Acute closed dislocation of the second through fourth carpometacarpal joints: satisfactory treatment with closed reduction and immobilization

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Introduction

Fracture dislocations of the carpometacarpal (CMC) joints are a rare injury in the hand. Dorsal dislocations are the most frequently reported [11]. Stronger dorsal ligaments and wrist extensor restraints cause failure of the bone dorsally with subsequent rupture of the volar ligaments, allowing for dorsal fracture dislocations to occur more commonly than volar dislocations [7]. In most cases, treatment of such injuries requires open reduction and internal fixation (ORIF) or closed reduction with percutaneous pinning [9]. The purpose of this report is to present a patient with radially deviated fracture dislocations of the second through fourth CMC joints that were satisfactorily treated with closed reduction.

Case Report

A 71-year-old right-hand-dominant male arrived to the trauma bay following a motor vehicle collision in which the patient was an unrestrained driver who lost consciousness and crashed his vehicle into a utility pole due to hypoglycemic coma. After the patient was adequately resuscitated and stabilized, the on-call orthopedic hand team was consulted to evaluate injuries to the patient's right hand. On initial physical examination, the patient appeared to have suffered a deep laceration extending into the web space between the right fourth and fifth digits (Fig. 1). No bone or joint space was visible within the laceration. In addition,

there was a radial deviation deformity of his hand in relation to his wrist with significant swelling throughout the palmar and dorsal aspects of the hand; compartments were soft and compressible. There was a strong palpable radial pulse and brisk capillary refill, and sensation was intact to light touch throughout the right upper extremity. Isolated active and passive range of motion of the distal and proximal interphalangeal joints was normal. Active range of motion (AROM) of the metacarpophalangeal joints was limited by pain. Passive range of motion was greater than AROM, but also limited by pain. Radiographs revealed a radial dislocation of the second and third metacarpals with fractures seen in the base of the second and fourth metacarpals (Fig. 2). Metacarpal cascade lines imposed on the radiograph offer insight to the dislocation [5]. In a normal hand, this radiographic technique described by Hodgson and Shewring [5] results in an intersection point of all the cascade lines at the distal radius (Fig. 3).

While in the trauma bay, the patient was given narcotic pain medication and his right hand was carefully placed in fingertraps with two 1-L saline bags suspended over the elbow joint via a stockinette to help provide traction along the longitudinal axis of the forearm. During this time in fingertrap traction, attention was turned to the patient's web space laceration, which was thoroughly cleaned and closed with nonabsorbable sutures. After approximately 20 min of suspension in the fingertraps, the patient's deformity persisted. At this time, it was deemed necessary to achieve complete muscular relaxation for the process, and the trauma surgical team provided rapid-sequence intubation due to the risk associated with conscious sedation without airway given the patient's recent diabetic coma. After intubation, gentle pressure was applied to the protruding radial base of the index metacarpal, and minimal force was required to achieve reduction of the deformity. Repeat radiographs in the trauma bay confirmed the reduction, and the

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Fig. 1 Clinical photograph of right hand laceration in the web space between the fourth and fifth digits

patient was placed in a right upper extremity sugar tong splint.

The patient was admitted to the hospital under the trauma surgery service and remained in-house for 3 days. Upon his discharge, the patient was instructed to follow up with the orthopedic hand outpatient clinic within 1 week. He was lost to follow-up and did not return until about 3 months later. At that time, the patient informed us that he had been followed

by a local orthopedic surgeon closer to his residence. The local orthopedic surgeon continued immobilization of the hand in a short arm cast for 6 weeks. After this period of immobilization, the patient had been working with physical therapy and using his hand for daily activities.

The patient returned to our office for evaluation 7 months post-injury. He reported that he is able to carry out activities of daily living without noticing disability. He had minimal complaints with only occasional pain and inability to make a complete fist, lacking 1 to 2 cm of full flexion into the distal palmar crease. Wrist range of motion displayed deficits in extension and supination only for the injured side (Table 1). The patient's grip strength was measured using a Jamar dynamometer (Lafayette Instrument Company, USA; Table 2). The Jamar dynamometer has five settings which measure at the grip spans of 1.0, 1.5, 2.0, 2.5, and 3.0 in. Measurements were taken at settings I through IV correlating with 1.5 through 2.5 in. of grip span. This displayed a decent return of his grip strength on the affected hand ranging from 73 to 90 % of the contralateral side. While we did not measure precise motion at each finger joint, the measurement of finger flexion to the distal palmar crease is commonly used to assess overall active digital motion. The patient did demonstrate active flexion at all three joints (DIP, PIP, MP) of all involved digits based on this criterion offering a reasonable assessment of satisfactory hand function. There was minimal step-off observed between his right fourth and fifth digits when making a fist (Fig. 4), and the radiographic examination confirmed minimal dorsal displacement of the metacarpal bases with metacarpal cascade lines displaying improved alignment of the bony structures (Fig. 5) [5].

Fig. 2 **a** Pre-treatment anteroposterior radiograph of the right hand displaying radial dislocation of the second and third metacarpals with fracture at the base of the second and fourth metacarpals. *Metacarpal cascade lines* imposed on image to display dislocation [5]. **b** Pre-treatment lateral radiograph of the right hand displaying radial dislocation of the second and third metacarpals with fracture at the base of the second and fourth metacarpals. *White arrow* is a radiologic marker noting the area of maximum tenderness for the patient and was correlated to the region of pathology

Fig. 3 Antero-posterior radiograph of normal right hand. *Metacarpal cascade lines* imposed on image to show normal alignment [5]

Discussion

The bony and soft tissue stabilizers of the CMC joints are numerous, including variable articular congruity and strong capsular insertions. The second and third CMC joints have limited motion [2, 8, 9]. The second metacarpal articulates with the trapezium and trapezoid, while the third metacarpal articulates with the bases of the second and fourth metacarpals and distal capitate. This bony stabilization, in conjunction with the dynamic stabilization provided by the insertions of the flexor carpi radialis and extensor carpi radialis longus and brevis, creates the need for a high-energy force to cause any significant disruption of the CMC joints. The bony constraint is appreciated less in the

articulations of the fourth and fifth CMC joints, which have a saddle configuration and looser ligamentous attachment [8]. However, the dense palmar, dorsal, and intermetacarpal ligaments provide significant stabilization in these joints [2, 9]. As such, carpometacarpal injuries account for <1 % of all hand injuries [4].

The force required to disrupt this robust and complex anatomy is often high energy and is commonly associated with motorcycle-related trauma or boxing injuries [8, 9]. Historically, dislocation of the metacarpals at the CMC joint was described in either the palmar or the dorsal direction, often with associated fractures at the base of the metacarpals [3]. More recently, such injuries have been described as divergent or lateral, similar to the classification of the Lisfranc fracture dislocation seen in the foot [11]. To our knowledge, there has only been one other reported case of a laterally dislocated CMC joint injury in the literature [6]. That reported case involved the second and third carpometacarpal joints and was a chronic deformity that was discovered 4 months after the initial injury to the subject's hand during a rugby match [6]. The patient was treated with open reduction and fusion.

Our patient's injury involved the second through fourth metacarpals and was acutely identified and treated. Dislocations of the CMC joint can be easily missed in the acute setting. The most common presentation of a fracture dislocation at this joint is significant hand swelling [3, 6, 7, 9, 10]. Some authors have suggested that this swelling can often mask the underlying bony deformity. When a patient is initially treated in a busy trauma bay setting, such as our patient, the concern for more life-threatening injuries can especially lead to a missed diagnosis. As such, it is imperative to always conduct a thorough secondary exam and get proper imaging studies. In the case of our patient, the standard postero-anterior best served to reveal our patient's injuries and allowed us to adequately treat the patient in a timely manner with closed reduction. The use of the metacarpal cascade lines imposed on the PA radiograph assists in both diagnosis and critical assessment of the reduction [5].

Table 1 Wrist range of motion measurements for injured and uninjured hand at 7-month follow-up

Wrist motion movement	Right (injured) wrist ROM (°)	Left (uninjured) wrist ROM (°)
Flexion	50	50
Extension	35	50
Pronation	75	75
Supination	65	75

Table 2 Grip strength of injured and uninjured hand with Jamar dynamometer at 7-month follow-up

Jamar dynamometer setting	Right (injured) hand grip strength (lb)	Left (uninjured) hand grip strength (lb)
I	40	45
II	55	70
III	55	75
IV	58	65

Fig. 4 **a** Clinical photograph of the right hand in full extension 7 months after injury displaying normal splay and extension of the fingers. **b** Clinical photograph of the right hand in full flexion 7 months after injury displaying minor splay between the fourth and fifth digits

Typically, one would assume that this injury pattern would need some form of surgical intervention, as is the case with most multiple CMC dislocations. We believe that timely diagnosis, adequate sedation with muscle relaxation, followed by gentle reduction maneuvers allowed us to achieve near-anatomic reduction of the fracture dislocation, which was adequately treated conservatively. Our patient demonstrated minimal disability at 7-month follow-up. A case report by Agarwal and Agarwal demonstrated a similar satisfactory result in a patient treated with closed reduction and splinting for a divergent carpometacarpal dislocation of all four digits [1]. This patient displayed normal to near-normal

range of motion and grip strength in the hand despite some residual swelling and was able to continue his daily activities as a farmer [1]. There are, however, reports of failed closed reduction management that eventually led to open reduction [9]. The two largest reviews of successful management of this injury pattern both treated their patients with ORIF [8, 9]. However, as demonstrated in our case, correct diagnosis during the acute setting and timely intervention can potentially keep these patients out of the operating room. If this approach is chosen, close follow-up and serial radiographic evaluation is recommended to ensure maintenance of reduction and recovery of hand function.

Fig. 5 **a** Antero-posterior radiograph of the right hand at 7 months post-injury displaying healed fractures and near-anatomic alignment of the carpometacarpal joints. *Metacarpal cascade lines* imposed on image to display improved alignment [5]. **b** Lateral radiograph of the right hand at 7 months post-injury displaying healed fractures and near-anatomic alignment of the carpometacarpal joints

Conflict of interest The authors declare that they have no conflict of interest.

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