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REVIEW ARTICLE

Management algorithm for index through small finger carpometacarpal fracture dislocations

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Abstract
Purpose Injuries to the carpometacarpal (CMC) joints are rare. The most common CMC fracture dislocations occur in the ring and small finger CMC joints. The aim of this study was to review the structured diagnostic procedure and different treatment options.
Methods We review the importance of early and correct diagnosis in CMC fracture dislocation, because it is needed to ensure pain-free hand function. Moreover, we contrast different therapeutic options, including non-operative and surgical therapy for CMC fracture dislocation.
Results If a clinical suspicion for a CMC dislocation based on patient examination or radiographic findings exists, then a thin slice CT should be considered. Non-operative treatment is rarely indicated. Surgical treatment may include closed or open reduction efforts. In the case of most fracture dislocations, open reduction is recommended. Fracture fixation may be accomplished with K-wires, mini plates or screws.
Conclusion CMC fracture dislocations of the fourth and fifth CMC joints are uncommon and often overlooked. Primary goal of treatment is to restore normal function to the hand. Therefore, operative therapy might be the method of choice.

Keywords Carpometacarpal fracture · Carpometacarpal joints · Open reduction · Fracture fixation

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Introduction

Injuries to the carpometacarpal (CMC) joints are rare. The most common CMC fracture dislocations occur to the 4th and 5th CMC joints [1]. Although these injuries also affect the thumb, this review will focus on CMC fracture dislocations involving the index through small fingers. CMC dislocations constitute >1 % of all hand injuries and are easily missed in clinical examination as well as in radiographic evaluation [2–4]. The treatment goal is to restore normal function to the hand [5]. Early diagnosis and treatment is needed as these injuries, if untreated, have the potential to significantly compromise hand durability [6].

The anatomic configuration of the metacarpal base and the stout dorsal and palmar ligamentous structures readily prevent joint instability [7, 8]. The index finger CMC joint is particularly rigid due to its bony articulation between the trapezium, the trapezoid, and the third metacarpal [9]. Moreover, extensor carpi radialis longus and extensor carpi radialis brevis tendons insert into the proximal dorsal aspect of the second and the third metacarpals and impart dynamic stability to this region. The dynamic stabilizer of the 5th CMC joint is the extensor carpi ulnaris tendon, which may also act as a deforming influence once injury to this region occurs.

Incidence

CMC fracture dislocations are unusual. A multitude of case reports and retrospective studies exist, yet none includes a large number of patients [10–14]. Dobbins et al. [10] reported on its rarity. CMC fracture dislocations occurred in only three out of 1621 reviewed hand fractures. This represented an incidence of >0. 2 %. Dorsal dislocation of

the carpometacarpal joints occurs much more frequently than in a volar direction as nearly described CMC fractures demonstrated instability in a dorsal direction [11–14].

Injury mechanism/etiology

The majority of injuries to the CMC joints of the index through small fingers occur secondary to high-energy trauma: direct punching mechanism against hard objects or other people (54 %), motor vehicle accidents (23 %), and falls (14 %) are the most common causes [7]. However, the exact mechanism of injury remains unclear, as no reproducible pattern has been identified. Even controlled loading environments have been shown to create different fracture patterns [15].

Diagnosis

Typical clinical symptoms accompanying CMC joint injuries are pain and swelling on the dorsum of the hand. Decreased motion ability and reduced strength can also occur. In rare cases, an observable humpback deformity of the hand due to dorsal subluxation of the metacarpal bases can be identified. If a clinical suspicion for a CMC fracture-dislocation exists, then three radiographs should be taken: a dorsopalmar, a true lateral, and an oblique view of the hand. Fisher et al. [16, 17] developed a systematic approach to identify 4th and 5th carpometacarpal joint dislocations on plain radiographs. We recommend the oblique view in 45° pronation for the 2nd and 3rd metacarpal bases and a 45° supination oblique view for the 4th and 5th metacarpal bases. Cain et al. [18] reported that a 45° oblique hand radiograph is the best evaluation method for 4th and 5th CMC injury. Whatever views are obtained, detailed fracture pattern characterization and identification of degree of joint subluxation are often difficult to accomplish. Thus, a thin slice CT scan is recommended to confirm the diagnosis and to provide a better assessment of the injured joint surfaces [19].

Classification

At present, no uniformly accepted classification for CMC fracture dislocations exists. It is important to characterize the soft tissue envelope and delineate whether the fracture is either extra-articular or intra-articular. CMC fracture dislocations are described by fracture location, direction of dislocation, and the numbers of displaced fragments [20]. The injury can be further characterized by whether or not neighboring carpal bones have been injured. Shearing or intra-articular compression fractures of the hamate or capitate are common. Because of their rarity, open fractures are not included and described in this manuscript.

Treatment options

The primary goal of treatment should be the restoration of a durable and painfree hand. Restoring the articular anatomy of the 4th and 5th CMC joints will preserve mobility and prevent posttraumatic arthritic discomfort. To achieve these goals, no uniformly agreed-upon management algorithm exists, which may be due to the rare nature of these injuries [19].

Non-operative immobilization in a short dorsal arm splint until fracture union has occurred is an option reserved for clinical scenarios characterized by non-displaced fractures and perfectly seated joints status post closed reduction [5]. It is imperative to repeat clinical and radiographic examinations weekly, given that these injuries are at a high risk for subsequent joint subluxation. If these were to occur status post initial successful joint relocation and fracture reduction effort, then longitudinal traction to the affected finger while, a gentle dorsal to volar force is applied remains an option that is reasonable. It must be understood, however, that these injuries as a whole are frequently unstable and that a pinning effort in these instances will ensure maintenance of alignment and may be most advantageous. It is for that reason that non-operative treatment is best reserved for very stable fracture dislocations that do exhibit a propensity for subluxation [6].

Indications for operative treatment are open fracture dislocations, joint instability despite closed reduction efforts, significant intra-articular damage, and concomitant fractures to the carpal or metacarpal bones. Furthermore, displaced avulsion fractures involving the extensor carpi radialis longus, extensor carpi radialis brevis, and extensor carpi ulnaris tendons are additional indications for surgery.

Surgical treatment may include closed or open reduction efforts. A closed approach is possible if the joint surfaces are uninjured and the joint relocation effort is successful (Figs. 1, 2). Nevertheless, the presence of carpal fracture fragments, especially fractures to the hamate, frequently prevent an acceptable articular alignment. Additionally, closed reduction of intra-articular fragments of the metacarpal base is also frequently unsuccessful.

Thus, in the case of most fracture dislocations, open reduction is recommended. This is accomplished through a longitudinal incision centered on the injured joint (Fig. 3). It is imperative to identify the dorsal radial sensory nerve and the dorsal ulnar sensory nerve and gently retract these

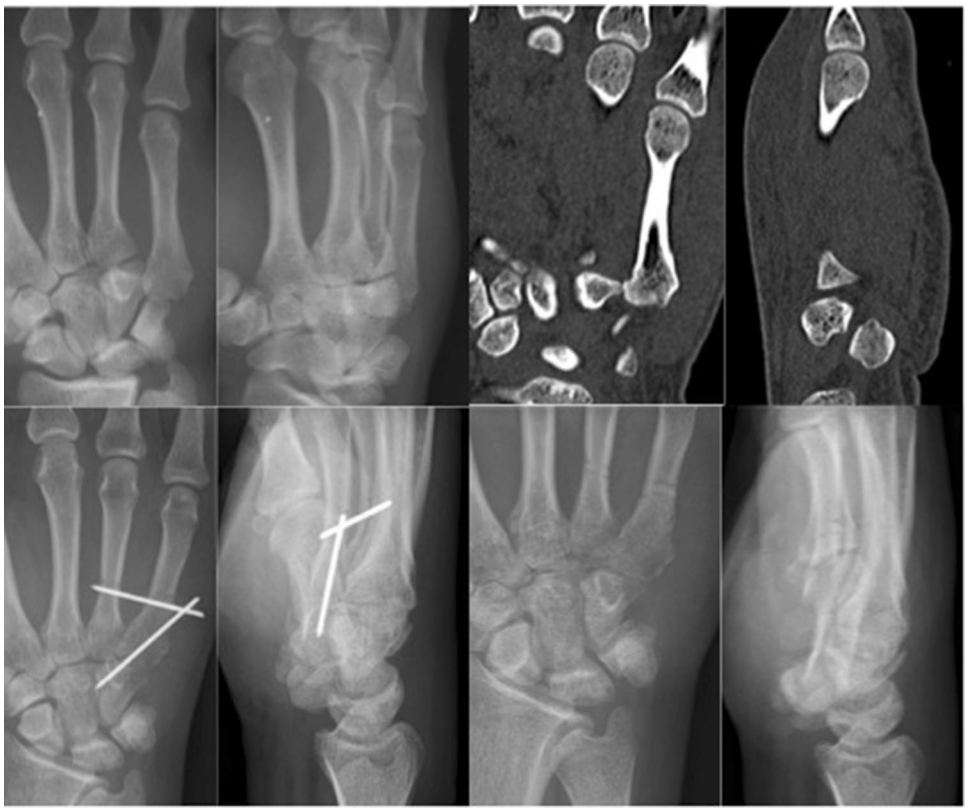

Fig. 1 35-year-old patient with an isolated CMC luxation of the 5th metacarpal. CT scan excludes bony fragments. Closed reduction and transfixation of the joint and transverse to the 4th metacarpal. K-wires were removed 6 weeks postoperatively

Fig. 2 Multifragmentary CMC base fracture with dorso-ulnar dislocation in 53-year-old patient. Fracture is limited visible on plain radiographs. CT scan (3D reconstruction) shows detailed fracture pattern. Open reduction and transfixation of the 5th to the 4th metacarpal with two K-wires

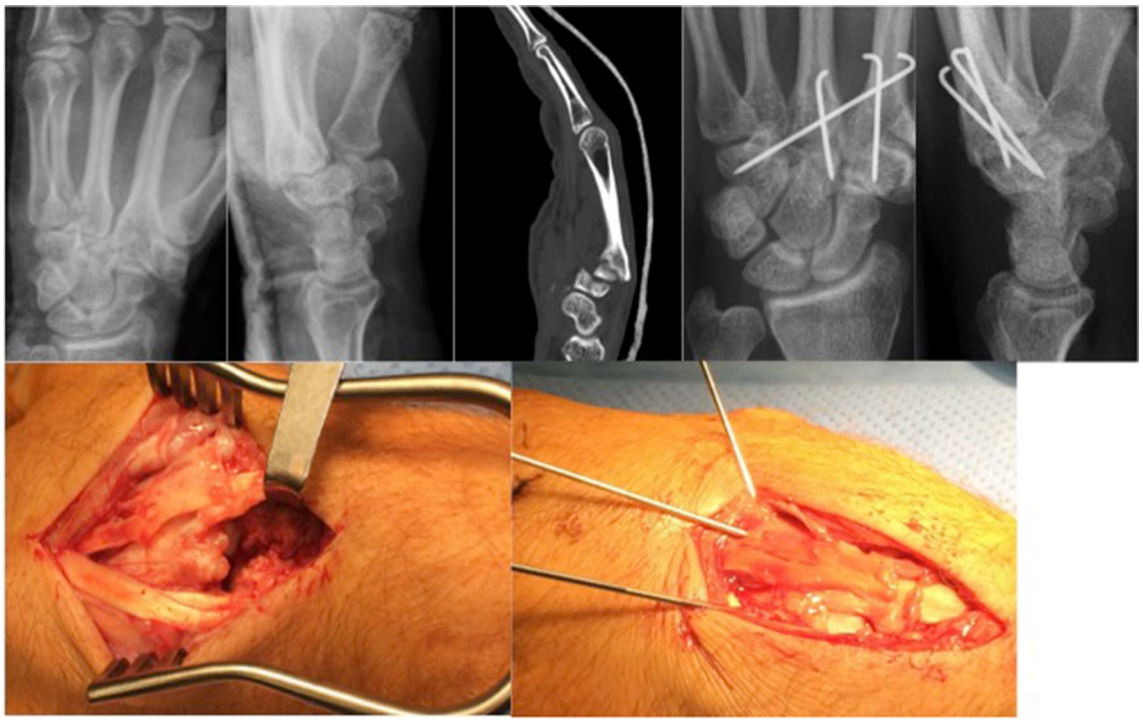

Fig. 3 40-year-old patient with a rare CMC luxation fracture of the 2nd and 3rd metacarpal. CT scan shows a dorsal dislocation. Intraoperative fractures were stabilized with K-wires after open reduction and transverse stabilization to the hamate

Fig. 4 Multifragmentary luxation fracture of the 5th metacarpal in a 32-year-old patient. Limited visualization on plain radiographs. CT scan shows dorso-ulnar dislocation. Open reduction and stabilization with three K-wires. 6 weeks postoperatively implant removal

Fig. 5 CMC luxation fracture of the 4th and the 5th metacarpal. Fracture of the 4th is not visible on plain radiographs. CT scan shows a dorsal fragment of the hamate, which is adequate for fixation. Open reduction, screw fixation of the hamate and temporary K-wire arthrodesis of 4th and 5th CMC joint

branches out of harm's way. The extensor tendons are retracted gently and then thick capsular flaps are created. This provides excellent visualization of the injured metacarpal and carpal bones.

Fracture fixation may be accomplished with K-wires or mini plates and screws (Figs. 3, 4, 5) and is governed by the fracture location, the direction of instability, and the fragment morphology.

K-wires are quite effective for these injuries and can be employed in most situations. A host of different K-wire placement methods, including trans-fixation of the affected CMC joints and/or transverse fixation of metacarpals, may be employed. The trans-fixation of the affected metacarpal to the neighboring uninjured metacarpal will reliably transfer axial forces away from the healing environment (Fig. 4). K-wire placement across the CMC joints stabilizes this area and prevents further subluxation (Fig. 5).

Mini screws can stabilize carpal fragments of adequate size after anatomic reduction (Fig. 5). Even when screws are employed, the biomechanical healing environment is augmented with the use of additional K-wires, which are then removed 4 to 6 weeks status post index procedure. While the pins are in place, a removable dorsal arm splint that protects the pins is worn at all times and only removed to clean the pins. We recommend physical therapy of the fingers while the arm splint is attached. Physiotherapy of the wrist is not suggested until pin removal, as pins are at risk for dislocation.

Plate fixation imparts the greatest stability and may be indicated in the management of extra-articular fractures. Activity advancement can proceed more quickly.

Joint fusion is not recommended in the treatment of acute fractures regardless of severity, as patients will experience a strikingly reduced hand function. Definitive CMC arthrodesis, an option reserved for posttraumatic arthrosis has been developed.

At present, only few studies compare functional results in patients who were treated with closed and open approaches. Restoration of pre-injury anatomy through meticulous intra-articular fragment open reduction and internal fixation with small K-wires has been postulated to contribute to improved functional results, when compared to closed reduction and stabilization with K-wires [21]. Our own results showed that the group of patients treated with open reduction and K-wire fixation exhibited the best functional outcome scores compared to all the other groups [12]. Low functional results in CMC fracture dislocations have been associated with delayed treatment, concomitant injuries such as ulnar nerve dysfunction and secondary displacement of the fracture dislocation [6]. Furthermore, unsatisfactory results were identified in patients needing an arthrodesis [6].

Conclusion

CMC dislocations are rare injuries involving the ring and small fingers most often. Early diagnosis and treatment is needed to restore pre-injury anatomy and ensure pain-free function. If a clinical suspicion for a CMC dislocation based on patient examination or radiographic findings exists, then a thin slice CT should be considered to aid in the diagnosis. It reliably demonstrates the detailed fracture pattern and characterizes the joint surfaces accurately. This facilitates establishment of an accurate operative management algorithm. Non-operative treatment is rarely indicated. Open reduction and internal fixation with K-wires might be the method of choice.

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Compliance with ethical standards

Conflict of interest Carina Büren, Sebastian Gehrmann, Robert Kaufmann, Joachim Windolf und Tim Lögters declare that they have no conflict of interest.

Ethical standard This article does not contain any studies with human participants or animals performed by any of the authors.

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