A Rare Case of Complex Carpal Injury: Divergent Trapezium-Trapezoid Fracture Dislocation

Bushu Harna[1] Dhananjaya Sabat[1]

[1]Department of Orthopaedics, Maulana Azad Medical College, New Delhi, India

Address for correspondence Bushu Harna, MS, Room No 407, ORDH Hostel, Maulana Azad Medical College, New Delhi, India (e-mail: bushu.edu@gmail.com).

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Abstract

Background Divergent trapezium-trapezoid fracture dislocation is a rare and complex injury. The authors present an unusual case of dislocation of the trapezium-trapezoid complex with scaphoid fracture.

Case Description A 25-year-old man suffered a road traffic accident leading to complex carpal injury due to axial and rotation forces (steer wheel injury) on the left wrist. X-rays and computed tomographic (CT) scan were done showing trapezium-trapezoid dissociation with fracture of distal pole of scaphoid and ulna styloid. The second metacarpal base was fractured with many ligamentous injuries in the wrist.

Methods Volar flexor carpi radialis (FCR) approach was used to reduce and fix scaphoid fracture with 2.7-mm cannulated screw. Dorsal approach was used to fix fracture of second metacarpal base and perform reduction in trapezium-trapezoid complex with help of 0.8-mm K-wires, and suspension wiring of first to second and second to third metacarpal was done using 1.5-mm K-wires. The transverse flexor retinaculum (TFR) in this case was avulsed.

Discussion The divergent trapezium-trapezoid joint with scaphoid fracture is not described in the literature yet. The authors implicate steering wheel injury pattern for such complex carpal fracture dislocations. CT scan is imperative to diagnose and plan treatment of such fracture morphology. Early fracture reduction and stabilization of carpal dislocations are essential for proper functioning of wrist.

Keywords
- complex carpal injuries
- divergent axial-radial-ulnar
- steering wheel injury
- scaphoid fracture
- divergent trapezium-trapezoid dissociation

Introduction

The wrist injuries are common and sustained in all age groups. However, the carpal dislocation and fracture dislocations are rare injuries. Complex carpal injuries are difficult to diagnose and manage. The axial carpal dislocations and fracture dislocations account for 1.4% of all fracture and dislocations of the wrist.[1] Mode of injury is complex although most injuries are caused by high-energy compressive dorsopalmar forces.[1,2] The most common injury mechanisms are crushing, blast, torsion, or a combination of all.[3,4]

It is rare for multiple carpometacarpal dislocation to occur without associated fracture. Divergent carpometacarpal fracture dislocations are even rarer. Divergent trapezium-trapezoid fracture dislocation is a unique and rare fracture entity.[5,6] To achieve a "divergent variant" of multiple carpometacarpal dislocations, a combination of axial and torsion force is required, termed as "steering wheel injury."[7] Multiple carpometacarpal fracture dislocations are rare, which account for less than 1% injuries of the hand. According to Garcia-Elias classification, axial carpal fractures are divided into three types: axial-ulnar (58%), axial-radial (40%), and divergent axial-radial-ulnar (ARU) (2.5%), of all axial carpal fracture dislocations.[4] Other injury patterns include fracture dislocation of multiple carpal bones. Rarely pure ligamentous disruption of carpal bones can occur. The divergent ARU fracture dislocations are rare injuries, with only 11 cases previously reported in the literature.[8] Distal carpal row is commonly affected though proximal transverse arch is also affected. Such complex carpal injuries are associated with ligamentous injury. The transverse flexor retinaculum (TFR) is broken or avulsed in most of these cases, not requiring a surgical decompression.[1,3]

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In this case, the authors describe a patient with traumatic divergent trapezium-trapezoid dissociation with scaphoid fracture and peripisiform ARU with ulna styloid fracture. Such a complex fracture morphology and injury pattern are not yet described in the literature so is its management. This article enlightens the management difficulties in complex carpal injuries.

Case Report

The authors report an interesting case of unusual fracture pattern of the wrist causing complex carpal fracture dislocations.

A 25-year-old man suffered a road traffic accident leading to axial and rotation forces on left wrist. The patient presented to orthopaedics emergency with swelling in the left wrist with no other injury. At presentation the patient had swelling in the left hand and wrist with painful range of motion. Fortunately the patient did not have blisters in the hand or wrist. There was no neurologic deficit in the hand, and both radial and ulnar pulses were palpable. X-rays were done (►**Figs. 1** and **2**) suggesting complex carpal injury but not clearly delineating the fracture morphology. Noncontrast computed tomographic (CT) scan was done depicting trapezium-trapezoid dissociation with fracture of distal pole of scaphoid and ulna styloid. The second metacarpal base was fractured with many ligamentous injuries in the wrist (►**Figs. 3** and **4**). The left forearm was splinted, and the limb was elevated. The swelling subsided in 3 days. The patient was planned for definite surgery then.

Dual approach to the wrist was used. Dorsal approach was used to reduce trapezium-trapezoid complex. Reduction in trapezoid was difficult as it was unstable dorsally. Hence trapezoid was first fixed onto capitates and fixed with 0.8-mm K-wire. Then trapezium was aligned to trapezoid and fixed with 0.8-mm K-wire. Scaphoid fracture fell into place when the distal carpal row was aligned. Volar flexor carpi radialis (FCR) approach was used to fix scaphoid fracture with 2.7-mm cannulated screw in retrograde manner. Suspension wiring of first to second and second to third metacarpal was done using 1.5-mm K-wires (►**Figs. 5** and **6**) to maintain the alignment, improve the stability, and decrease the axial loading on first and second ray. The TFR in this case was avulsed, so no separate surgical carpal tunnel decompression was required.

Below-elbow slab was given for 2 weeks. After suture removal, guarded wrist mobilization was started (►**Figs. 7** and **8**). Suspension K-wire was removed after 6 weeks. The patient was followed for 3 months. He had normal supination-pronation, 15-degree terminal dorsiflexion restriction and normal volar flexion as compared with unaffected right wrist (►**Fig. 9**). He went back to his profession with normal grip strength.

The case was challenging in understanding the mechanism, morphology of fracture, and its management.

Fig. 1 X-ray of the wrist, posterior-anterior view.

Fig. 2 X-ray of the wrist, lateral view.

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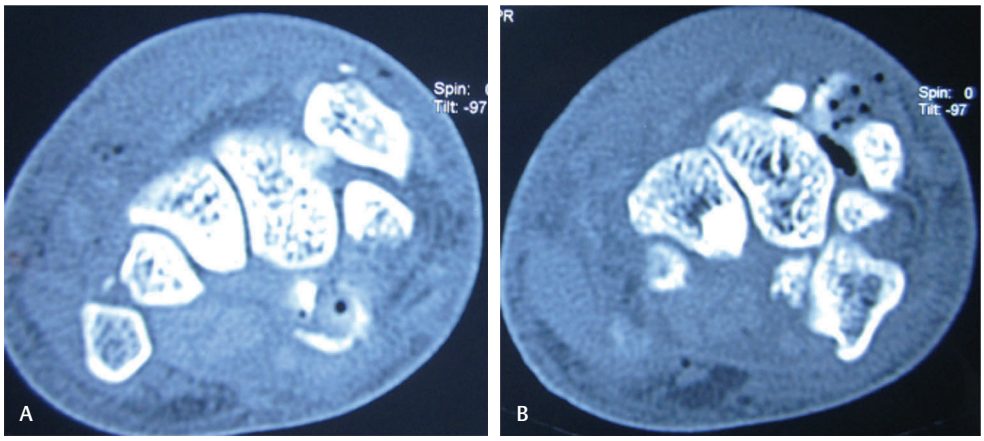

Fig. 3 (A, B) CT scan axial view.

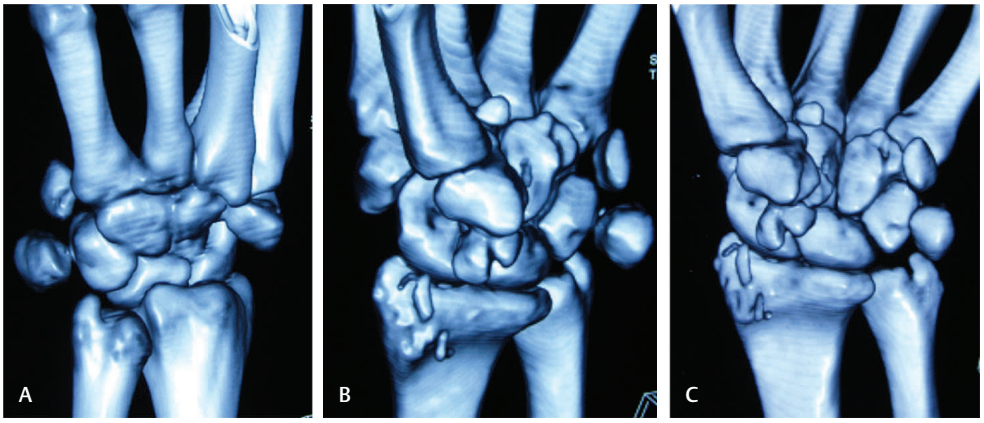

Fig. 4 (A–C) CT scan 3D reconstruction of wrist.

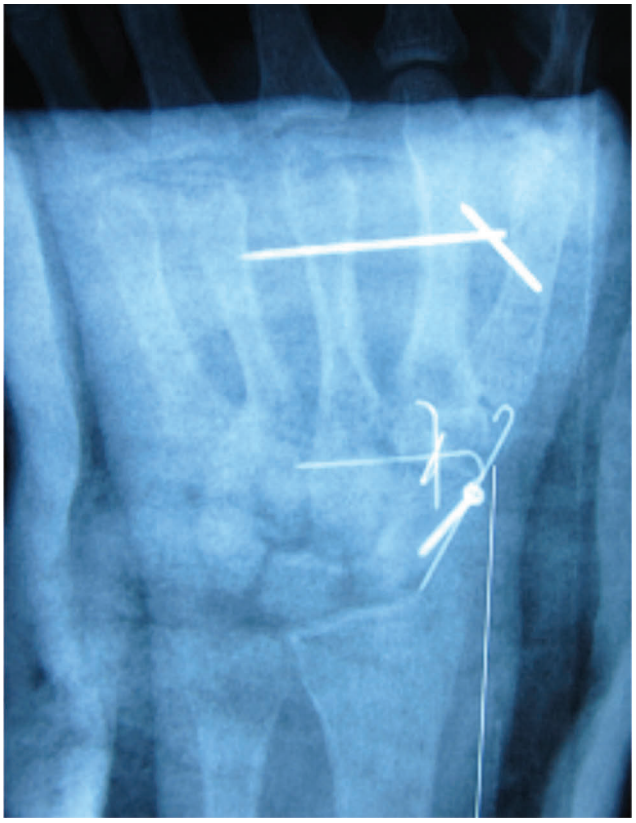

Fig. 5 Postoperative X-ray of the wrist, posterior-anterior view.

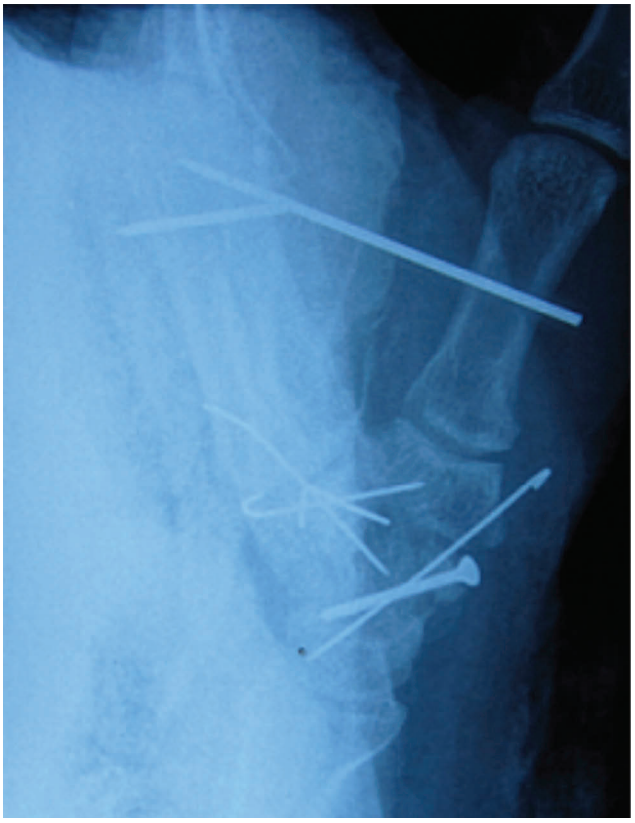

Fig. 6 Postoperative X-ray of the wrist, lateral view.

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Fig. 7 Postoperative X-ray of the wrist, posterior-anterior view after 3 weeks.

Fig. 8 Postoperative X-ray of the wrist, lateral view after 3 weeks.

Fig. 9 (A–F) Clinical picture of patient after 6 weeks.

Discussion

This case shows the complexity of the fracture pattern and difficulties in management of this fracture morphology. The authors postulate the injury mechanisms as combination of axial compressive and torsion forces. The accurate diagnosis and understanding of these injuries are difficult in plain X-rays due to the bone superposition of carpal bones. CT scan is recommended as part of the diagnostic protocol without delaying the initial emergency management.[1,3,8] The CT scan helps delineate even the subtle fractures and dislocations. CT scan also helps chalk out the surgical plan. Because of the amount of energy transmitted in ARU, the associated injuries are present almost in all cases, including neurovascular injuries that define the viability and outcome of the hand. Fortunately in this case, there was no neurovascular deficit. Compartment syndrome and loss of soft tissue cover are concerning problems in such injuries. They not only affect the rehabilitation protocol but also jeopardize the final outcome. In ARU cases because of the extensive carpal damage, fibrotic scar formation

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occurs between carpal bones and muscular compartments. In such injuries, carpal instability is likely to happen, leading to restriction of movements. Early mobilization and an intensive rehabilitation protocol are needed to obtain a good functional outcome. In this case, compartment syndrome and loss of soft tissue coverage were not major problems. The TFR in this case was avulsed, so no separate surgical carpal tunnel decompression was required.[1,3] The ARU fracture dislocations are the type of axial injuries with more complications and worst prognosis, due to the extensile carpal involvement and soft tissue damage. In 2013, Garcia-Elias[3] said that the injury pattern will depend on the angle formed between the applied force and plain of the joint surface, speed, magnitude, force entrance point, and relative strength of bone and ligament structures. The ARU fracture involves combination of mechanism of injury. In ARU fracture dislocation, one side of the injury is always produced before the other. Direct violence is the most common mechanism of injury for carpometacarpal dislocation. Whether volar or dorsal dislocation occurs is determined by direction of force. Shorbe[9] demonstrated that carpometacarpal dislocations were not possible unless both the anterior and posterior ligaments are ruptured. Waugh and Yancey[10] opined that these dislocations result from direct force applied to the bases of metacarpals, and the resulting palmar or dorsal dislocation was determined by the direction of the force. Gunther[11] suspected a rotation mechanism, with the hand firmly fixed and forces causing the carpus to rotate on a fixed metacarpal base.

Understanding the injury mechanism can help us know the injury pattern and suspect for specific associated injuries, which would in turn help us in our decision making and in the sequential reduction and fixation algorithm. In this case, the mechanism of injury is complex involving axial and torsion forces. The starting point was his first and second fingers, producing torsion force advancing further producing fracture and dislocation of proximal and distal row of carpals.

Kumar et al[12] described the need to apply a torsion force to achieve a "divergent variant" of multiple carpometacarpal dislocations in which divergence is defined as one or more joints dislocating volarly with concomitant dislocation dorsally of one or more joints.

The complex sequence of events includes supination and flexion at wrist, leading to stresses on midcarpal joint. Torsion force produces stresses in the different plane, mainly in distal carpal bones. The axial compressive force displaces the proximal pole of scaphoid dorsally, and excessive stress leads to scaphoid fracture. Distraction of the first ray and concomitant palmodorsal pressure forced the trapezium dorsally with failure of the trapezium-trapezoid and scaphotrapezial ligaments, leading to divergent trapezium trapezoid dissociation. Finally, the anterior oblique ligaments and trapeziometacarpal ligaments at the first metacarpal base failed, resulting in dissociation of the first metacarpal from the second metacarpal and trapezium. The flexor transverse retinaculum is torn due to such fracture dislocations. On the ulnar axis, these forces cause injury to the triangular fibrocartilage complex (TFCC) and ulna styloid. The patient fortunately did not have any neurovascular deficit.

Principal concerns in such complex carpal dislocations include reduction in fracture dislocations and early soft tissue cover. Use of a dorsal approach is usually sufficient for reduction and fixation of fractures and dislocations. In this case, however, a combined dorsal and palmar approach was necessary due to fracture of scaphoid and divergent dissociation of trapezium and trapezoid. Meticulous surgical planning is essential for orderly fracture reduction and fixation. Once the fractures are fixed, joint reduction and pinning follow sequentially. Scaphotrapeziotrapezoid (STT) fusion after stabilization of scaphoid fracture gives carpal stability. Pinning of trapezium-trapezoid joint after fracture dislocation gives added stability. The suspension K-wiring maintains the joint and ligaments in position. These surgical interventions help in early mobilization of wrist.

Last, the divergent trapezium-trapezoid joint with scaphoid fracture is not yet described in the literature. The principal consideration involves emergent fracture reduction and soft tissue cover. Noncontrast CT of the wrist is a radiologic investigation of choice, which is essential to assess the fracture morphology. Surgical planning is essential for management of such complex injuries. Fracture reduction and fixation with pinning of other dislocated joint stabilize the carpal in such fracture morphology and help in early mobilization.

Conflict of Interest

None.

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