Chapter 6

Current Treatment Methods for Carpometacarpal Joint Fractures and Dislocations

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Abstract

Carpometacarpal (CMC) joint fractures and dislocations are rare hand injuries often resulting from a fall onto a flexed wrist. Treatment options vary as there is no consensus due to these injuries' rarity. The CMC joints connect the hand and carpal bones, with each joint playing a distinct role, making the injuries examined in three groups.

These joints have a robust design due to strong ligaments and unique articulations. Extensor tendons contribute to hand stability, and injuries to these structures can have varying clinical consequences. Despite the absence of a universally recognized categorization method, fractures and dislocations are generally categorized based on displacement direction, joint count, and injury nature.

Diagnosing carpometacarpal (CMC) joint fractures and dislocations involves detailed examination and imaging, including X-rays, CT scans, and MRIs. These injuries are treated to restore the hand's anatomy and functionality. Treatment varies widely and may include conservative measures, open reduction, or internal fixation, with no consensus due to the rarity of such injuries.

Complications include metacarpophalangeal joint stiffness, which can lead to contractures. Despite the severity of these injuries, both surgical and non-surgical treatments often result in positive outcomes, with delayed treatment, inaccurate articular restoration, and secondary fracture displacement leading to poorer outcomes.

Key to successful treatment is early detection and a comprehensive approach including potential surgical intervention and rehabilitation.

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1. INTRODUCTION

Fractures and dislocations of the Carpometacarpal (CMC) joint are infrequently observed injuries of the hand. [1]. These injuries can occur as isolated dislocations or as complex fracture dislocations. They typically result from a fall onto a flexed wrist[2]. Since these injuries are rare and often undiagnosed, there is no consensus on their treatment. Some authors opt for closed reduction and follow-up, while others favor open reduction and internal fixation[2–5]. The literature mostly consists of case series[6].

The CMC joint not only provides a connection between the hand and the carpal bones but also plays a distinct role in each joint in the hand. Therefore, it's often examined in three separate groups. These are classified as the first CMC (thumb, preaxial), second and third CMC (central), and fourth and fifth CMC (postaxial or ulnar) injuries[1]. This chapter will focus on 2.-5. CMC joint fractures and dislocations.

1.1.Anatomy

The carpometacarpal (CMC) joints, which connect the carpals of the wrist and the metacarpals of the fingers, have significant clinical importance due to their relevance in understanding various hand pathologies, such as fractures and degenerative joint diseases. These joints showcase a notable stability, which can be attributed to their unique anatomical configuration. The scant number of reported dislocations or fractures in these joints in the literature could well be due to this robust design[7].

Integral to this joint stability are the strong dorsal, palmar, and interosseous ligaments. An interesting pattern to note is the decreased stability provided by these ligaments as one moves radially to ulnarly from the second to the fifth CMC joint. This decrease in stability manifests as augmented mobility in the 4.-5. CMC joints, which, regrettably, results in enhanced fracture instability at these locations [8,9].

Further contributing to the hand's anatomical intricacy are particular tendons: the extensor carpi radialis longus, brevis, and ulnaris. These tendons are notably instrumental in the onset of avulsion fractures at the 2.-3.-5. metacarpals[10].

Taking a closer look at the unique articulations within the hand, one can appreciate the critical role that the CMC joints play in maintaining each ray's longitudinal arch. For instance, the trapezoid is connected to the 2. metacarpal, the capitate to 3.metacarpal, and the hamate to the 4.-5. metacarpal. This setup provides the distal carpal row a greater degree of rigidity compared to the more flexible proximal row, thereby striking a fine balance between stability and mobility within the hand [11].

The crucial role of ligaments, the connective tissue that links bones together, cannot be overstated. They provide a critical contribution to joint integrity. Specifically, the dorsal ligaments are stronger and more distinct than the palmar ligaments. However, the palmar ligaments, despite being less prominent, bring substantial support to their respective joints[8,11]. The interosseous ligaments connect the third and fourth metacarpals to the capitate and hamate.

The 2.-3. metacarpals establish a stable core structure in the hand, backed by complex bony articulations and ligaments.Key tendons, such as the extensor carpi radialis longus and brevis, contribute to wrist extension and grip strength. Notably, the 2.-3. CMC joints have limited flexibility, mostly in flexion-extension. This rigidity makes these structures susceptible to fractures under high-energy loads, such as falls, punches, or athletic collisions. These injuries can be compounded by the contraction of key extensor muscles, leading to possible bone fragment displacement and varied clinical consequences depending on the injury's specifics.

The base of the fourth metacarpal, presenting five distinct shapes, may form a joint exclusively with the hamate or additionally with the capitate. Its stability is derived from both ligaments and the support of adjacent metacarpals, making isolated fractures very rare due to lack of muscular insertions. The fifth metacarpal base, however, can become unstable due to its ulnar slope and absence of a supportive structural pillar. Notwithstanding, sturdy ligaments and tendons provide additional support, and these tendons can also generate deforming force during a fracture.

Both the 4.-5. CMC joints provide more flexibility than the 2.-3. CMC joints, allowing for flexion-extension, radial-ulnar deviation, and pronation-supination, which is crucial for grasping and palmar cupping. Their fractures are usually the result of axial loading, often associated with dislocations, and can be instigated by different types of trauma. Uncontested extensor forces acting on the base of the fifth metacarpal can cause a shift of the fractured piece towards the body and in the direction of the ulnar back side, necessitating proper adjustment and treatment to prevent further complications.

The synovial membrane forms an essential part of joint anatomy. It encapsulates the joint, reducing friction by secreting synovial fluid, a lubricating liquid that allows the smooth gliding of articulating bones

Blood supply to the CMC joints, pivotal for their normal functioning, arises from a combination of several arteries. The 3.-4. metacarpals are nourished by carpal arches and deep palmar arteries, while the 5. metacarpal depends on the ulnar artery.

Innervation of the CMC joints, which communicate with the central nervous system, primarily stems from ulnar nerve, the median nerve, and the posterior interosseous nerves.

2. FRACTURE TYPE

Fractures and dislocations of the CMC joint can be classified according to direction of displacement, joint count, and nature of the injury. Nonetheless, a universally agreed-upon classification system for these injuries does not exist. Studies have reported that dorsal dislocations are more common, while volar dislocations are less frequently observed. Rarely, complex dislocations known as divergent complex injuries can occur, accompanied by torsional forces.

Nalebuff has categorized isolated 5. CMC joint dislocations as volar radial and volar ulnar dislocations[12]. Additionally, Cain has classified 5th CMC joint fractures and dislocations based on the absence of the hamate bone's involvement[13].

A modification to the classification was proposed by Garcia-Elias, which includes the involvement of the radial two lesser digits[14]. This classification system describes three subtypes: trans-metacarpal injuries, carpometacarpal injuries, and trans-carpal injuries.

3. DIAGNOSIS

Diagnosing and evaluating hand injuries, particularly those involving the carpometacarpal joint (CMCJ), requires a detailed examination and imaging [15]. When assessing hand injuries, it is important to be thorough as swelling can conceal deformities. Recognizing dorsal and volar deformities is particularly significant.

The Indian greeting known as 'namaste' test can serve as a valuable technique to assess potential finger shortening. It is crucial to perform a meticulous evaluation of neurovascular status to identify any possible nerve injury[16]. Swelling can lead to median nerve involvement, which may necessitate carpal tunnel release[17]. Motor examination is critical for identifying ulnar nerve involvement[18].

It is crucial to evaluate the possible detachment of specific muscles and the thumb. In addition to the clinical examination, imaging plays a vital role in the diagnosis and evaluation of hand injuries.

Plain radiographs from different angles should be included in the examination (figure 1). Radiographic assessment should be systematic and should focus on IC and CMC joints. Several features need to be evaluated on X-rays, including Gilula's arcs, parallel articular surfaces, absence of surface overlap, uniform joint space, and metacarpal cascade lines.

Figure 1. Plain radiographs from different angles, 3-5. CMC fracture dislocation

If clinical signs warrant it, further evaluation with 3D CT or MRI should be taken into account (figure 2). CT scans are preferred for surgical planning and provide better visualization of cortical breaches [5]. On the other hand, MRI excels at detecting purely trabecular fractures.

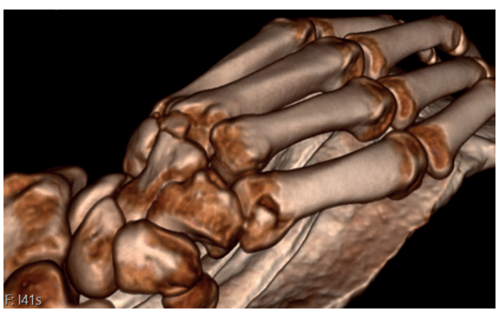

Figure 2. 3D CT 3-5.CMC fracture dislocation

4. TREATMENT

The aim in the fractures-dislocations of the CMC joint is to restore disrupted anatomy (figure 3). A painless, stable hand that can perform normal functions is targeted. Since these cases are rarely seen, there is no common consensus in treatment.

Several factors are considered in the evaluation of second and third carpometacarpal joint fractures and dislocations. The fitting of the joint surface, the attachment site of extensor carpi radialis longus and brevis relative to the fracture are important for surgical indication. However, some authors have expressed the opposite view due to partial immobility of this joint.

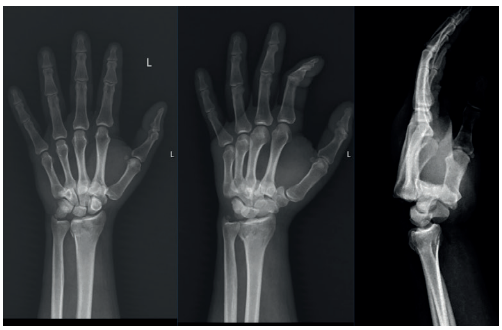

Figure 3. Disrupted anatomy of 2-5 CMC joints

In the literature, there are cases followed by conservative treatment and open reduction (figure 4). Since the ligaments cannot be evaluated accurately without directly seeing the injured area in surgery, many authors suggest open reduction & K-wire [2,19]. Based on the fracture type, cases using tension band, screw, or suture anchor have also been reported.

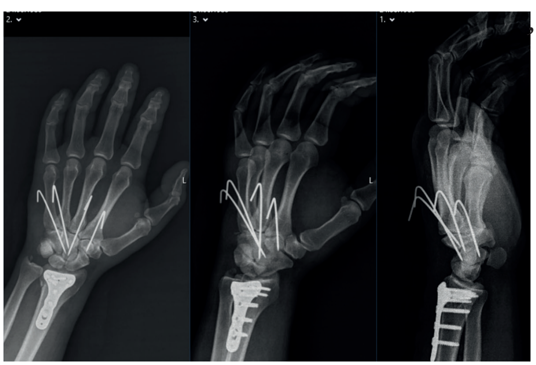

Figure 4. Open reduction, k wire fixation of 2-5. CMC joint

There isn't a widely agreed-upon treatment strategy for fractures of the bases of the 4.-5. metacarpals. Utilizing a compact dorsal arm splint for conservative immobilization is an alternative considered for clinical situations involving non-displaced fractures and well-aligned joints after closed reduction, allowing for fracture union to take place. However, in the case of significant displacement, fragmentation, or complete tear, closed reduction and percutaneous K wire or open reduction and internal fixation are recommended.

Some studies indicate that conservative management can be effective for fractures involving the joint at the base of the 5. Metacarpal [8]. However, it is stated that osteoarthritis development can occur with conservative treatment in displaced intra-articular fractures and surgical intervention may be required in some cases. Other studies show that even after surgical treatment, some patients may experience sustained pain.

There is a limited body of literature concerning fractures at the base of the 4. metacarpal. Typically, these fractures are found in conjunction with 5. CMC dislocations or hamate fractures (figure 5). Open reduction and internal fixation are advised in the surgical treatment of hamato-metacarpal fracture dislocations (figure 6).

Figure 5. Hamate fracture with 4-5. CMC fracture dislocation

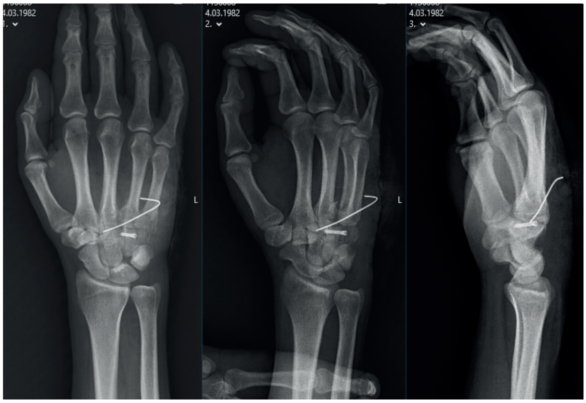

Figure 6. Open reduction, internal fixation and k wire

The treatment protocol of the 4.-5. metacarpal base fractures is still a disputed issue. While conservative treatment is generally preferred for minimally displaced fractures, surgical intervention should be considered in cases of significant displacement or comminution.

Currently, there are only a few studies that compare the functional outcomes of closed and open treatment [16]. There is evidence suggesting that obtaining a precise reconstruction of the original anatomical structure through meticulous open reduction and internal fixation of intra-articular fragments using small K-wires may result in superior functional outcomes relative to closed reduction and stabilization with K-wires. It is crucial to assess each case on an individual basis and tailor the treatment decision based on patient-specific factors.

5. COMPLICATION

A common complication of CMC joint fracture dislocation is metacarpophalangeal (MCP) joint stiffness, potentially leading to extension contractures. This issue, resulting from factors like swelling-induced MCP joint extension, postoperative patient comfort habits, and interossei muscle injuries, is multifaceted.

Prompt surgical intervention is recommended to release hematoma, reduce hand swelling, and prevent ischemic injury to the interossei muscles. Throughout the treatment of the CMC joint using K-wires, the MCP joint is maintained in full flexion to prevent any tethering of the skin or soft tissues. K-wires are inserted from both the radial and ulnar aspects of the hand to further mitigate the risk of tendon tethering. Postoperatively, patients diligently elevate their hand and engage in supervised therapy that specifically targets flexion of the MCP joint. If stiffness persists, early-stage rubber band traction is utilized, with established contractures potentially requiring surgical release.

6. PROGNOSIS AND CONCLUSION

Regardless of the severity of CMC joint fracture dislocations, positive results are typically attained through the utilization of both non-surgical and surgical treatment approaches. Outcomes are enhanced by the hand's ability to compensate for loss in motion through adjacent joints. However, poor outcomes are tied to delayed treatment, inaccurate articular restoration, concurrent neurological injuries, and secondary fracture displacement.

Various treatments such as CMC joint arthrodesis, interposition arthroplasty, and CMC joint resection have been successfully employed. Anatomical reduction with adequate stabilization is key to satisfactory results. The most favorable results observed in individuals undergoing open reduction and K-wire.

Fractures occurring at the bases of the 2.-3. metacarpals typically exhibit improved outcomes when treated through open reduction and internal fixation. Conversely, fractures involving the base of the 4. metacarpal, though infrequent, tend to demonstrate more positive long-term results with open reduction and internal fixation. The management of fractures at the base of the 5. metacarpal remains a subject of debate, as both surgical and non-surgical approaches frequently result in persistent pain for patients.

In conclusion, early detection and a comprehensive approach to treatment, which could include surgical and non-surgical management and rehabilitation, often lead to favorable outcomes in CMC joint fracture dislocations[20].

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