fracture patients in the nonlocking device (NLD) group, the hand was supported for 4 weeks with a metacarpophalangeal (MCP) flexion block splint or cast that allowed interphalangeal motion. This splinting technique supports the fracture, prevents rotational malalignment, and avoids the development of an MCP extension contracture. Metacarpal fracture patients belonging to the locking device (LD) group were allowed unsupported MCP and proximal interphalangeal (PIP) joint motion, and splinting was not used. For phalangeal fracture patients in the LD group, splinting in the form of buddy, extension, or MCP block splinting was commonly used, as well as more aggressive physical therapy. After radiological confirmation of bone healing (usually between 4 and 8 weeks) the nails were routinely removed under local anesthesia. Final clinical evaluation included assessment of the range of motion at the distal interphalangeal (DIP), PIP, and MCP joints to calculate total digital active motion (TAM); measurements of grip strength; and estimation of pain using the visual analog scale (VAS). Anteroposterior and lateral radiographs were used to assess healing and residual displacement of the fracture. Shortening was measured according to the method described by Manueddu and Della [12].

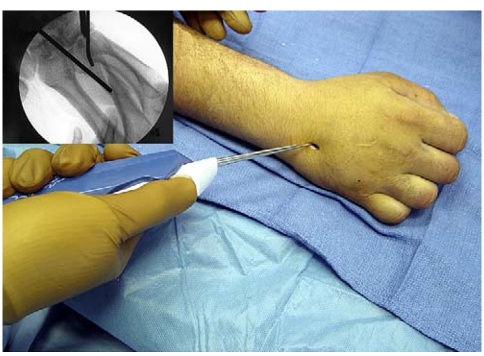

Fig. 1. The nail is inserted through a percutaneous incision using a special bone awl.

Results

Of the 125 patients included in the study, 83 patients who had 95 fractures were in the LD group, and 42 patients who had 55 fractures were in the NLD group. The demographic data in each group, including the sex, age, injured side, mechanism of injury and follow-up period, are summarized in Table 1. This series includes fractures of the first to fifth metacarpals, and second to fifth proximal phalanxes.

Metacarpal fractures

The incidence of metacarpal fractures generally increased toward the ulnar side of the hand; fractures of the fifth metacarpal (35%) were the most common, followed by fractures of the fourth (21%). Fourteen percent of patients had two or more metacarpal fractures. Of the metacarpal fractures in the NLD group, 50% were transverse shaft, 32% neck, and 18% oblique, spiral, or comminuted; versus 37% transverse shaft, 33% neck, and 30% oblique, spiral, or comminuted for the LD group. The average preoperative angular deformity for metacarpal fractures was 38° for the