An Evidence-Based Approach to Metacarpal Fractures

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The Maintenance of Certification module series is designed to help the clinician structure his or her study in specific areas appropriate to his or her clinical practice. This article is prepared to accompany practice-based assessment of preoperative assessment, anesthesia, surgical treatment plan, perioperative management, and outcomes. In this format, the clinician is invited to compare his or her methods of patient assessment and treatment, outcomes, and complications, with authoritative, information-based references.

This information base is then used for self-assessment and benchmarking in parts II and IV of the Maintenance of Certification process of the American Board of Plastic Surgery. This article is not intended to be an exhaustive treatise on the subject. Rather, it is designed to serve as a reference point for further in-depth study by review of the reference articles presented. (*Plast. Reconstr. Surg.* 126: 2205, 2010.)

CLINICAL SCENARIO

A 20-year-old student gets into an altercation where he suffers a spiral fracture of the ring finger metacarpal shaft. The fracture is minimally to moderately displaced. There is no appreciable shortening of the metacarpal on radiographs. There is no malrotation of the finger on clinical exam. What is the best evidence to guide you in the management of his condition?

Most surgeons treat metacarpal fractures according to what they learned in training, altered only by anecdotal evidence with regard to complications and personal outcomes. The purpose of this article is to provide a summary of the best available evidence on the treatment of metacarpal fractures that, when combined with individual clinical expertise, can assist the surgeon in the continuing evolution toward optimal outcomes.

METHODS FOR IDENTIFYING EVIDENCE

A literature search of PubMed, Cumulative Index to Nursing and Allied Health Literature, and the Cochrane Library was performed to obtain the best available evidence on metacarpal fracture, with emphasis on preoperative assessment, treatment, and outcomes. The following search terms were combined as appropriate, and PubMed MeSH terms were used when available: bone, fractures, metacarpal bones, boxer's fracture, Bennett's fracture, Rolando fracture, diagnosis, preoperative assessment, risk factors, antibiotic prophylaxis, anesthetics, premedication, surgical treatment plan, treatment, surgery, splinting, casting, Kirschner wires, lag screws, plate fixation, outcome, complications, postoperative complications, pain management, and analgesia. The initial search was limited to human studies that were published from 1999 to 2009 and indexed as meta-analyses, randomized controlled trials, clinical trials, comparative studies, or case-series; however, additional references were included if deemed necessary for discussion. Articles were excluded if they involved cadaver studies or if the full-text was inaccessible or of non-English language, as study quality could not be evaluated. Relevant studies were appraised for quality and validity according to criteria defined by the Critical Appraisal Skills Program[1] and assigned a level of evidence with the American Society of Plastic Surgeons Evidence Rating Scale for Therapy (Table 1). Levels of evidence are indicated throughout the text below. Evidence ratings were not assigned to studies with inadequately described methods and/or worrisome

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Table 1. American Society of Plastic Surgeons Evidence Rating Scale for Therapy

Level of Evidence	Qualifying Studies
I	High-quality, multicenter or single-center, randomized controlled trial with adequate power; or systematic review of these studies
II	Lesser-quality, randomized controlled trial; prospective cohort study; or systematic review of these studies
III	Retrospective comparative study, case-control study, or systematic review of these studies
IV	Case series
V	Expert opinion; case report or clinical example; or evidence based on physiology, bench research, or "first principles"

biases or to references included for discussion purposes only (e.g., narrative reviews).

EVIDENCE ON PREOPERATIVE ASSESSMENT

No specific evidence for diagnosis and preoperative assessment of metacarpal fractures was found. Physical examination and plain radiographs can be considered the definitive standard for diagnosis of this injury. Physical examination of a suspected metacarpal fracture should concentrate on hand deformity, tenderness, digit malrotation, and presence of open wounds.

EVIDENCE ON ANESTHESIA

No specific evidence on anesthesia for treatment of metacarpal fractures was found. Initial closed reduction of a metacarpal fracture is usually performed with local anesthesia in the form of a hematoma block and/or wrist block. Surgical treatment of isolated metacarpal fractures is typically straightforward; therefore, regional anesthesia (wrist block, intravenous anesthesia (Bier block), or brachial plexus block) is sufficient. More complex injuries with multiple metacarpal fractures may require general anesthesia for treatment.

EVIDENCE ON SURGICAL TREATMENT PLAN

Nonthumb Metacarpals

When analyzing evidence for treatment protocols, the highest quality evidence is found in studies of nonsurgical treatment of this injury. The most commonly fractured metacarpal is the small finger metacarpal at the level of the neck (the so-called boxer's fracture). The small finger metacarpal can withstand a significant amount of flexion deformity through the fracture and still retain good function. Therefore, the boxer's fracture is often treated with closed reduction and splinting. Hofmeister et al. performed a randomized study of fifth metacarpal neck fractures in which patients were treated with either a cast with the metacarpophalangeal joint in flexion or a cast extending to the proximal interphalangeal joint with the metacarpophalangeal joint extended (**Level I Evidence**).[2] There was no difference in grip strength, range of motion, or Disabilities of the Arm, Shoulder, and Hand score. They assert that the cast with metacarpophalangeal joint extended is advantageous due to ease of cast application. Similarly, Poolman et al. completed a Cochrane review of splinting and mobilization protocols for nonsurgical treatment of fifth metacarpal fractures and found that no one protocol is more advantageous than any other (**Level II Evidence**).[3]

Although not as common as fifth metacarpal neck fractures, long oblique fractures of the metacarpal shaft are fairly frequent. Conventional teaching holds that these fractures are inherently unstable and require fixation. Al-Qattan, however, studied 42 patients with these fractures and found that a palmar splint and immediate mobilization yielded excellent grip strength and range of motion at 1 year (**Level IV Evidence**).[4]

Most published clinical studies regarding metacarpal fractures address various methods of operative fixation. It is worth nothing that there are no studies that met criteria for this review that *prospectively* compare operative versus nonoperative treatment of metacarpal fractures. Westbrook et al. performed a retrospective comparative study of patients who had sustained small finger metacarpal fractures and who had undergone either surgical fixation or nonoperative treatment (**Level III Evidence**).[5] At long-term follow-up, patients treated nonoperatively had better Disabilities of the Arm, Shoulder, and Hand and aesthetic scores; however, the differences were not statistically significant, and the operative group was very small compared with the nonoperative group, thereby constituting a study limitation.

Like the studies on nonoperative treatment of metacarpal fractures, fractures of the fifth metacarpal are commonly reported in the studies about operative treatment. Kirschner wire pinning and intramedullary nailing have been compared in several studies. Winter et al. analyzed 36 patients with small finger metacarpal fractures who were treated with either transverse pinning or intramedullary pinning ("bouquet" technique) (**Level II Evidence**).[6] Total active motion in the intramedullary group was significantly better. Schädel-Höpfner et al. performed a retrospective study of retrograde

Kirschner wire pinning compared with intramedullary pinning, and found better outcomes with intramedullary pinning (**Level III Evidence**),[7] similar to the Winter et al. study. Wong et al., however, found no differences in transverse pinning versus intramedullary pinning in a retrospective comparative study (**Level III Evidence**).[8]

Because of the long, slender nature of the metacarpal, combined with the close juxtaposition of the extensor tendons, intramedullary fixation continues to be an attractive option. Simultaneously, plate fixation is also favored by many practitioners due to ease of application and ability to quickly mobilize the plated digit. Ozer et al. performed a prospective comparative study of these two fixation methods (plates and intramedullary nails) for metacarpal fractures and found that there were no differences in terms of Disabilities of the Arm, Shoulder, and Hand score or time to bony union (**Level II Evidence**).[9] The intramedullary nail required less operative time for hardware placement. Other authors have met with similar results using intramedullary fixation. Balfour found that intramedullary nailing was appropriate even for multiple metacarpal fractures (**Level IV Evidence**).[10] Other evidence on intramedullary fixation produced by Itadera et al. demonstrates good results with the technique (**Level IV Evidence**).[11]

Plate fixation remains a common method of fixation and has been shown to be effective in multiple studies. Agarwal and Pickford prospectively compared two plating systems for metacarpal and phalanx fractures and found there to be no differences in terms of motion and complications (**Level II Evidence**).[12] The plating systems were a 1.3-mm-thick system and a new very low profile (0.6 mm) system, and both were found to provide adequate fixation. There were only 20 metacarpal fractures in the study, which can be considered a limitation due to sample size. Omokawa et al. found good postoperative results with miniature titanium plates for intraarticular metacarpal and phalanx fractures (**Level IV Evidence**).[13] Souer and Mudgal also reported good results with mini-plate fixation for multiple ipsilateral metacarpal fractures in a small series (level IV evidence).[14] Plate fixation has obvious disadvantages (chiefly due to plate proximity to extensor mechanism). For this reason, there has been some interest in absorbable plates that, in theory, would mitigate the effects of adhesions to hardware. Dumont studied absorbable plates constructed of L-lactide and glycolic acid, finding that these plates provided adequate fixation and resulted in acceptable range of motion, grip strength, and Disabilities of the Arm, Shoulder, and Hand scores (**Level IV Evidence**).[15] Importantly, however, these absorbable plates have not yet been compared with nonabsorbable plates or to any other fixation modality.

Gunshot wounds involving the metacarpal present unique challenges, often due to bone loss. This problem has by no means been solved. Kömürcü et al. found good results with both plating and external fixation in both phalanges and metacarpals injured with low-velocity gunshots (**Level IV Evidence**),[16] while Bach et al. demonstrated acceptable results using a locked intramedullary nail in the metacarpal with missing bone (**Level V Evidence**).[17]

In terms of other methods of metacarpal fixation, acceptable results have been demonstrated with a variety of other techniques. Al-Qattan used interosseous wiring, reportedly to good effect (**Level IV Evidence**).[18] Dailiana et al. demonstrated good function outcomes following use of a miniature external fixation device for phalanx and metacarpal fractures (**Level V Evidence**).[19] Margić recommends external fixation of distal metacarpal fractures to allow more immediate mobilization (**Level IV Evidence**).[20] Lag screws are also an acceptable fixation method.[21] It is worth noting that no one fixation modality has been consistently proven superior to others when treating metacarpal fractures. This is reflected in studies that utilize multiple methods of fixation (**Level IV Evidence**).[22] Further, it has not been shown that, for the treatment of extraarticular metacarpal fractures, operative treatment is superior to nonoperative treatment. A further complicating factor is that outcome measures (radiographic parameters, strength, range of motion, patient-reported outcomes) are highly variable between studies.

Thumb Metacarpal

Fractures of the thumb metacarpal, especially the base, are a special situation due to the thumb's unique action; therefore, a separate discussion of fractures of this bone is warranted. Extraarticular fractures of the thumb can be managed with surgical or nonsurgical management. Surgical techniques for extraarticular fracture fixation of the thumb metacarpal are similar to those discussed above. Treatment of the intraarticular thumb metacarpal base (Bennett) and comminuted intraarticular thumb metacarpal base (Rolando) fractures has garnered significant interest in the recent literature.

Nonoperative treatment of intraarticular thumb metacarpal base fractures is not routinely reported, presumably because significant intraarticular incongruity results from these fractures. The displacement of the fracture is in large part due to the abduction of the metacarpal base by the abductor pollicis brevis tendon and adduction of the distal metacarpal due to action of the thumb adductor muscle.[23] Generally, surgery is required to restore the articular surface.

The best evidence regarding treatment of Bennett fractures comes from Lutz et al. This group compared open reduction/internal fixation with closed reduction and pinning, and found no differences in clinical outcome (pain, range of motion, pinch, grip) (**Level III Evidence**).[24] They noted that the closed reduction/pinning group had more adduction deformity on radiographs and that greater adduction deformity correlated with increased carpometacarpal joint arthrosis. Arthrosis, however, did not correlate with clinical outcome. Interestingly, this group excluded patients with joint surface step-offs greater than 1 mm, thus limiting the generalizability of the study. Sawaizumi et al. presented a small series of Bennett fractures treated with a modification of closed reduction and pinning in which the pins are driven into the trapezium after levering the thumb metacarpal back into place. Like Lutz et al., they noted good results (**Level IV Evidence**).[25] Other practitioners have utilized external fixation for Bennett or Rolando fractures: Niempoog and Waitayawinyu reported 100 percent union and good clinical results for Rolando fractures (**Level IV Evidence**),[26] while El-Sharkawy et al. also claims good results with dynamic external fixation for Rolando fractures (**Level V Evidence**).[27] Like nonthumb metacarpals, no single operative fixation modality has been demonstrated to be superior to others when treating fractures of the thumb metacarpal.

EVIDENCE ON POSTOPERATIVE OUTCOMES

As stated in the previous section, there have been no prospective studies comparing nonoperative with operative fixation of metacarpal fractures, and there is little evidence comparing different fixation modalities. Therefore, no definitive conclusions can be made regarding postoperative outcomes following metacarpal fracture treatment. It also bears repeating that the postoperative outcomes are not standardized. Most studies report on one or more of the following: range of motion, grip strength, radiographic parameters, and patient-reported outcomes (such as the Disabilities of the Arm, Shoulder, and Hand survey). Consistency in terms of which outcomes variables are studied, however, is lacking.

Special mention can be made regarding the time of immobilization following metacarpal fracture treatment. Classic teaching regarding many types of fracture treatment holds that some period of immobilization is required to allow fracture healing. The amount of immobilization time required for optimal healing has not been demonstrated. The most recent Cochrane review of small finger metacarpal fractures found no superior time of immobilization or method of remobilization following treatment (**Level II Evidence**).[3] Not surprisingly, many of investigators allow early range of motion following operative fixation.[6,10,12,13,15,18–20,22,26,27] The long oblique metacarpal shaft fracture that is treated nonoperatively has traditionally been immobilized for a number of weeks. Al-Qattan, however, reports a series of 42 patients who were treated with immediate finger mobilization along with 2 weeks of metacarpophalangeal joint splinting. After 2 weeks of splinting, the splint was removed and metacarpophalangeal joint motion was initiated. Good results were noted with this regimen (**Level IV Evidence**).[4]

SUGGESTED TREATMENT FOR CLINICAL SCENARIO

When practicing evidence-based medicine, the surgeon should consider the strength of the available evidence and integrate the evidence with his or her clinical expertise and the patient's values and preferences to develop an appropriate treatment plan. The treatment plan below is an example of how the surgeon might use the evidence to care for this particular patient.

Using the best available evidence, the fracture can initially be treated nonoperatively with some form of immobilization if good reduction is obtained (**Level II, IV Evidence**[3,4]). The fracture should be closely evaluated to ensure that progressive displacement is not occurring. If the reduction remains stable, immobilization can be discontinued as early as 2 weeks (**Level II, IV Evidence**[3,4]).

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