Different Treatment Methods of Metacarpal Fractures

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Abstract

Metacarpal fractures comprise between 18–44 % of all hand fractures. Non-thumb metacarpals account for around 88 % of all metacarpal fractures, with the fifth finger most commonly involved. The majority of metacarpal fractures are isolated injuries, which are simple, closed, and stable. While many metacarpal fractures do well without surgery, there is a paucity of literature and persistent controversy to guide the treating physician on the best treatment algorithm. The purpose of this article is to review different treatment methods of metacarpal fractures.

KeyWords: Metacarpal fractures, hand injury, fixation, hand fractures.

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Introduction:

Metacarpal fractures represent about 1/3 of hand fracture, which represent 10% of all fractures, mostly in the second and third decades of life. It usually results from direct hit over the dorsum of the hand as in assault, boxing, fall, road traffic accident, crush injuries and industrial trauma. The little finger neck fractures (Boxer's fractures) and ring –finger shaft fractures among the most common metacarpal fractures.(1)

The metacarpal fractures can be classified based on the site and pattern of fracture. As per the anatomic site, it could be a metacarpal head, neck, shaft, or base fracture, or according to the AO/ OTA classification, or according to the pattern of fracture as same as of other long bones that may be open or close, intra-articular or extra-articular, and could be oblique, spiral, transverse, or comminuted.(2)

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The aim of treatment of metacarpal fractures is to correct the shortening, angulation and rotation. This could be done through conservative method if non or minimally displaced extra-articular fractures. Or through operative methods as: pins, wiring techniques, intramedullary fixation, plate fixation, and inter-fragmentary screws.(3)

The goals of the management of metacarpal fractures(4)

- Maintain normal range of motion
- Restore normal range of motion
- Restore grip strength
- No residual pain
- Normal digital alignment
- Minimize stiffness
- Bone union
- Restore normal functional capacity

An important part of a conservative management of patients with metacarpal fractures at the authors‟ institution is the immediate start of home therapy. A night splint can be given to protect the fracture and decrease pain at nighttime, but during the day, the patient maintains his or her full active range of motion with flexion and extension exercises. Formal hand therapy is usually not required. Patients do not have a period of immobilization except for the period of time from the injury to the time they see the surgeon. Follow-up office visits at 1 week and then 3 weeks are needed to make sure the patient has not developed scissoring or other negative sequelae. The patient is limited from hard labor but allowed to use the hand, with pain being the guiding factor of whether to limit movement. (5)

Non operative:

Indications for nonoperative treatment:

Undisplaced, or minimally displaced, fractures of the metacarpal shaft can be treated nonoperatively. Most of these fractures produce a flexion deformity and often minimal shortening. If the flexion deformity exceeds 10-20 degrees in fractures of the second and third metacarpals, or 20-30 degrees in fractures of the fourth and fifth metacarpals, surgical treatment is recommended. Shortening of less than 2 mm does not interfere with function, but more than 5mm cannot be accepted.(6)

Immobilization with palmar splint:

A splint may be applied with the hand in an intrinsic plus (Edinburgh) position and the wrist in slight extension of 20-30 degrees. Extension of PIP joints and DIP joints only the fractured finger ray and the two adjacent rays are included in the splint, in fractures of the third, or fourth, metacarpal. In fractures of the second metacarpal, it may be sufficient to include only the second and third rays. In fractures of the fifth metacarpal, the fifth and fourth rays are included. The splint is held in place with an elastic bandage. The bandage should not be over tightened at the level of the wrist joint, so as to avoid excessive swelling of the hand. Direct skin contact of adjacent fingers should be pre- vented by placing gauze pads between them. This splint is easy to apply and needs no hand therapy during the period of immobilization. A potential disadvantage of this technique is the complete immobilization of uninjured fingers and joints.(6)

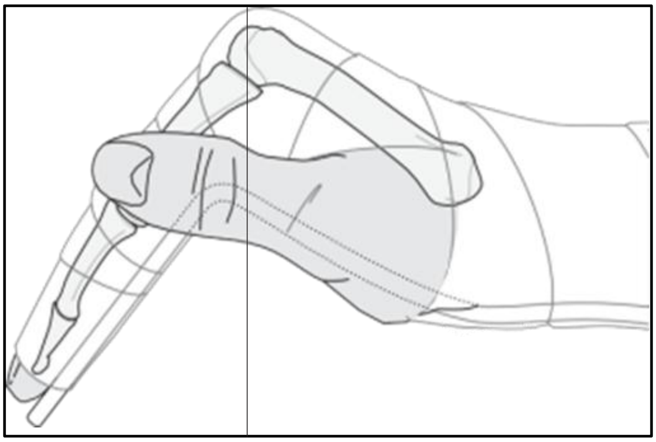

Fig. (1): Immobilization with palmar splint. (6)

Surgical management of metacarpal fractures:

➔ **Indications for surgery include;**

- Open fractures
- Intraarticular fractures
- Angulation of the fracture greater than 30 degrees
- Rotational deformity greater than 10 degrees and gross (>5mm) shortening of the metacarpal.

Likewise, the irreducible or unstable fracture requires operative management, as does multiple digit involvement. If the fracture is open, or a compound fracture, this requires formal debridement and irrigation, as well as appropriate antibiotic cover, and this can be done with reduction with or without fixation. Human bites, including the fight bite scenario, require intravenous antibiotics. Injuries involving extensive soft tissue loss, with or without bony injury require operative management too. Cosmetic and aesthetics of the hand may also precipitate surgical input. (7)

Operative management aims to restore sufficient skeletal stability to achieve fracture union without loss of function. Such stability must be sufficient to allow for early mobilization. Prolonged immobilization should be avoided because of the risk of permanent stiffness; however, overly aggressive attempts at internal fixation may lead to soft tissue damage, tendon adhesions, infection, and the necessity for a secondary procedure for implant removal. Operative fixation must be used judiciously and with the expectation that the ultimate outcome will be as good as, and optimally better than the outcome after non- operative management. (8)

Closed reduction and internal fixation (CRIF):

Multiple options exist for operative fixation of metacarpal fractures. Percutaneous Kirschner wires remain an important technique to control and stabilize fracture fragments. Several pinning techniques can be used for metacarpal or phalangeal fractures. (9)

The easiest technique is transfixion pinning of the fractured metacarpal to an intact adjacent metacarpal. A second pinning technique uses K-wires to cross near the fracture site. These can be placed antegrade or retrograde. In antegrade method a prebended K-wires is intramedullary inserted in the metacarpal bone passing the fracture under fluoroscopy. The divergent tips of the wires in the metacarpal head resemble the stems of flowers, and thus the term "bouquet" osteosynthesis. In retrograde method a K-wire is inserted through the metacarpal head in the retrograde direction. (10) **(Fig. 2)**

Intramedullary headless compression screw (IMHS) fixation for metacarpal neck and shaft fractures has been shown to be a reliable option for axially stable fractures. The advantages of headless compression screws are relatively fast insertion and the minimally invasive insertion technique, decreasing risks associated with more extensive soft tissue dissection, stability allowing early range of motion, and that it is an intramedullary implant, which eliminates the risk of hardware irritation (11).

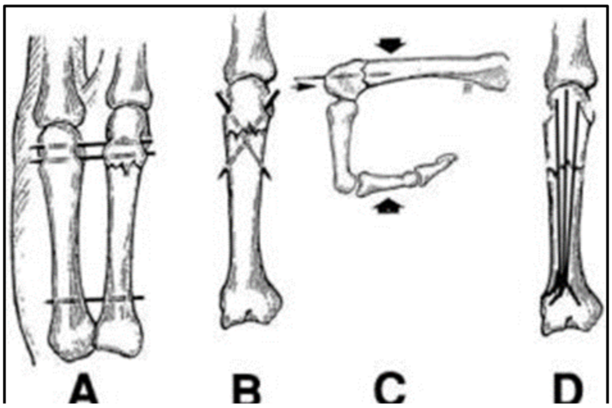

Fig. (2). Various pinning fixation techniques described for the management of metacarpal fractures. **(A)** Transfixion pinning. **(B)** Cross k-wires. **(C)** Retrograde intramedullary fixation. **(D)**Antegrade intramedullary fixation.(10)

- **IMHS Fixation method:**

IMH screw fixation has been performed in a retrograde manner in which a guidewire and then a cannulated headless screw are placed through a skin excision, a split in the sagittal band or extensor tendon, and the dorsal central articular cartilage surface of the metacarpal head (2).

- **Implant:**

The Headless Compression Screws, offer different diameters and lengths covering a wide range of indications for fracture management. The special head design minimizes soft tissue irritation and enables a minimally invasive method.

Various diameters for a wide range of indications: 2.0, 2.5, 3.0, 3.5, 4 mm (12).

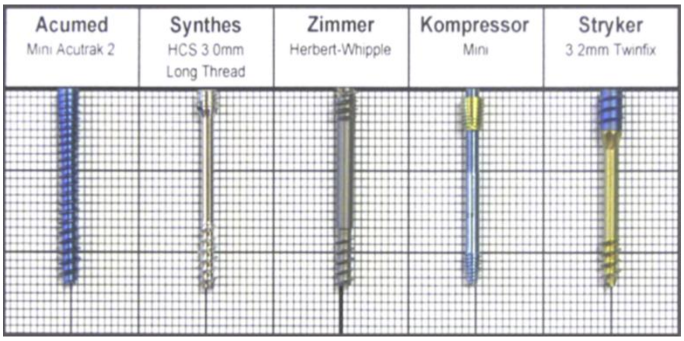

Fig. (3). Intramedullary headless screws implants and different shapes (13).

- **Biomechanics of IMHS**

The biomechanical features of IMHS are thoroughly described as load-sharing devices in orthopaedicliterature. The screw initially supports the majority of the load and anatomic alignment across the fracture, but when the fracture heals, the stress is passed to the bone. Bending and torsional forces during MCP or PIP joint flexion are two forces that must be effectively addressed. In biomechanical experiments, using a screw wide enough to engage the intramedullary cortical bone with adequate purchase while preventing blow out and using the maximum allowed screw length on each side of the fracture increases the surface area of bone resisting bending. There is more bone-to-nail friction as the nail width rises, making the fixation more resistant to both bending and torsional force(14).

Metacarpal fractures have low rates of non-union regardless of fixation technique. Although most intramedullary screw fixation devices rely on variable pitch threads to achieve compression, in these types of fractures, compression is not mandatory for successful healing. This is in contrast to scaphoid fractures that rely on compression of the fracture site for optimal healing (11).

Fixation can be achieved with a variety of screw designs, including variable pitch fully threaded, variable pitch partially threaded, and consistent pitch fully threaded. The consistent screw pitch avoids compression, allowing fractures which otherwise tend to be over-compressed to be more reliably treated (long, oblique, or comminuted fractures of the metacarpal)(15).

- **Surgical approach and technique:**

Appropriate screw length and width should be measured on pre-operative imaging. First, a closed reduction is performed. To better reach the head of the metacarpal, the MCP joint is flexed to 90°. A 4.0 mm longitudinal incision made over the MCP joint. A guidewire inserted along the metacarpal axis under fluoroscopy. The entry point should be on the dorsal part of the metacarpal head for optimal positioning of the screw inside the intramedullary canal. Some suggest using a blunt K-wire to avoid cortical penetration(16).

It was suggested to reach the metacarpal isthmus with the screw to ensure a rigid fixation. To minimize the cartilage injury, advice the use of 3.0 mm screws even for the fifth metacarpal where the isthmus can measure 5.0 mm. In this case, the relative stabilization will lead to callus formation by means of an elastic fixation. (17)

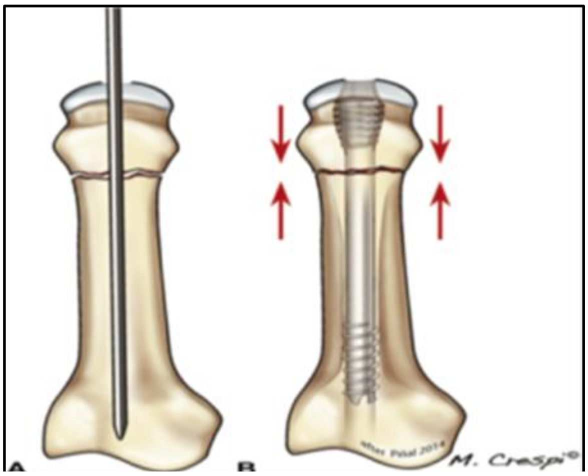

Fig. (4). Application of Intramedullary headless screws(12).

Open reduction and internal fixation (ORIF):

Mini plate and screws provide a rigid fixation. These implants neutralize rotational, torsional and shearing forces at the fracture area, thus enabling earlier and stronger rehabilitation. A rigid fixation enabling bone healing and early active finger motion is important in surgical treatment. After the recent development of mini plate and screw, their use in metacarpal and phalangeal fractures has increased(18).

Inserting K- wires across the fracture site and using supplemental 26 - gauge wire looped around the protruding K- wire ends to create a compressive force at the fracture site (19).

Intraosseous wiring involves passing a 26-gauge wire transversely across the fracture line dorsal to the mid axis and looping it around oblique K- wires to neutralize the rotational forces. Excellent success has been reported using this technique for transverse fractures (20).

Lag screw fixation fixation of metacarpal fractures only with lag screws is a technique many surgeons employ because of the implants' low profile and biomechanical stability (21).

Biodegradable hemicirculage sutures, it was reviewed the use of biodegradable hemicirculage sutures in the treatment of metacarpal fractures. The poly glycolic acid hemicirculage achieved sufficient fracture fixation to permit early motion exercises, without jeopardizing bony union. Ideal indications are oblique or torsion fractures of the metacarpals (22).

Expandable intramedullary device the device consists of cylindrical apparatus made of titanium that allows for collapse in the circumferential diameter. It is introduced into the medullary canal in its collapsed state and then is released to allow re-expansion to its normal diameter in the canal with the fracture reduced over it. It gives excellent fixation and affords stability approaching that of normal bone. Minimal post-operative immobilization is needed and early restoration of motion is possible (23).

Conclusion:

Metacarpal fractures are common injuries in the hand. Most metacarpal fractures have a good outcome with non-operative treatment because there is substantial tolerance to angulation and shortening, particularly fractures of the small finger metacarpal shaft and neck. Rotation is poorly tolerated as it is magnified with flexion and often results in scissoring, which interferes with grip.

REFERENCES

1. **Souer JS, Mudgal CS.** Plate fixation in closed ipsilateral multiple metacarpal fractures. J Hand Surg (European Vol. 2008;33(6):740–4.
2. **Al-Madawy AM, Abou Elatta MM, Hasanin MM, Al-Nahal AAE-K.** The use of minilocked plate for management of unstable metacarpal fractures. J Hand Microsurg. 2016;8(3):159.
3. **James JIP.** Fractures of the proximal and middle phalanges of the fingers. Acta Orthop Scand. 1962;32(1–4):401–12.
4. **Wang Y, Gan X, Li K, Ma T & Zhang Y.** Comparison of operative and non-operative management of fifth metatarsal base fracture: A meta-analysis. Plos one, 2020; 15(8), e0237151.
5. **Meinberg EG, Agel J, Roberts CS, Karam MD & Kellam JF.** Fracture and Dislocation Classification Compendium-2018. Journal of Orthopaedic Trauma, 32, S1-S10
6. **Kollitz KM, Hammert WC, Vedder NB & Huang JI.** Metacarpal fractures: treatment and complications. Hand, 2014; 9(1), 16-23.
7. **Al Shahat OA, Ismail YH, Kaseer A, Hasan M & El Genidy AS.** Management of Metacarpal and Phalangeal Bone Fractures of the Hand. The Egyptian Journal of Plastic and Reconstructive Surgery, 2018; 42(2), 405-409.
8. **Watt AJ, Ching RP, Huang JI.** Biomechanical evaluation of metacarpal fracture fixation: application of a 90 internal fixation model. Hand. 2015; 10(1):94-99.
9. **Wong VW & Higgins JP.** Evidence-based medicine: management of metacarpal fractures. Plastic and reconstructive surgery; 2017, 140(1), 140e-151e.
10. **Lee SK, Kim KJ, Choy WS.** Modified retrograde percutaneous intramedullary multiple Kirschner wire fixation for treatment of unstable displaced metacarpal neck and shaft fractures. Eur J Orthop Surg Traumatol. 2013; 23(5):535-543.
11. **Elmaraghy M, Elmaraghy A, Richards R, Chinchalkar S, Turner R & Roth J.** Transmetacarpal intramedullary K-wire fixation of proximal phalangeal fractures. Annals of plastic surgery, 1998; 41(2), 125-130.
12. **Hug U, Fiumedinisi F, Pallaver A, van de Wall BJ, Beeres F, Giesen T &Liechti R.** Intramedullary screw fixation of metacarpal and phalangeal fractures–A systematic review of 837 patients. Hand Surgery and Rehabilitation, 2021; 40(5), 622-630.
13. **Jann D, Calcagni M, Giovanoli P &Giesen T.** Retrograde fixation of metacarpal fractures with intramedullary cannulated headless compression screws. Hand Surgery and Rehabilitation, 2018; 37(2), 99-103.
14. **Kibar B, Cavit A &Örs A.** A comparison of intramedullary cannulated screws versus miniplates for fixation of unstable metacarpal diaphyseal fractures. Journal of Hand Surgery (European Volume), 2021; 17531934211021521.
15. **McNemar TB, Howell JW, Chang E.** Management of metacarpal fractures. J Hand Ther. 2003;16(2):143–51.
16. **Ben-Amotz O &Sammer DM.** Practical management of metacarpal fractures. Plastic and reconstructive surgery, 2015; 136(3), 370e- 379e.
17. **Souer J & Mudgal C.** Plate fixation in closed ipsilateral multiple metacarpal fractures. Journal of Hand Surgery (European Volume), 2008; 33(6), 740-744.
18. **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. The Journal of hand surgery, 2013; 38(2), 322-330. e322.
19. **Tobert DG, Klausmeyer M & Mudgal CS.** Intramedullary fixation of metacarpal fractures using headless compression screws. Journal of hand and microsurgery, 2016; 8(03), 134-139.
20. **Warrender WJ, Ruchelsman DE, Livesey MG, Mudgal CS & Rivlin M.** Low rate of complications following intramedullary headless compression screw fixation of metacarpal fractures. Hand, 2020; 15(6), 798-804.
21. **Boyes JH.** Burnell's surgery of the hand. 5th ed, Philadelphia, JB Lippincott 1970; 100-5. (Quoted from James Strickland & Thomas Graham the hand vol 1, 2005; 417-34.
22. **Barton NJ.** Fractures of the shafts of the phalanges of the hand. Hand 1979; 11:119-133. (Quoted from J Hand Surg Eur Vol October 2003 vol. 28 no. 5 491-95).
23. **Bloem JJ.** The treatment and prognosis of uncomplicated dislocated fractures of the metacarpals and phalanges. Arch chirneerlandicum 1971; 23: 55-65.