Early Recognition and Treatment of Carpometacarpal Fractures and Dislocations

Reconhecimento Precoce e Tratamento das Fraturas e Luxações Carpometacarpais

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Abstract

Carpometacarpal (CMC) injuries can easily be missed in more than half of the cases. Early diagnosis is crucial for treatment. Although the clinical aspect can lead the treating physician to suspect that anything is going wrong, appropriate radiographs, especially in the lateral view, are crucial for the diagnosis. The most common CMC fracture dislocations affects the 4th and 5th joints. Treatment will depend on the type of injury and on the degree of joint involvement. Reduction and fixation are usually required. When only one ray is affected, usually the 5th, closed reduction and fixation with Kirschner wires can be performed. In complex cases, open reduction and fixation are required, with Kirschner wires being the most commonly used materials. After the hardware removal, rehabilitation can be intensified. If an appropriate reduction has been achieved, satisfactory functional and radiological outcomes are expected.

Keywords
- carpometacarpal joints/injuries
- carpometacarpal joints/pathology
- carpometacarpal joints/surgery
- joint dislocations
- hand bones

Resumo

As lesões na região carpometacarpal (CMC) podem passar despercebidas em mais da metade dos casos. O diagnóstico precoce é determinante para o tratamento. Embora clinicamente o paciente já possa demonstrar que de fato ocorreu a lesão, radiografias apropriadas, principalmente na incidência em perfil, são fundamentais para o diagnóstico. A lesão mais comum afeta as articulações de 4° e 5° dedos. O tratamento vai depender do tipo da lesão e o grau de envolvimento das articulações. Geralmente, é necessária redução e fixação. Quando apenas um raio é acometido, habitualmente o 5°, pode ser feita redução fechada e fixação com fios de Kirschner. Nos casos complexos, faz-se necessária a redução aberta e fixação, sendo os fios de Kirschner os materiais mais comumente usados. Após a retirada dos fios, intensifica-se a reabilitação. Se foi alcançada uma redução apropriada, esperam-se resultados funcionais e radiográficos satisfatórios.

Palavras-chave
- articulações carpometacarpais/lesões
- articulações carpometacarpais/patologia
- articulações carpometacarpais/cirurgia
- luxações articulares
- ossos da mão

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Introduction

Although it corresponds to < 1% of hand injuries,[1] it is not uncommon to doubt whether there is any radiographic alteration in the base of the carpometacarpal (CMC) from the second to the fifth fingers in the routine of attending orthopedic trauma. This is because there is a bone overlap between the CMC and the carpal bones, which may generate some misunderstanding in the interpretation of the images.[2] This difficulty can be mitigated if the clinical evaluation is well done and if the anatomical knowledge is improved.

The joints in the so-called CMC region are, as a rule, rigid, firm, stable, especially in the most radial fingers. Mild trauma is unlikely to lead to major injuries. Therefore, establishing the real mechanism of the accident and performing a good physical examination can be decisive for not neglecting this type of injury. Henderson et al.[2] reported diagnostic failure in 15 of 21 patients, relating to 2 main factors: edema, which hinders a more accurate examination, and the lack of a lateral x-ray view.

Thus, if there may be some complexity in the diagnosis, it is to be expected that the treatment also has its drawbacks. And this in fact occurs, because those injured ligaments, with a view to return to the stability they had before the accident, need to be healed in the correct position, that is, with the joints relating perfectly to each other, in order to provide a functional and painless hand.[3]

At first, it could be deduced that, since there is no mobility at the base of the second and third CMCs, then any reduction would be acceptable. This is not true, for the simple reason that the center of the hand falls exactly on the third radius, and if it is badly reduced, it may have consequences such as a decrease in grip strength.[4]

The purpose of the present review is to cover pertinent anatomical and functional aspects, which is the state of the art regarding the diagnosis of carpometacarpal fractures and dislocations (►**Box 1**), and to consider the updates regarding different types of treatment.

Anatomy and Kinesiology

There is a considerable difference in anatomical terms between the bases of the different metacarpal bones, and as a result, the range of motion in flexion-extension, although variable, is smaller in the 2nd and 3rd than in the 4th and 5th metacarpals. Gunther[5] showed, in a cadaveric study, that there is no more than one degree of movement in flexion-extension at the base of the 2nd CMC, three degrees in the 3rd, eight degrees in the 4th and 15 degrees in the 5th. Harwin et al.[6] found 25° to 30° for the 5th, 15° for the 4th, and limited movement in the 2nd and 3rd.

There are several ligaments that maintain stability in this region. Nakamura et al.[7] stated that in the 2nd CMC there are two dorsal ligaments and one volar, in the 3rd CMC there are four volar and three dorsal ligaments, on the 4th CMC there are one volar and two dorsal ligament, and on the 5th CMC there are one volar and two dorsal ligaments, with different morphological variations between them. This greater number of volar and dorsal ligament structures at the base of the 3rd CMC contributes to the stability of the adjacent CMC joints.

Regarding joints, the same authors reported that between the 4th and 5th CMC, the 2nd CMC and the trapezium, and between the trapezium and the trapezoid were all simple joints. There was a greater variation in the joints between the 3rd and 4th CMC (5 types: double facet of equal size, small facet with double back, small facet double volar, single facet only dorsal, and single large facet), between the 2nd and 3rd MTC (2 types: single facet and double facet), between the capitate and the hamate (3 types: single L-shaped facet, double facet and simple O-shaped facet) and between the trapezoid and the capitate (3 types: volar single facet, double facet and large single facet).

Box 1 Carpometacarpal Lesions

Patient Profile
- Men, young, trauma involving high-energy impact
- Direct trauma with a clenched fist

Observe at the Clinic
- Edema and fist pain
- Palpate the back of the metacarpal with crackling
- Check alignment of the base of the metacarpal bones and the carpal bones

Images
- Hand x-ray: posteroanterior, Metacarpal lateral, Oblique
- Most Common: Dislocation associated with fracture at the base of the metacarpal or carpal bones (hamate)
- Most affected metacarpal structures: 4th and 5th fingers
- Fractures with multiple dislocations are more common than isolated ones
- CT-Scan if there is doubt in the radiographic image

Treatment
- Closed reduction and plaster often result in loss of reduction and poor results
- Fracture-dislocation of the 5th CMC isolated with or without hamate fracture:
  Closed reduction and fixation with transverse K wires, from the 5th to the 4thmetacarpal, and if necessary, in the hamate
- Multiple fracture-dislocation of all fingers
  Open reduction and stabilization with K wires or mini-micro fragment plates and screws
  Start with the reduction and alignment of the 3rd CMC
- K wires for 6 weeks on average
- Early guidance for mobilization of interphalangeal and metacarpophalangeal

So, briefly, what we have are the bases of the index and middle finger rigid, due to the articulation with the trapezium, trapezoid and third metacarpal, and also by the presence of those dorsal and volar ligaments, in greater number at the base of the 3rd CMC. In addition, there are insertions of the tendons of the flexor carpi radialis and the long and extensor carpi radialis longus and brevis tendon at the bases of these metacarpal bones, which may even contribute to the avulsion of bone fragments. The dynamic stabilizer of the 5th CMC joint is the tendon of the extensor carpi ulnaris, which also contributes to the dorsal deviation in dislocations.[3]

Epidemiology and Classification

Dobyns et al.[8] reported that, among 1,621 studied hand fractures, only 3 corresponded to carpal-metacarpal dislocation fracture.

Steinmetz et al.[1] described that among 81 injuries, 23 (28.8%) corresponded to the isolated injury in the CMC region of the 5th, and 37 (45%) were due to the 4th and 5th injuries. In the same study, 87.5% of the cases corresponded to men, with the right hand being affected in 78.8% of the total. Most cases were due to a blow with a closed fist (46.3%), followed by a fall from a height (20%) and a traffic accident (12.5%). Fisher et al.[9] reported that multiple dislocations occur more frequently than isolated ones. In 50% of the cases there was isolated involvement of the joint between the fifth metacarpal and the hamate, and 25% affected the 2nd metacarpal.

As there are very strong ligament structures, there may be avulsion and impacted fractures concomitantly with carpometacarpal injuries. Dorsal dislocations are more common than volar, since direct trauma tends to force the metacarpal in flexion. Steinmetz et al.[1] found only one volar dislocation among 165 evaluated cases.

There are several classification systems described.[10–13] As most injuries affect the ulnar rays, the classifications are more focused on this area and highlight the possible association with hamate fractures. Cain et al.[10] divided them into type 1A (subluxation or dislocation of the 5th CMC without hamate fracture), type 1B (dorsal hamate fracture), type 2 (dorsal hamate comminution) and type 3 (coronal hamate fracture). Tay et al.[12] stratify the lesions as type 1 those that involve only one ray, type 2 those that affect two rays, but in subtype 2A the fracture of the 4th CMC is extra-articular, and in 2B there is dislocation or fracture-dislocation of 4th and 5th, and type 3, those that involve hamate fracture. There is another classification, simpler, cited by Pundkare et al. which covers all injuries, but refers only to the direction of the deviation, whether dorsal (type A), volar (type B) or divergent (type C).[13]

Other less frequent injuries are also described. The dislocation of the 2nd and 3rd CMC, volar or dorsal, has been reported in the literature.[14] Zaizi et al.[15] published a case of divergent dislocation, in which the 3rd CMC moved to volar, and the 2nd CMC dislocated to the dorsal region. Mane et al.[16] showed an undiagnosed lesion in a patient who had volar dislocation of the five carpometacarpal joints.

Clinical Investigation

The initial clinical evaluation is extremely important for the identification of the lesion. Attention should first be paid to the reported history of the trauma mechanism. Usually, the patient narrates a direct impact on the hand, with significant amount of kinetic energy. In the majority of cases, the report is of trauma with a clenched fist – as in aggressions with punches –, car accidents, and falls. Routinely, it should always be asked if there was a previous accident, as it is not uncommon, due to an absolute technical failure in the anamnesis, that the doctor only discovers that there was an old injury when he or she tries to obtain the reduction by any means, and realizes that it is not possible.[2]

Physical examination reveals pain, functional impotence and swelling. Pronounced edema hinders dorsal bone palpation and the perception of discontinuity between the base of the metacarpal bones and the distal row of the carpal bones. If this stage is overcome, that is, if one suspects that something is not satisfactory, the radiographic examination is carried out. Here is perhaps the main moment when an error may occur, as identifying the change, especially in the ulnar fingers, is difficult. More than half of the injuries in this region can go unnoticed in a first visit, in which the focus of attention is often diverted due to the existence of other injuries that have a greater impact on the life support of the patients.[17]

The Images

The radiographic anatomy of the CMC region seems, at first glance, simple to understand. From the second to the fifth, the articulation with the trapezium, the trapezoid, the capitate and the hamate occurs. However, as the lines overlap in the two-dimensional image, it is not always possible to detect, immediately, that there was an injury, especially in those cases where there is isolated involvement in any of the rays, such as the fifth.

Fisher et al.[9] described the parallelism that must exist in the articular surfaces of the second row of the carpus (►**Figure 1**). On the posteroanterior (PA) view, if an absence of this congruence is already identified, the lesion should already be suspected.

Fig. 1 Radiograph of the front of the normal wrist region, showing the parallelism between the articular surfaces.

Furthermore, attention should be paid to the lines of the metacarpal cascade in PA view, as described by Hodgson et al.[18] These authors reported that the lines of the central axis of each metacarpal converge to a common point, located about two centimeters proximal to the articular surface of the radius. If any of the metacarpals presents either a subluxation or a dislocation, then there will be no convergence of all rays.

One of the points that may be the cause of misinterpretation of the lesions is the routine request for radiography of the hand in the frontal and oblique projections. As the patient reports trauma to the hand, the initial impulse is for the doctor not to pay attention to the lateral view, and to be satisfied only with these two projections. This way, if you are not familiar with the radiographic anatomy of the wrist seen from the front, you may miss an injury at the base of the metacarpal bones. Hence the need for at least lateral incidence.[19] In this view, it is also possible to evaluate the intermetacarpal angle, as described by McDonald et al.[20] These authors demonstrated that, in metacarpal lesions on the ulnar side of the carpus, the diaphyseal angles between the 2nd and 5th metacarpals and between the 3rd and 5th metacarpals are generally $> 10°$; but emphasized that for these cases there is an indication for advanced imaging exams.

In addition to these projections, there are other possibilities. Lefere et al.[21] when describing a systematization for radiographic analysis of the wrist, recommended requesting PA, lateral and oblique views. In PA, they remind us that the carpal arches must be aligned and there is no overlapping of joint surfaces. In the suspicions of CMC involvement, the oblique ones would serve to analyze the dislocations in more detail. The lateral view would be intended to assess the radio-semilunar-third metacarpal alignment.

Requesting computed tomography (CT) can be an option to clear up doubtful cases, in which the association between trauma mechanism, careful physical examination and clear radiographs in appropriate views are not enough to point out the diagnosis or even outline whether there are joint bone fragments. Steinmetz et al.[1] in their analysis of 80 patients with this type of injury reported that there was no need for this type of examination. In contrast, Talmaçet al.[4] used the test for all 14 patients evaluated.

Treatment

The main objective of any therapy is to restore hand function without pain, preventing post-traumatic joint degeneration. The treatment of carpometacarpal lesions will depend on a series of elements, such as affected area and structures, degree of displacement, patient activity, and there is no uniform treatment algorithm, mainly due to the low frequency of this type of trauma.[3] The accepted therapeutic modality varies from intramedullary or transverse fixation with Kirschner (K) wires to fixing with back support plates.[12,22] A study compared plate and screws with K-wires fixation, concluding that fixation with wires is the gold standard for the treatment of fourth and fifth metacarpal lesions.[23] Arthroscopy has also been described as an auxiliary method.[24]

In isolated dislocations, eligible to closed reduction, stabilization with transverse wires supported by the uninjured metacarpal may be sufficient to provide stabilization and appropriate treatment.[25] However, Cobb et al.[26] in a systematic review, stated that the clinical evidence is scarce to let us conclude which is the best treatment method for fractures-dislocations of the 5th CMC. Nevertheless, there are alternatives to fixation with K-wires. Nishimura et al. treated 10 patients, who presented dislocations of metacarpal ulnar rays associated with comminuted fracture of the base, using an external fixator, infering that all patients returned to the level of function they had before the accident.[27]

In cases of multiple injuries, open surgery and fixation are indicated, given the difficulty of obtaining adequate closed reduction due to the interposition of soft tissues.[3] In these dislocations that involve from the 2nd to the 5th MTC, the key to the reduction is the 3rd MTC next to the capitate.[4] As it is in the center, if it is not appropriated reduced, it will make all the others remain in an inadequate position.

There is no consensus on the best treatment for these multiple injuries. In the literature, there are descriptions ranging from closed reduction with plaster cast immobilization to arthrodesis.[28] However, the tendency of plastered immobilization after closed reduction is to result in subluxation, mainly due to ligamentous interposition.[29,30] Therefore, as mentioned, open reduction is recommended for cases of multiple dislocations, as this reduces the risk of compartment syndrome and inadequate reduction.[3,4]

When there is a fracture in the carpus, it may be that the reduction becomes more difficult. For example, the hamate, when fractured, can hinder joint alignment, thus requiring an open reduction and more attention. This is possible through a longitudinal access, identifying vessels and mainly isolating the sensory branches of the radial nerve and the dorsal ones. The tendons are moved away, the capsule is exposed, and its opening is performed, leaving the edges planned for later closure. Next, lesions are identified, and reduction and fixation are performed.

Sometimes, the initial treatment carried out may not have been satisfactory, and a review may be necessary. In ►**Figure 2**, we can see the sequence of a multiple volar dislocation, the initial fixation that proved to be inadequate, and the fracture revision, with the correct reduction and fixation with multiple K-wires.

Once the surgical procedure is completed, a splint is maintained that can be removed for cleaning around the K-wires. Weekly radiographs are taken to check the maintenance of the reduction. The patient is advised to keep the hand elevated to reduce edema and encouraged to move the fingers, as soon as pain allows. This early rehabilitation favors long-term recovery, especially of the metacarpophalangeal joints. After the removal of the hardware, at approximately 6 weeks, the rehabilitation is intensified. As the range of motion improves, the patient is stimulated to hold objects, initially of light weight, progressing as the grip strength gradually returns.

Complications can occur, most of the time due to the severity of the trauma or the delay in starting treatment.

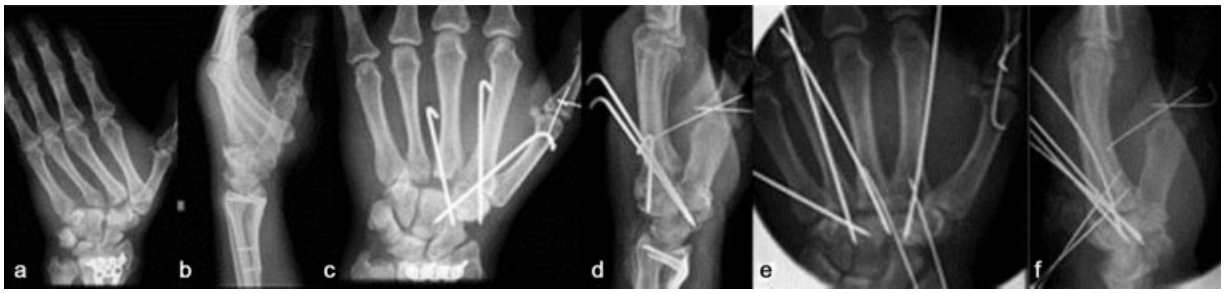

Fig. 2 Volar dislocation from 2nd to 5th carpometacarpal. A and B initial radiographs, showing the volar lesion; C and D showing the first treatment, in which the articular incongruity is perceived, both in the PA and in the lateral view; C and D show the correct joint correlation.

Depending on the location, the patient may show up a few weeks after the accident, and this makes therapy difficult. In other cases, the diagnostic failure may be responsible for the delay. Concomitant injuries, such as ulnar nerve damage, can also be liable for poor results. Inadequate fixation can lead to loss of reduction, and the need for further surgery. Infection can result in joint degeneration. Anyway, cases of treatment failure can culminate in post-traumatic osteoarthritis, in which case an arthrodesis would be necessary in the future.[3] In cases of chronic symptomatic lesions of the base of the 5th CMC, an alternative is to perform the Dubert technique, in which a resection of the base of the metacarpal is performed, associated with the creation of a synostosis next to the 4th CMC.[31] To avoid such complications, once a diagnosis of carpometacarpal fractures or dislocations is made, early reduction, adequate stabilization and rehabilitation as soon as possible should be implemented.

Care Systematization

As a routine and systematization of approach to carpometacarpal injuries, the following can be established. Initially, in traumatic injuries, the appendicular skeleton should always be examined in order to avoid injuries that may go unnoticed, especially in unconscious patients. Once ectoscopic changes in the hand have been identified, palpation may reveal crackling. Confirmation takes place with the radiograph, and attention should be paid to the lateral view, in which the alignment of the 3rd CMC is observed. Computed tomography may be requested, especially in cases of diagnostic doubts or to determine the extent of joint involvement. If there is an isolated lesion, closed reduction and fixation with K-wires to the adjacent intact metacarpal is possible. In multiple lesions, open reduction allows a better visualization of joint congruence.

In our experience, the results are no longer satisfactory when the lesion is not recognized in the first stage, or if the reduction is not obtained in full, there is remaining subluxation or dislocation of one or more metacarpal bones. To prevent this from occurring, fluoroscopic images must assess multiple planes, driving special attention to the lateral view. Another aspect that weakens the results is the difficulty for rehabilitation, as the patient should be encouraged to move the fingers as soon as the edema recedes, and the pain allows it. Delaying the start of the movements can lead to stiffness of the joints. Also, the cases in which the postoperative immobilization was inadequate, due to the difficulty in obtaining flexion of the metacarpophalangeal joints, keeping them extended, will bring future problems for the hand grip function.

Final Considerations

Carpometacarpal lesions may go unnoticed, notably if due attention is not paid to the trauma mechanism and if the radiographic evaluation is not accurate. Articular anatomy must be known so that prompt diagnosis can be made. Lateral radiographic view may be the key for detecting these injuries. Once diagnosed, the CMC lesion should be treated as soon as the conditions are met. Isolated lesions can be managed with percutaneous fixation, anchoring the affected metacarpal in the adjacent intact one. Multiple injuries usually require open reduction and fixation. The most used synthesis material, with good results, is the K-wire, and postoperative immobilization should be performed with flexed metacarpophalangeal joints and interphalangeal joints in extension. Since the beginning of the postsurgical period, the patient is encouraged to move the fingers. After removing the K-wires, rehabilitation is intensified. If a good reduction has been achieved, it is expected that the patient will regain strength and function of the hand, without pain. Otherwise, degenerative changes may appear, which will require new interventions in the future, such as arthrodesis.

Note

The present review article does not require submission to the Research Ethics Committee, to the best of my knowledge.

Conflict of Interests

The authors have no conflict of interests to declare.

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