Dorsal dislocation of the Metacarpophalangeal Joint of the Index Finger

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Dislocations of the metacarpophalangeal joint of the index finger are expected to occur more frequently than the relatively rare reports in the literature would indicate, considering the amount of varied traumathe finger is subjected to, in the activities of daily life. The border digits are involved most commonly due to their increased vulnerability to trauma and lack of stabilization by two adjacent deep transverse metacarpal ligaments, an endowment for the middle and ring fingers where such injuries are infrequent.Dislocations of the metacarpophalangeal joint of the index finger present

certain characteristics which make it distinctly different from dislocations of the thumb or little finger.

The dislocations can be simple or complex. Simple dislocations are those which can be reduced with closed manipulation. Clinically, in a simple dislocation, the finger is held at close to 90 degrees of hyperextension whereas in a complex dislocation, the finger is held in only about 20 degrees of hyperextension[1]. So, the deformity is more striking in a simple dislocation. The technique of manipulative reduction involves hyperextension of the proximal phalanx to 90 degrees over the metacarpal and volar directed pressure over the dorsal surface of the base of the phalanx and guiding it into the anatomical position over the metacarpal head.

The term ‘complex dislocation’ was introduced by Farabeuf in 1876, who studied the mechanism and anatomy of such dislocations involving the thumb. He also noted that a simple dislocation or an incomplete subluxation, would be transformed to a complicated or complex dislocation with attempts of traction alone[2].

In 1957, Kaplan published his observation in two cases where the dislocation could not be reduced by manipulation and therefore required open reduction. He studied the pathological anatomy from the volar side and described the various anatomical interposing structures that hinder the reduction by closed manipulation as listed below.

1. Volar plate: The fibrocartilaginous plate is a reinforcement in the anterior capsule of the metacarpophalangeal joint. It is loosely attached to the subcapital region of the metacarpal proximally and firmly attached to the base of the proximal phalanx on the volar side distally.
2. Flexor tendons: The flexor tendons pass through a closed tunnel, the vaginal ligament, on the volar surface of the volar plate.
3. Fibers of palmar fascia: Three groups of fibers in the midpalmar fascia, one longitudinal and two transverse groups are noted in a normal hand. The longitudinal fibers or the pretendinous bands extending from the wrist to the fingers are firmly

adhered to the vaginal ligament across the metacarpophalangeal joint. The proximal group of transverse fibers or the superficial transverse metacarpal ligaments extends across the palm of the hand, connecting the pretendinous bands. The distal group of transverse fibers extends across the hand just below the interdigital folds, connecting the index to the little finger and forming the natatory ligament[3].

4. Lumbrical muscle: It forms the radial border of the noose, completing the wedge around the metacarpal neck.

Kaplan continues to describe the pathological anatomy of the dislocated metacarpophalangeal joint as follows: when dislocation occurs following forceful hyperextension, the metacarpal head is displaced radial to the flexor tendons, owing to the angle(45 degrees) at which these tendons pass from the wrist to the fingers across the ulnar third of the metacarpal head. The fibrocartilaginous plate breaks away at its weakest attachment, the subcapital region of the second

metacarpal. The flexor tendons in the vaginal ligament and the pretendinous bands that are attached to it are displaced to the ulnar side of the head. Now the volar plate is displaced over the metacarpal head, drawn to the dorsal side of the metacarpal where it becomes firmly wedged between the base of the proximal phalanx and the metacarpal head. The natatory ligament comes to lie on the dorsum of the metacarpal head and the superficial transverse metacarpal ligament lies on the volar aspect, applying pressure over the corresponding sides and hold the head in the dislocated position. The lumbrical muscle, arising from the flexor digitorum profundus changes the course, running across the metacarpal neck from the ulnarly displaced flexor tendons to get inserted on the radial side of the extensor apparatus of the index finger. Thus the dislocated head is wedged between the natatory ligament and the volar plate distally, superficial transverse metacarpal ligament proximally, the flexor tendons with the pretendinous bands on the ulnar side and the lumbrical on the radial side as shown below.

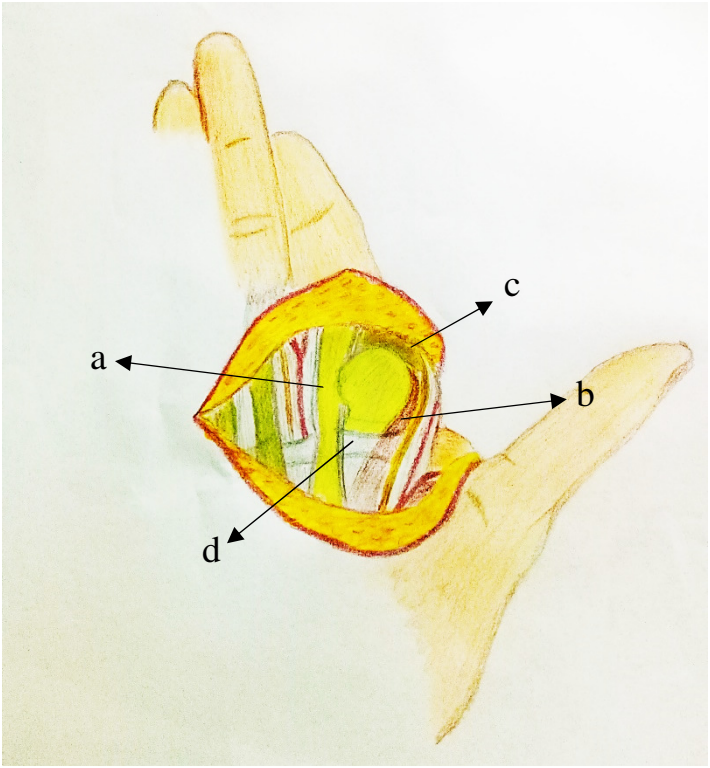

Fig.1: The displaced metacarpal head wedged between a. flexor tendon and pretendinous bands, b. lumbrical, c. natatory ligament and the volar plate d. superficial transverse metacarpal ligament

Role of deep transverse metacarpal ligaments

Kaplan, followed by various authors[4, 5, 6], firmly believed that the volar plate, interposed into the joint, represents the most important element preventing reduction.

However there were reports of unsuccessful open reduction or difficulty with open reduction of the metacarpophalangeal joint, following which descriptions and recommendations made by Kaplan were modified. Murphy, in 1967, implicated the deep transverse metacarpal ligament, through which the metacarpal head is forced, as the reason for unsuccessful open reductions[7]. These ligaments lie in direct continuity with the volar plates anterior to the metacarpal heads, also known as the intervolar plates as suggested by Eaton.

Green and Terry noted that the avulsion of the metacarpal is necessarily accompanied by incomplete or partial tear of the plate on both sided from the adjacent deep transverse metacarpal ligament[4]. The remaining partial attachment of the volar plate with the deep transverse metacarpal ligament made extrication of the volar plate difficult. They also noted that when a short incision is made longitudinally completing the tear, the volar plate can easily be extracted from the joint, accomplishing the reduction.

Decosta noted that the detached volar plate draws the deep transverse metacarpal ligament along and displacing it dorsal to the metacarpal[8]. So, instead of running volar to the metacarpal neck from the third to second metacarpal, it ran dorsally, described as the "bucket handle" displacement. He reported that even after performing the steps of open reduction, described by Kaplan, the metacarpal head continued to dislocate anteriorly despite multiple attempts of reduction. The deep transverse metacarpal ligament was found displaced dorsal to the metacarpal neck forcing the metacarpal head anteriorly. Stable reduction was achieved after longitudinal division of the deep transverse metacarpal ligament and the cut ends were brought volar to the metacarpal neck. He concludes that an awareness of the possibility of a displaced deep transverse metacarpal ligament might facilitate achieving a complete stable reduction.

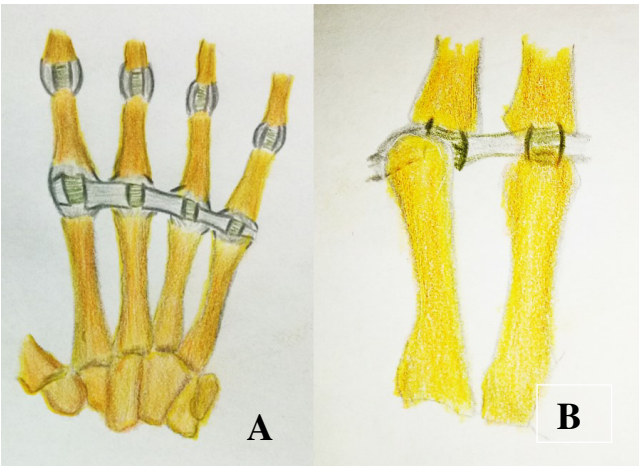

Fig.2: Deep transverse metacarpal ligament- Normal (A) and dorsally displaced (B)

Diagnosis

The mechanism of injury is a fall on outstretched hand with forcible hyperextension of the metacarpophalangeal joint. In a typical situation, the patient presents with a slightly hyperextended index finger with the proximal phalanx resting on the dorsum of the metacarpal and deviated towards the adjacent middle finger (Fig. 3).

The middle and distal phalanges are slightly flexed. As mentioned earlier, when the joint is hyperextended more acutely, approaching to 90 degrees, it is more likely to be

a simple dislocation that can be reduced with closed manipulation.

Fig. 3

On examination, the metacarpal head can be palpated easily in the palm, underlined by the pathognomonic puckering of the skin (Fig. 4) in the proximal palmar crease, described by Kaplan as similar to the “dimpling of the skin in carcinoma of the breast”[3]. The intimate connection between the fibers of the palmar fascia (the pretendinous bands and the transverse group of fibers) and the skin, which is stretched by the displaced metacarpal head is responsible for the puckering of the skin. When present, this sign, indicates firm wedging of

the metacarpal head and excludes or contraindicates the use of closed reduction.

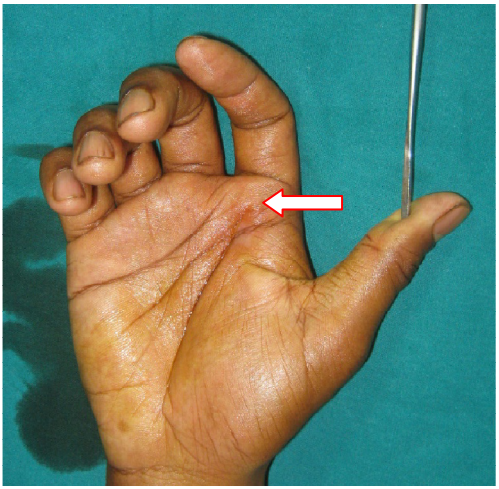

Fig. 4: Puckering of the palmar skin is the pathognomonic sign of complex dislocation

Three radiographs, anteroposterior, lateral and oblique views are required to demonstrate the exact nature of the deformity. The findings include increased space between the proximal phalanx and the metacarpal head, increased intermetacarpal space between the second and third metacarpals and volar depression of the metacarpal head with the proximal phalanx shifted to the dorsum of the second metacarpal neck. The presence of a sesamoid

within the increased metacarpophalangeal joint space of the index finger indicates irreducible nature of the dislocation, as in the fingers, the sesamoid lie embedded in the volar plate unlike the thumb where they lie along the lateral margins of the volar plate. The sesamoid should also be differentiated from an osteochondral chip fracture of the metacarpal head, as it does not carry any similar diagnostic significance.

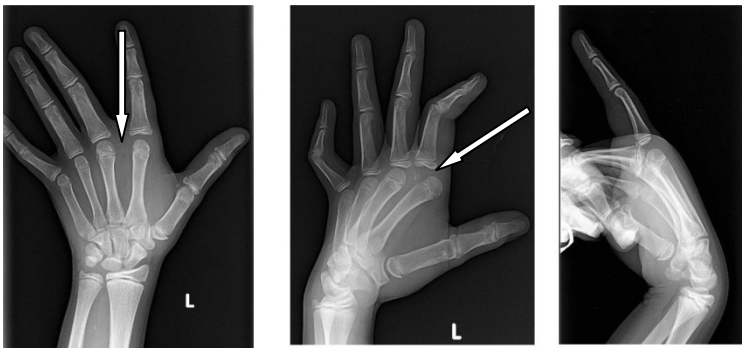

Fig.5: Typical radiographs of complex dorsal dislocation showing increased space between the proximal phalanx and the metacarpal head, increased intermetacarpal space between the second and third metacarpals and volar depression of the metacarpal head with the proximal phalanx shifted to the dorsum of the second metacarpal neck.

Surgical technique

Since Kaplan and Becton have described the volar and dorsal approaches respectively, for the open reduction of the index finger metacarpophalangeal joint, the literature has witnessed multiple case reports and case series, supporting each of them. The volar approach as described by Kaplan had the advantages of offering the surgeon a more direct visual access to the pathology and facilitates surgical release. It also permits the extraction of the volar plate from the joint and anatomical repositioning. But multiple reports claimed that the volar approach is fraught with the danger of injuring the radial digital neurovascular bundle (Fig. 6) which becomes stretched over the displaced metacarpal head lying immediately beneath the skin. However, Chadha and Dhal reported that visualizing the neurovascular bundle through the volar approach is a constant reassuring factor and also avoids the inadvertent damage to the bundle while dividing the volar plate through dorsal approach[9]. Becton, in 1975, described the dorsal approach and stated the advantages of the approach as follows: there is full exposure of the fibrocartilaginous volar plate, digital neurovascular bundle are not endangered to be damaged

and accurate reduction and fixation of the osteochondral fracture of the metacarpal head, frequently seen with this dislocation, is possible[10]. The disadvantage with this approach is the need to divide the volar plate longitudinally to achieve reduction, which may lead to instability as the volar plate repair is not amenable following reduction from dorsal approach. The need for splitting the extensor apparatus is considered as another drawback with the dorsal approach

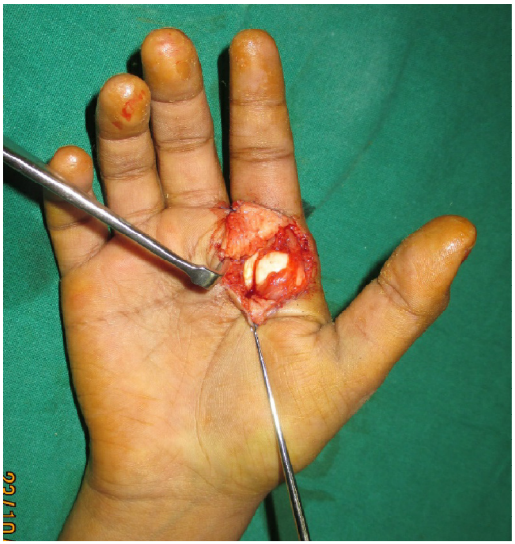

Fig. 6: Radial digital nerve tented over the metacarpal head

In 2014, Kodama described minimally invasive arthroscopic reduction of complex dorsal

metacarpophalangeal joint dislocation. However it has the limitation of inability to view the extra- articular patho-anatomy[11].

Surgical technique at our center

Volar approach is the preferred method for the open reduction at our center. We use the incision described by McLaughlin, in which the volar incision across the proximal palmar crease, described by Kaplan, is extended with a mid-lateral incision along the radial side of the second metacarpal[12]. The distorted anatomy secondary to trauma may pose difficulty in understanding the patho-anatomy. Care must be taken to avoid injury to the digital neurovascular bundle lying just beneath the skin tented over the displaced metacarpal head. The superficial palmar fascia and the A1 pulley are divided. The radial neurovascular bundle and the lumbrical muscle are retracted towards the radial side and the flexor tendons are withdrawn from behind the metacarpal and retracted towards the ulnar side.

Fig. 7: Volar approach exposing the displaced flexor tendons and lumbrical

A longitudinal incision through the superficial transverse ligament and a second longitudinal incision through the deep transverse metacarpal ligament (at the margin of the volar plate) are made to allow the volar plate to be extracted from the joint and the dislocation is reduced. McLaughlin noted that often a periosteal sleeve had been elevated off the metacarpal head which might be part of the hindrance to the reduction of the joint[12]. In the

presence of osteochondral fracture, the fragment gets repositioned with anatomical reduction of the joint and is left in place. The volar plate is repositioned and repaired or reattached to the periosteum with absorbable sutures. The stability of the joint is checked and the wound is closed with non-absorbable sutures. A below elbow dorsal slab is applied with which the patient is allowed to perform active finger flexion from the first post-operative day.

Rehabilitation

McLaughlin observed thatthe amount of motion eventually regained is inversely proportional to the duration of immobilization following operation[12]. Therefore it is recommended that full range of finger mobilization should be encouraged from the first post-operative day with a dorsal extension blocking slab that will be maintained for three weeks. Active finger extension is allowed after three weeks.

Summary

Managing the complex dorsal dislocation of the metacarpophalangeal joint demands profound knowledge of the regional anatomy and the biomechanics involved. The slightly hyperextended index finger with puckering of the palmar skin indicate firm wedging of the metacarpal head and require open reduction of the joint. The volar approach with care to avoid injury to the neurovascular bundle is the preferred method. Early mobilization would result in better eventual range of motion.

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