Metacarpal fractures in the athlete

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Abstract

Purpose of review To describe current evaluation and treatment of metacarpal fractures in athletes

Recent findings Biomechanical and clinical studies involving lower-profile, locking, shorter length, and double-row or separate-dual plate configurations, as well as intramedullary screw fixation, have demonstrated the potential benefits of internal fixation with promising results.

Summary Treatment should be customized to the specific athlete and injury, and is often successful without surgery, or with percutaneous pin fixation. Internal fixation of metacarpal fractures has improved with new hardware and new techniques, and may expedite return to play, although further clinical studies are needed.

Keywords Athlete · Metacarpal fracture

Introduction

Metacarpal fractures are common in the general population, with an estimated incidence of over a quarter million in the USA annually, predominantly in males (76%), and peaking among 15–24-year-olds [1]. While punching a wall or door is by far the most commonly involved mechanism of injury, sporting activities account for the next largest portion, in particular

American football [2]. The specific mechanism of injury leading to fracture may be direct impact against another player or the ground as in football or rugby, being struck by a hard ball at high velocity as in baseball or cricket, being struck by a stick or against a helmet as in hockey or lacrosse, or even repetitive stress from forcefully gripping an implement, such as a golf club, tennis racquet, or baseball bat. These injuries should be expected to remain common considering the growing popularity of sports, health, and fitness in our society. When discussing treatment options with athletes and deciding on return to play, attention should be given to factors including fracture location and pattern, hand dominance, the demands of specific sports and positions, patient age and level of play, proximity to the off-season, as well as league regulations regarding protective equipment.

Anatomy

The metacarpals are stabilized by the intrinsic muscles and intermetacarpal ligaments, particularly in the central rays (third and fourth), thus resisting shortening and rotation. In general, the fourth and fifth carpometacarpal joints are more mobile than the second and third, and therefore better accommodate distal deformity in their respective rays. Rotational malalignment may be poorly tolerated due to significant digital overlap interfering with grasp and manipulation, although the border rays (second and fifth) may be less likely to interfere if rotation is directed away from the other digits. At the metacarpophalangeal joints, the metacarpal heads have greater anteroposterior radius of curvature and transverse diameter volarly, while the collateral ligaments are eccentrically attached dorsal to the axis of rotation. This results in a cam effect, with the ligaments becoming tighter and more stable to lateral forces when in flexion, and conversely more lax when in extension.

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Evaluation

Physical examination should include observation of skin integrity to rule out open fracture, gross deformation suggesting displaced fracture, and neurovascular function. Digital alignment must be observed throughout the full range of motion to assess digital overlap, which may sometimes be appreciated only in full flexion. The contralateral hand should also be assessed for comparison. However, it is important for both the patient and physician to understand some degree of overlap and variability may be normal. One study of 240 uninjured digits found that 90% of individuals had overlap of up to 50% of the adjacent nail plate, and most subjects had overlap involving different digits among both hands [3]. Therefore, hand function should be of greater priority than strict appearance and symmetry.

Radiographs should include the standard posteroanterior, lateral, and oblique views of the entire hand, to evaluate all metacarpals for fracture and overall alignment. Pronated and supinated views are helpful for evaluating the second and fifth metacarpals, respectively [4]. If the metacarpals deviate more than 10° from parallel on the lateral view, metacarpal base dorsal fracture–dislocation should be suspected, which is otherwise difficult to appreciate as the proximal metacarpals are superimposed [5]. Thumb metacarpal fractures, particularly involving the metacarpal base, require dedicated views of the thumb, including anteroposterior (Roberts view), lateral, and oblique. CT scans should be considered for intra-articular fractures, such as at the metacarpal head and base, and are particularly helpful for metacarpal base fracture–dislocations involving the fourth and fifth rays.

Fracture locations

Metacarpal head fractures

Fractures of the metacarpal head are uncommon but potentially serious. Articular congruity is important for optimal metacarpophalangeal joint function, including grip and manipulation, as well as to minimize risk of later arthritis. Avulsion fractures may involve the collateral ligaments, leading to joint instability [6].

Metacarpal neck fractures

Metacarpal neck fractures typically result from direct axial force, causing failure of the volar cortex and flexion deformity. The common so-called “boxer’s fracture” of the fifth metacarpal neck is inappropriately named, as trained boxers typically punch with greater force at the second and third rays [4]. Acceptable angulation in the general population ranges from 10° in the second ray, gradually increasing up to 40° in the fifth

ray, and even up to 70° according to various studies [7]. However, athletes may be more likely to require anatomic reduction, as palmar prominence of the flexed metacarpal head may create difficulty with grasping such as a baseball bat [8].

Metacarpal shaft fractures

Metacarpal shaft fractures may occur after direct impact to the dorsal hand from a hard object such as a pitched or batted baseball, football helmet, or hockey stick. They may also occur from axial loading similar to metacarpal neck fractures, or from a twisting injury. Metacarpal shaft fractures are less tolerant of angulation than metacarpal neck fractures, due to greater overall displacement of the mechanical axis. Angulation is typically apex dorsal, and is acceptable up to 10° in the second ray, gradually increasing up to 30° in the more mobile fifth ray [4]. Although the clinical consequences are not well-defined, metacarpal shortening of greater than 6 mm has been shown to result in greater than 20° of extensor lag in a cadaveric study [9]. Adjacent metacarpal fractures are at particular risk for shortening due to loss of the stabilizing effect of the intermetacarpal ligaments.

Metacarpal base fractures

Metacarpal base fractures typically involve an axial load and often lead to articular comminution and impaction. These injuries are often associated with dorsal fracture–dislocation, usually in the fourth and fifth rays. Bennett’s fracture is a partial articular thumb metacarpal base fracture–dislocation, often caused by axial load with simultaneous flexion. The volar–ulnar base fragment is held in place by the anterior oblique ligament, while the shaft along with the remaining articular surface is displaced proximally by the abductor pollicis longus and adducted/supinated by the adductor pollicis. These are highly unstable injuries and usually require surgery to maintain articular congruity. Rolando’s fracture is a comminuted complete articular thumb metacarpal base fracture, often T-shaped or Y-shaped, and similarly to Bennett’s fracture usually requires surgery.

Nonoperative treatment

Most metacarpal fractures are minimally displaced or readily reducible, and can thus be treated nonoperatively in the general population. Athletes may be casted for 3–4 weeks, followed by return to play in protective equipment. Injuries occurring during the off-season and at lower levels of competition are more likely to be managed nonoperatively. Considering that these patients tend to remain active and may be less compliant with activity restrictions while healing, particularly in the younger population, weekly follow-up for up to 3 weeks

may be necessary. This affords the opportunity for repeat radiographs, cast changes, and skin examination, as needed.

Because of the cam-shaped metacarpal head, metacarpophalangeal joint flexion has traditionally been advocated to maintain full collateral ligament length during cast immobilization, thus preventing contracture. However, clinical evidence from young active duty military personnel suggests that casting in extension with appropriate 3-point molding provides equivalent functional and radiographic outcomes, with faster application and better tolerability [10, 11]. Although a recent review suggests that a simple soft wrap may be sufficient treatment for the ubiquitous metacarpal neck fracture, [12] the included literature does not specifically address athletes.

Operative treatment

Surgical indications may include malrotation leading to functionally-limiting digital overlap, angulation and shortening beyond the limits discussed above, multiple fractures especially when involving a border ray, and open injuries. Athletes in particular may benefit from surgical reduction and fixation to optimize fracture alignment and ultimate hand function, while potentially expediting return to play.

Percutaneous pins and nails

Percutaneous pin fixation is commonly used in the general population, and may include crossed pins, intermetacarpal pins (i.e., using an adjacent metacarpal), and multiple intramedullary pins (so-called “bouquet” technique, resembling flower stems), yielding good outcomes. Percutaneous nails, which are essentially larger diameter pins for single intramedullary placement, are also available. However, all percutaneous hardware entail risk of loosening and infection during athletic activity, even simple conditioning, and may also require prolonged immobilization for supplemental support during healing.

Cortical screws and plates

Open reduction internal fixation may provide more rigid fixation, which may allow early return to play in a functional brace, as well as the opportunity for compression, which may optimize healing overall. Spiral or long oblique fractures are amenable to screw fixation with negligible hardware prominence, particularly if screw heads are seated with a countersink, while transverse or short oblique fractures may be treated with plate fixation. Plating of hand fractures has previously been associated with a major complication rate of up to 36%, including stiffness, nonunion, plate prominence, infection, and tendon rupture, particularly with phalangeal and/or open injuries [13]. However, later studies have been

more favorable toward fixation of closed metacarpal fractures in particular. One large study showed 93% good or excellent results among 236 patients with closed metacarpal or phalangeal injuries, with superior results among the metacarpal fractures [14]. A smaller study of open or closed fractures of the metacarpals and phalanges showed equally good results using less prominent plates of 0.6 mm compared to 1.3 mm thickness, without any cases of tendon rupture, nonunion, or hardware removal among the 21 metacarpal fractures [15]. Also, biomechanical studies of newer constructs, including locking plates, shorter length plates, double-row plates (sometimes called “cage,” “ladder,” or “three-dimensional”), and smaller dual orthogonal plates demonstrate equivalent or superior fixation to standard constructs, thus potentially minimizing soft tissue dissection and/or hardware prominence [16–19].

Intramedullary compression screws

The latest development in metacarpal fracture fixation is the use of intramedullary compression screws placed retrograde through the metacarpal head. Proposed benefits over traditional internal fixation include minimally invasive technique and zero hardware prominence. Patients are immobilized for approximately 1 week, then provided with a removable brace and allowed range of motion exercises. One study involving nine patients with fifth metacarpal neck and shaft fractures demonstrated radiographic healing and return to work as early as 4 weeks postoperatively without complications [20•]. Another study involving 48 metacarpal fractures, several of which were open and/or multiple, demonstrated return to work or sports as early as 3 weeks postoperatively [21•]. These two studies involved predominantly simple transverse fractures treated with a single screw, although some were short oblique or comminuted, the latter of which required a modified technique using a second obliquely placed screw.

One concern about intramedullary compression screw fixation is the articular defect created in the metacarpal head, although this may be clinically insignificant based on size and relatively dorsal location [22]. Furthermore, such an articular defect has not been shown to be clinically detrimental at medium term in comparable situations such as with scaphoid fixation [23]. Another possible disadvantage may be rotational instability, but such complications have not been reported clinically. Further clinical studies of this technique are needed, although early reports are encouraging, particularly for the athlete who wishes to return to play as soon as possible, and who may be less concerned about potential risk of later arthritis, perhaps long after peak playing years.

Despite advances in internal fixation, clinical evidence specifically demonstrating successful early return to play in athletes is limited. One study of 20 high school and college football players treated mostly with locking plates demonstrated return to play at an average of 6 days for in-season injuries, wearing

protective equipment for an average of 3 weeks after return [24•]. Another study of eight metacarpal fractures treated with internal fixation demonstrated return to play within 3 weeks on average [25•]. All metacarpal fractures in these two studies went on to union and none had refracture during play.

Authors' experience

In our practice, we have treated high school and college athletes with early internal fixation when appropriate, using low-profile, double-row, and shorter length-plate designs with or without locking. Outcomes have been excellent including early return to play and complete union without major complications or reoperations.

Important surgical considerations

Bennett's fracture–dislocation may be treated with pins from the metacarpal shaft into the volar–ulnar fragment, trapezium, and/or index metacarpal, although open reduction internal fixation may be preferable for athletes as discussed above.

Fractures of the fourth metacarpal shaft deserve particular attention as it is particularly narrow, which should be considered when placing hardware [26]. Specifically, intramedullary screws or multiple pins may not pass through the narrow isthmus, and bicortical screws may risk iatrogenic weakening or fragmentation of the bone.

For the uncommon metacarpal head fractures, headless screws countersunk flush with the subchondral bone may be used [6].

All hand injuries that involve an open wound near the metacarpophalangeal joint from punching near the mouth, with or without metacarpal fracture, should raise concern for the so-called “fight bite” injury, which mandates operative irrigation and debridement to prevent septic arthritis from oral flora.

With internal fixation, meticulous closure of periosteal tissues is usually achievable and should be performed to cover hardware and protect tendons.

Aftercare and return to play

Metacarpal fractures generally heal well, and nonunion is uncommon, particularly in typically otherwise healthy athletes. Bone stimulators may potentially speed healing and have been advocated for use in the athlete, [27] although evidence regarding their benefit specifically for metacarpal fractures is limited. During healing, regardless of operative or nonoperative treatment, formal hand therapy should be considered and should involve range of motion exercises for uninvolved joints in the hand, as well as the wrist (i.e., radiocarpal and radioulnar), shoulder, and elbow. We prefer to avoid the use of a sling, which may discourage upper extremity mobilization and promote dependent positioning and swelling. One exception may be in the

immediate postoperative period while a regional block is still active, as the sling may be helpful for convenience of support.

Once a fracture is determined to be stable, either inherently, or after a period of casting, or sooner in the case of surgical fixation, return to play may be considered. For positions that do not involve manipulation of a ball or implement, such as a football lineman, early return in a cast may be acceptable. Buddy taping of the fingers may be a helpful adjunct, particularly for metacarpal head or neck fractures in border digits, as these are less supported by surrounding structures. Padded splints or gloves provide greater manual ability, while injuries involving a throwing or gripping hand may require more time before return to play, particularly when protective equipment is incompatible with demands of participation or league rules.

Conclusions

Metacarpal fractures are common in athletes. After proper physical exam and imaging, treatment should be customized to the specific athlete and injury, with consideration of optimal function and the demands of competition. Nonoperative treatment is often successful for these injuries, and percutaneous fixation, when appropriate, is reliable and common. Recent studies demonstrate that rigid internal fixation with modern hardware and techniques may expedite return to play, although further clinical studies are needed.

Compliance with ethical standards

Conflict of interest The authors declare that there are no conflicts of interest.

Human and animal rights and informed consent This article does not contain any studies with human or animal subjects performed by any of the authors.

References

Papers of particular interest, published recently, have been highlighted as:

- Of importance

1. Chung KC, Spilson SV. The frequency and epidemiology of hand and forearm fractures in the United States. *J Hand Surg Am.* 2001;26(5):908–15. doi:10.1053/jhsu.2001.26322.
2. Nakashian MN, Pointer L, Owens BD, Wolf JM. Incidence of metacarpal fractures in the US population. *Hand (N Y).* 2012;7(4):426–30. doi:10.1007/s11552-012-9442-0.
3. Tan V, Kinchelov T, Beredjiklian PK. Variation in digital rotation and alignment in normal subjects. *J Hand Surg Am.* 2008;33(6):873–8. doi:10.1016/j.jhsa.2008.02.006.

4. Cotterell IH, Richard MJ. Metacarpal and phalangeal fractures in athletes. *Clin Sports Med*. 2015;34(1):69–98. doi:[10.1016/j.csm.2014.09.009](https://doi.org/10.1016/j.csm.2014.09.009).
5. McDonald LS, Shupe PG, Hammel N, Kroonen LT. The intermetacarpal angle screening test for ulnar-sided carpometacarpal fracture–dislocations. *J Hand Surg Am*. 2012;37(9):1839–44. doi:[10.1016/j.jhsa.2012.05.042](https://doi.org/10.1016/j.jhsa.2012.05.042).
6. Tan JS, Foo AT, Chew WC, Teoh LC. Articular placed interfragmentary screw fixation of difficult condylar fractures of the hand. *J Hand Surg Am*. 2011;36(4):604–9. doi:[10.1016/j.jhsa.2010.12.004](https://doi.org/10.1016/j.jhsa.2010.12.004).
7. Fufa DT, Goldfarb CA. Fractures of the thumb and finger metacarpals in athletes. *Hand Clin*. 2012;28(3):379–88. doi:[10.1016/j.hcl.2012.05.028](https://doi.org/10.1016/j.hcl.2012.05.028).
8. Goldfarb CA. Commentary: metacarpal fracture in the professional baseball player. *Hand Clin*. 2012;28:389. doi:[10.1016/j.hcl.2012.05.029](https://doi.org/10.1016/j.hcl.2012.05.029).
9. Strauch RJ, Rosenwasser MP, Lunt JG. Metacarpal shaft fractures: the effect of shortening on the extensor tendon mechanism. *J Hand Surg Am*. 1998;23(3):519–23. doi:[10.1016/S0363-5023\(05\)80471-X](https://doi.org/10.1016/S0363-5023(05)80471-X).
10. Tavassoli J, Ruland RT, Hogan CJ, Cannon DL. Three cast techniques for the treatment of extra-articular metacarpal fractures. Comparison of short-term outcomes and final fracture alignments. *J Bone Joint Surg Am*. 2005;87(10):2196–201. doi:[10.2106/JBJS.D.03038](https://doi.org/10.2106/JBJS.D.03038).
11. Hofmeister EP, Kim J, Shin AY. Comparison of 2 methods of immobilization of fifth metacarpal neck fractures: a prospective randomized study. *J Hand Surg Am*. 2008;33(8):1362–8. doi:[10.1016/j.jhsa.2008.04.010](https://doi.org/10.1016/j.jhsa.2008.04.010).
12. Dunn JC, Kusnezov N, Orr JD, Pallis M, Mitchell JS. The boxer's fracture: splint immobilization is not necessary. *Orthopedics*. 2016;39(3):188–92. doi:[10.3928/01477447-20160315-05](https://doi.org/10.3928/01477447-20160315-05).
13. Page SM, Stern PJ. Complications and range of motion following plate fixation of metacarpal and phalangeal fractures. *J Hand Surg Am*. 1998;23(5):827–32. doi:[10.1016/S0363-5023\(98\)80157-3](https://doi.org/10.1016/S0363-5023(98)80157-3).
14. Bannasch H, Heermann AK, Iblher N, Momeni A, Schulte-Mönting J, Stark GB. Ten years stable internal fixation of metacarpal and phalangeal hand fractures-risk factor and outcome analysis show no increase of complications in the treatment of open compared with closed fractures. *J Trauma*. 2010;68(3):624–8. doi:[10.1097/TA.0b013e3181bb8ea0](https://doi.org/10.1097/TA.0b013e3181bb8ea0).
15. Agarwal AK, Pickford MA. Experience with a new ultralow-profile osteosynthesis system for fractures of the metacarpals and phalanges. *Ann Plast Surg*. 2006;57(2):206–12. doi:[10.1097/01.sap.0000215925.58902.bc](https://doi.org/10.1097/01.sap.0000215925.58902.bc).
16. Barr C, Behn AW, Yao J. Plating of metacarpal fractures with locked or nonlocked screws, a biomechanical study: how many cortices are really necessary? *Hand (N Y)*. 2013;8(4):454–9. doi:[10.1007/s11552-013-9544-3](https://doi.org/10.1007/s11552-013-9544-3).
17. Sohn RC, Jahng KH, Curtiss SB, Szabo RM. Comparison of metacarpal plating methods. *J Hand Surg Am*. 2008;33(3):316–21. doi:[10.1016/j.jhsa.2007.11.001](https://doi.org/10.1016/j.jhsa.2007.11.001).
18. Gajendran VK, Szabo RM, Myo GK, Curtiss SB. Biomechanical comparison of double-row locking plates versus single- and double-row non-locking plates in a comminuted metacarpal fracture model. *J Hand Surg Am*. 2009;34(10):1851–8. doi:[10.1016/j.jhsa.2009.07.005](https://doi.org/10.1016/j.jhsa.2009.07.005).
19. Watt AJ, Ching RP, Huang JI. Biomechanical evaluation of metacarpal fracture fixation: application of a 90° internal fixation model. *Hand (N Y)*. 2015 Mar;10(1):94–9. doi:[10.1007/s11552-014-9673-3](https://doi.org/10.1007/s11552-014-9673-3).
20. Doam MC, Nydick JA, Williams BD, Garcia MJ. Retrograde headless intramedullary screw fixation for displaced fifth metacarpal neck and shaft fractures: short term results. *Hand (N Y)*. 2015;10(2):314–8. doi:[10.1007/s11552-014-9620-3](https://doi.org/10.1007/s11552-014-9620-3). **Retrospective study demonstrating intramedullary screw fixation**
21. del Piñal F, Moraleda E, Rúas JS, de Piero GH, Cerezal L. Minimally invasive fixation of fractures of the phalanges and metacarpals with intramedullary cannulated headless compression screws. *J Hand Surg Am*. 2015;40(4):692–700. doi:[10.1016/j.jhsa.2014.11.023](https://doi.org/10.1016/j.jhsa.2014.11.023). **Retrospective study demonstrating intramedullary screw fixation**
22. ten Berg PW, Mudgal CS, Leibman MI, Belsky MR, Ruchelsman DE. Quantitative 3-dimensional CT analyses of intramedullary headless screw fixation for metacarpal neck fractures. *J Hand Surg Am*. 2013;38(2):322–30. doi:[10.1016/j.jhsa.2012.09.029](https://doi.org/10.1016/j.jhsa.2012.09.029).
23. Geurts G, van Riet R, Meermans G, Verstreken F. Incidence of scaphotrapezial arthritis following volar percutaneous fixation of nondisplaced scaphoid waist fractures using a transtrapezial approach. *J Hand Surg Am*. 2011;36(11):1753–8. doi:[10.1016/j.jhsa.2011.08.031](https://doi.org/10.1016/j.jhsa.2011.08.031).
24. Etier BE, Scillia AJ, Tessier DD, Aune KT, Emblom BA, Dugas JR, Cain EL. Return to play following metacarpal fractures in football players. *Hand (N Y)*. 2015;10(4):762–6. doi:[10.1007/s11552-015-9769-4](https://doi.org/10.1007/s11552-015-9769-4). **Retrospective study demonstrating rapid return to football after internal fixation**
25. Kodama N, Takemura Y, Ueba H, Imai S, Matsusue Y. Operative treatment of metacarpal and phalangeal fractures in athletes: early return to play. *J Orthop Sci*. 2014;19(5):729–36. doi:[10.1007/s00776-014-0584-5](https://doi.org/10.1007/s00776-014-0584-5). **Retrospective study demonstrating rapid return to sports after internal fixation**
26. Soong M, Got C, Katarincic J. Ring and little finger metacarpal fractures: mechanisms, locations, and radiographic parameters. *J Hand Surg Am*. 2010;35(8):1256–9. doi:[10.1016/j.jhsa.2011.08.031](https://doi.org/10.1016/j.jhsa.2011.08.031).
27. Clinkscales C. Sports-specific commentary on Bennett's fractures in professional basketball players: Bennett fractures and metacarpal fractures. *Hand Clin*. 2012;28(3):391–2. doi:[10.1016/j.hcl.2012.05.030](https://doi.org/10.1016/j.hcl.2012.05.030).