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Case Report

Pure traumatic unstable radiocarpal dislocation over pre-existing ulnar impingement syndrome, extensively arched carpus and medially rotated scaphoid: An exceptional and complex case report

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ABSTRACT

Introduction and importance: Radiocarpal dislocation is a rare and severe injury that demands urgent diagnosis and treatment. In this case report, we present the unique scenario of a 32-year-old male who suffered a traumatic pure unstable radiocarpal dislocation. This dislocation was associated with ulnar impingement syndrome, an extensively arched carpus, and a medially rotated scaphoid. The complexity of this injury underscores the importance of timely intervention and comprehensive management.

Case presentation: The patient had a pre-existing short ulnar head with radial-sided deformity, radioulnar convergence, negative ulnar variance, erosive scalloping of the distal radius, subchondral sclerosis of the ulnar head, scapholunate diastasis, and distal radioulnar joint (DRUJ) diastasis. Following a high-velocity motor vehicle accident, the initial treatment involved closed reduction and radio-metacarpal external fixation. Additionally, surgical intervention was required for an open dislocation of the metatarsophalangeal (MTP) joint of the left hallux.

Clinical discussion: The subsequent management of this complex case included the Sauvé-Kapandji procedure, ulnolunate and ulnotriquetral ligamentoplasty using the palmaris longus tendon, and scapholunate fusion. The patient reported no prior wrist instability or injury upon awakening, but mild mechanical wrist pain persisted after exertion. Follow-up assessments revealed residual pain during prono-supination, along with slightly limited radial inclination. This exceptional case highlights the biomechanical challenges and the need for a multidisciplinary approach in treating such injuries.

Conclusion: To the best of our knowledge, this is the first documented instance of a traumatic pure unstable radiocarpal dislocation associated with ulnar impingement syndrome, an extensively arched carpus, and a medially rotated scaphoid. Despite the complexity, proper bone healing and favorable functional outcomes were achieved through meticulous surgical management. This case underscores the importance of individualized treatment strategies for rare and challenging wrist injuries.

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Background

Radiocarpal dislocation is a rare injury that accounts for <1 % of all wrist injuries [1,2]. It is defined as a complete disruption of the radiocarpal joint with loss of contact between the distal radius and the proximal carpal row [3]. It can be classified into four types according to the direction of displacement: dorsal, volar, medial, and lateral. The most common type is dorsal, followed by volar, while medial and lateral types are extremely rare [1,3]. Radiocarpal dislocation is usually associated with other injuries such as fractures of the distal radius, ulna, or carpal bones, ligamentous injuries, or soft tissue injuries. The mechanism of injury is usually a high-energy trauma such as a fall from a height, a motor vehicle accident, or a sports injury. The diagnosis is based on clinical and radiological findings, and the treatment is usually surgical, aiming to restore the anatomy and stability of the radiocarpal joint [1,3,4,5].

Ulnar impingement syndrome is a wrist condition caused by a shortened distal ulna impinging on the distal radius proximal to the sigmoid notch [6]. Ulnar impingement syndrome is distinct from ulnar impaction syndrome, which typically occurs due to a long ulna (positive ulnar variance) impacting upon the triangular fibrocartilage complex (TFCC) and lunate [7]. Ulnar impingement syndrome can result from surgical resection of the distal ulna, as in the Darrach procedure or the Sauvé-Kapandji procedure, or from de novo negative ulnar variance [6,7]. Ulnar impingement syndrome can cause pain, swelling, crepitus, and limitation of forearm rotation, especially in pronation and supination. The diagnosis of ulnar impingement syndrome is based on clinical examination and radiographic evaluation, which may show ulnar shortening, radioulnar convergence, subchondral sclerosis, and erosive scalloping of the distal radius [7]. The treatment of ulnar impingement syndrome depends on the etiology and severity of the condition, and may include conservative measures, such as activity modification, splinting, and medication, or surgical interventions, such as ulnar lengthening, ulnar head replacement, or revision of the previous distal ulnar resection [8,9].

Extensively arched carpus and medially rotated scaphoid are rare congenital anomalies of the wrist that may be associated with other skeletal deformities, such as Madelung deformity, radial club hand, or ulnar dysplasia [10–12]. Extensively arched carpus is characterized by an increased curvature of the carpal row, resulting in a convex shape of the proximal carpal row and a concave shape of the distal carpal row. Medially rotated scaphoid is characterized by a rotation of the scaphoid around its long axis, resulting in a medial displacement of the scaphoid tubercle and a lateral displacement of the scaphoid waist [13–16]. These anomalies may cause abnormal biomechanics of the wrist, leading to pain, stiffness, instability, and degenerative changes. The diagnosis of extensively arched carpus and medially rotated scaphoid is based on clinical examination and radiographic evaluation, which may show an increased scapholunate angle, an increased scaphocapitate angle, and an abnormal alignment of the carpal bones [13,16]. The treatment of extensively arched carpus and medially rotated scaphoid depends on the symptoms and functional impairment of the patient, and may include conservative measures, such as splinting, physiotherapy, and medication, or surgical interventions, such as osteotomy, arthrodesis, or arthroplasty [10,13,17].

To the best of our knowledge, there is no previous report of a traumatic pure unstable radiocarpal dislocation associated with ulnar impingement syndrome, extensively arched carpus, and medially rotated scaphoid in humans. We present a rare and complex case of such a condition in a 35-year-old male patient who sustained a high velocity motor vehicle accident, and we discuss the biomechanical aspects, the surgical management, and the literature review of this exceptional case. This report has been written in line with the

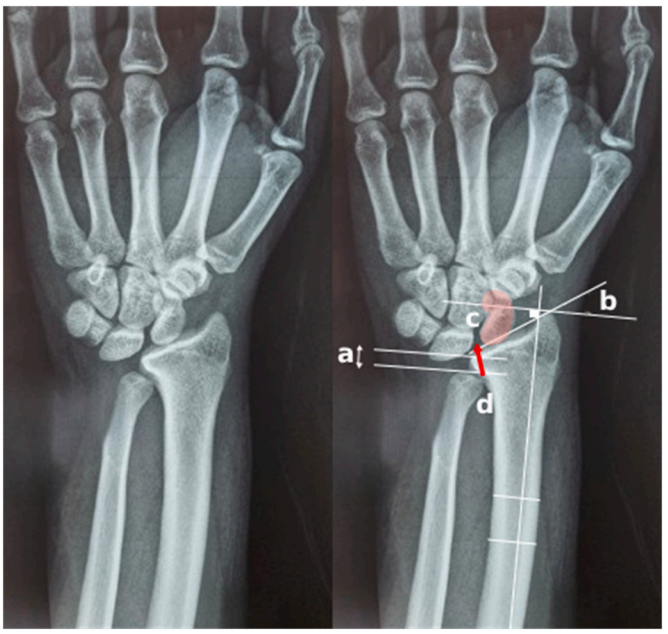

Fig. 1. AP X-ray of the wrist dislocation **(a)** ulnar variance −4.5 mm **(b)** normal volar tilt 30° **(c)** scaphoide medially rotated **(d)** scapholunate diastasis.

SCARE criteria [18].

Case presentation

A 35-year-old male patient was brought to the emergency department after sustaining a high velocity motor vehicle accident. He was the driver of the car and was not wearing a seat belt. He presented with polytraumatism, severe head injury, right upper limb and left lower limb trauma. His Glasgow Coma Scale (GCS) score was 11/15 and he was agitated and uncooperative. He was intubated and sedated and transferred to the intensive care unit. His vital signs were stable and his laboratory tests were normal. His initial clinical examination revealed a dislocated right wrist and an open dislocation of the metatarsophalangeal (MTP) joint of the left hallux. There was no neurovascular compromise of the right upper limb or the left lower limb. The rest of the physical examination was unremarkable.

The initial radiological examination showed a pure medial and volar radiocarpal dislocation of the right wrist, with no associated fractures of the distal radius, ulna, or carpal bones (Moneim type II and Dumontier Type I) [1,3] (Fig. 1). The radiological findings also showed a short ulnar head with radial-sided deformity, radioulnar convergence, erosive scalloping of distal radius, subchondral sclerosis of ulnar head, medial rotation of the scaphoid with the scaphoid tubercle located medially, extensively arched carpus, scapholunate diastasis, DRUJ diastasis, an increased scapholunate and scaphocapitate angles, a dorsal intercalated segment instability (DISI), and a trapezoid that articulated medially with the left aspect of scaphoid tubercle rather than its distal aspect (Fig. 1). The elbow and forearm radiographs were normal. The contralateral wrist radiographs were normal (Fig. 2).

The initial management consisted of closed reduction and radio-metacarpal external fixation of the right wrist. The reduction was achieved by applying traction and pressure on the carpus in a dorsal and lateral direction, while maintaining the wrist in flexion and ulnar deviation (Fig. 3). The stability of the reduction was assessed by passive and active movements of the wrist and the fingers. The external fixator was locked in a neutral position of the wrist. The reduction and fixation were confirmed by postoperative radiographs (Fig. 4). The patient was also treated for the left hallux open dislocation, which required surgical exploration, debridement, and serum rinsing, followed by reduction. The patient received prophylactic antibiotics and tetanus immunization.

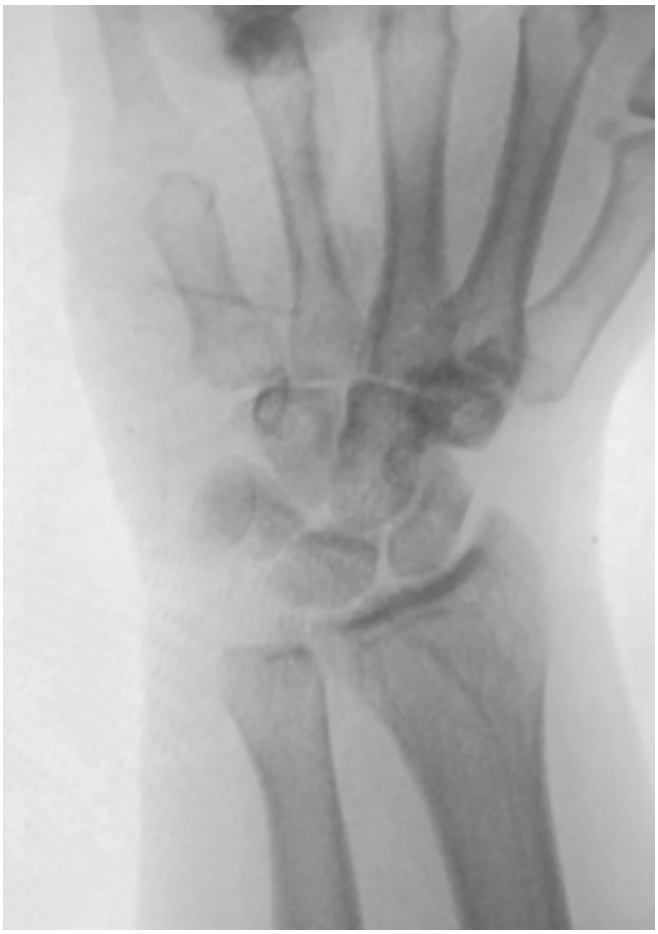

Fig. 2. AP X-ray of the controlateral side shows a normal wrist.

The patient was kept under medically induced general anesthesia in the intensive care unit for 10 days, due to his severe head injury. He underwent a computed tomography (CT) scan of the brain, which revealed a non-operative extra dural hematoma and meningeal hemorrhage. He was gradually weaned off sedation and extubated, and his neurological status improved. He was then transferred to the orthopedic ward, where he received physiotherapy and occupational therapy. After the patient's awakening, he reported no previous injury or trauma of the right wrist, and no previous episodes of wrist instability or dislocation. He also reported suffering from mild mechanical wrist pain after major efforts, with a slight limitation of the supination movement. He denied any history of congenital anomalies, rheumatoid arthritis, or gout. He had no family history of wrist disorders.

The follow-up radiological examination showed a satisfactory reduction and alignment of the radiocarpal joint, but a persistent ulnar impingement syndrome, an extensively arched carpus and a medially rotated scaphoid. The patient was informed about the nature and the severity of his injury and the possible treatment options. He consented to undergo a subsequent surgery to address the ulnar impingement syndrome, the arched carpus and the scaphoid rotation. The patient was scheduled for a definitive surgical treatment of his right wrist, which was performed 4 weeks after the initial injury. The surgery consisted of three steps: Sauvé-Kapandgi procedure, ulnolunate and ulnotriquetral ligamentoplasty using palmaris longus tendon, and scapholunate fusion. The surgery was performed under general anesthesia and tourniquet control, using a dorsal approach. The external fixator was removed, and the radiocarpal joint was exposed. The joint was found to be unstable and incongruent. The scapholunate ligament was found to be elongated but not ruptured with no macroscopic evidence of injury. The Sauvé-Kapandgi procedure was performed by resecting the distal 1 cm of the ulna, creating a pseudarthrosis between the ulnar stump and the ulnar head, and stabilizing the DRUJ with two 2.4 mm cortical screws [19,20]. The ulnolunate and ulnotriquetral ligamentoplasty was performed by harvesting the palmaris longus tendon, passing it through drill holes in the ulnar stump, the lunate, and the triquetrum, and suturing it in a tensioned fashion using two suture anchors [17,21]. The scapholunate fusion was performed by debriding the scapholunate joint, inserting a cancellous bone graft harvested from the distal radius, and fixing the scaphoid and the lunate with two headless compression screws [15,22]. The wound was closed in layers and a long arm splint was applied. The surgery was uneventful and the intraoperative radiographs confirmed the adequacy of the procedures (Fig. 5).

The patient was followed up regularly in the outpatient clinic. The long arm splint was replaced by a short arm splint after 8 weeks, The patient was allowed to start active and passive range of motion exercises of the wrist and the forearm and the patient was encouraged to resume his daily activities. The radiographs showed proper bone healing and no signs of infection, nonunion, or hardware failure (Fig. 5). The patient reported significant improvement in his pain and function of the right wrist. He was able to perform most of his personal and professional tasks without difficulty. He was satisfied with the cosmetic appearance of his wrist and had no complaints of ulnar impingement or instability. The patient was evaluated at 6 months and 12 months after the surgery, with a Patient-Rated Wrist Evaluation (PRWE) score of 15 [23], a Disabilities of the Arm, Shoulder and Hand (DASH) score of 18 [24], and a Visual Analog Scale (VAS) of 2 for pain. The radiographs showed no changes in the bone alignment or the hardware position (Fig. 5).

Discussion

We have presented a rare and complex case of a traumatic pure unstable radiocarpal dislocation associated with ulnar impingement syndrome, extensively arched carpus, scapholunate diastasis and medially rotated scaphoid in a 35-year-old male patient who sustained a high velocity motor vehicle accident. We have performed a detailed biomechanical description of this exceptional case and

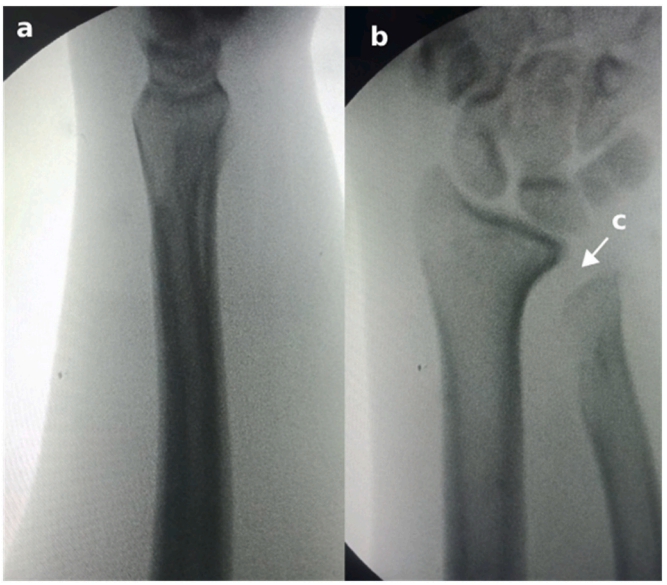

Fig. 3. fluoroscopic image of the dislocation reduction (a) lateral view (b) AP view (c) DRUJ diastasis.

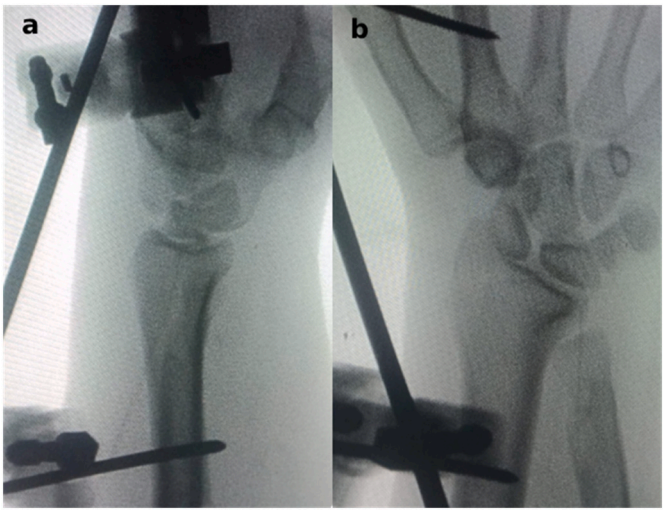

Fig. 4. fluroscopic image of external fixation (a) lateral view (b) AP view.

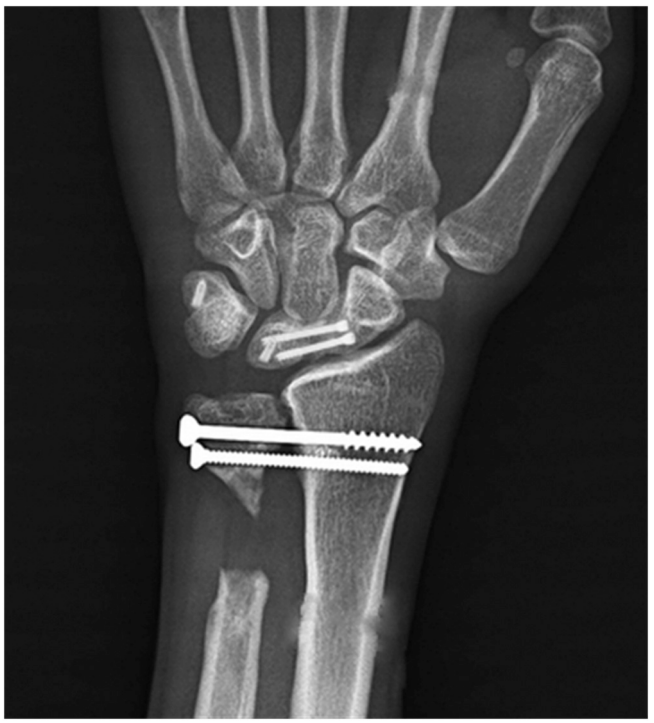

Fig. 5. 12 months follow-up AP wrist X-ray.

discussed the surgical management and the literature review.

The biomechanical description of this case reveals several interesting and unusual features. First, the mechanism of injury of the radiocarpal dislocation is unclear, as the patient had no recollection of the accident and no witnesses were available. However, based on the direction of displacement of the carpus, we can assume that the patient applied a strong force on his right wrist in a flexion, ulnar deviation, and pronation direction, while his forearm was fixed by the impact with the ground. This force caused a shear stress on the radiocarpal joint, resulting in a pure medial and volar dislocation of the carpus, without any associated fractures of the distal radius, ulna, or carpal bones [1,2,4,5,25]. This type of dislocation is extremely rare, as most of the reported cases of radiocarpal dislocation involve dorsal or volar displacement of the carpus, with or without associated fractures. The rarity of the medial and lateral types of radiocarpal dislocation may be explained by the stronger ligamentous support of the medial and lateral aspects of the radiocarpal joint, compared to the dorsal and volar aspects [17,26]. The radiocarpal dislocation was pure and medial, meaning that the radial carpal

ligaments were intact whereas the medial ligaments were under-tension, then ruptured or was ruptured or absent in association with pre-existing conditions. The radiocarpal dislocation was unstable, meaning that the reduction was difficult and the fixation was necessary, because the pre-existing conditions created a loss of congruency and a loss of contact between the distal radius and the proximal carpal row.

Second, the radiological findings of the right wrist showed several anomalies that were not related to the trauma, but rather to a congenital or developmental origin. These anomalies included a short ulnar head with radial-sided deformity, radioulnar convergence, erosive scalloping of distal radius, subchondral sclerosis of ulnar head, medial rotation of the scaphoid with the scaphoid tubercle located medially, extensively arched carpus, and a trapezoid that articulated medially with the left aspect of scaphoid tubercle rather than its distal aspect. These anomalies are suggestive of a variant of ulnar impingement syndrome, which is a condition characterized by chronic wrist pain due to impingement of the distal ulna on sigmoid notch of the distal radius [6,7]. The etiology of ulnar impingement syndrome can be classified into two types: acquired or congenital. The acquired type is more common and can be caused by various factors such as negative ulnar variance, ulnar head shortening, DRUJ instability, or previous wrist surgery [6,8]. The congenital type is less common and can be caused by congenital anomalies of the distal ulna, such as ulnar club hand, Madelung deformity, or hereditary multiple exostoses [6,7]. In our case, the patient had no history of previous wrist surgery or trauma, and no evidence of ulnar club hand, Madelung deformity, or hereditary multiple exostoses. Therefore, we hypothesize that the patient had a congenital anomaly of the distal ulna, which resulted in a short ulnar head with radial-sided deformity, radioulnar convergence, erosive scalloping of the distal radius, subchondral sclerosis of ulnar head, and ulnar impingement syndrome. The patient was asymptomatic or mildly symptomatic before the trauma, as he reported only mild mechanical wrist pain after major efforts, with a slight limitation of the supination movement. The trauma may have aggravated his condition and caused more pain and dysfunction.

Third, the radiological findings of the right wrist also showed a medial rotation of the scaphoid with the scaphoid tubercle located medially, extensively arched carpus, scapholunate diastasis, and a trapezoid that articulated medially with the left aspect of scaphoid tubercle rather than its distal aspect. These anomalies are suggestive of a variant of arched carpus or dorsal intercalated segment instability (DISI) [12–14,16]. The etiology of arched carpus is unknown, but it is speculated that it may be related to abnormal development of the carpal anlage or abnormal mechanical forces during fetal life. The clinical presentation of arched carpus varies from asymptomatic to severe wrist deformity and dysfunction. In our case, the patient had no history of congenital anomalies, rheumatoid arthritis, or gout. He had no family history of wrist disorders. He was asymptomatic or mildly symptomatic before the trauma, as he reported only mild mechanical wrist pain after major efforts, with a slight limitation of the supination movement. The trauma may have aggravated his condition and caused more pain and dysfunction.

Fourth, the radiological findings of the right wrist also showed a scapholunate diastasis, which is a condition characterized by a disruption of the scapholunate ligament, which is the main stabilizer of the scapholunate joint. The scapholunate diastasis can be caused by acute trauma, chronic repetitive stress, or degenerative changes. It can lead to instability of the scapholunate joint, which can progress to SLAC or SNAC [13,15]. The clinical presentation of scapholunate diastasis includes pain, swelling, and decreased range of motion of the wrist, especially in dorsiflexion and radial deviation. The radiological findings of scapholunate diastasis may show a widened scapholunate gap, a positive Terry Thomas sign, a DISI deformity, or degenerative changes of the radiocarpal and midcarpal joints [15]. In our case, the patient had no history of previous wrist injury or instability, and no evidence of SLAC or SNAC. He was asymptomatic before the trauma, as he reported only mild mechanical wrist pain after major efforts, with a slight limitation of the supination movement. The scapholunate ligament in our case was found to be elongated but not ruptured with no macroscopic evidence of injury. Therefore we decided to fuse the join to increase the carpus stability and improve the transversal arch morphology.

Fifth, the radiological findings of the right wrist also showed an increased scapholunate and scaphocapitate angles, along with the presence of scapholunate diastasis and medial rotation of the scaphoid. The scapholunate angle and the scaphocapitate angle are two important parameters that reflect the orientation and the stability of the scaphoid bone. The normal values of these angles are $47 \pm 9^{\circ}$ and $35 \pm 9^{\circ}$, respectively. The scapholunate angle and the scaphocapitate angle can be altered by various factors, such as scaphoid rotation, scaphoid fracture, scaphoid nonunion, scapholunate ligament injury, or carpal malalignment [13–16]. In our case, the patient had a scapholunate ligament injury and a medial rotation of the scaphoid, which would be expected to increase the scapholunate angle and decrease the scaphocapitate angle, respectively. This is suggestive dorsally intercalated segment instabilitity (DISI), yet, one cannot determine with certainty wether the DISI instability was pre-existing, associated with the other wrist deformities or acquired with the recent trauma.

The surgical management of this case was challenging, as it required a combination of three procedures: Sauvé-Kapandgi procedure, ulnolunate and ulnotriquetral ligamentoplasty using palmaris longus tendon, and scapholunate fusion. The rationale behind these procedures was to address the different aspects of the patient's condition: the Sauvé-Kapandgi procedure was performed to treat the ulnar impingement syndrome and to improve wrist stabilit [19,20], in adjunction with ulnolunate and ulnotriquetral ligamentoplasty which was performed to restore the stability and congruency of the ulnocarpal joint [17,21,26], and the scapholunate fusion was performed to treat the scapholunate diastasis and prevent the progression of SLAC or SNAC [22]. The Sauvé-Kapandgi procedure is a well-established technique for the treatment of ulnar impingement syndrome, which involves the resection of the distal ulna, the creation of a pseudarthrosis between the ulnar stump and the ulnar head, and the stabilization of the DRUJ [20]. The advantages of this procedure are that it preserves the length of the ulna, maintains the mobility of the DRUJ, and avoids the complications of ulnar head prosthesis, such as loosening, infection, or fracture [20,27]. The disadvantages of this procedure are that it may cause instability or pain of the pseudarthrosis, or impingement of the ulnar stump on the carpus [27]. The ulnolunate and ulnotriquetral ligamentoplasty is a technique that aims to reconstruct the ulnocarpal ligaments using a tendon graft, in order to restore the stability and congruency of the ulnocarpal joint [17,21]. The advantages of this technique are that it preserves the anatomy and function of the ulnocarpal joint, and avoids the complications of partial or complete wrist fusion, such as stiffness, nonunion, or hardware failure. The

disadvantages of this technique are that it may cause donor site morbidity, graft failure, or recurrence of instability [17]. The scapholunate fusion is a technique that aims to fuse the scaphoid and the lunate bones, in order to treat the scapholunate diastasis and prevent the progression of SLAC or SNAC. The advantages of this technique are that it eliminates the pain and instability of the scapholunate joint, and preserves some degree of wrist motion, compared to complete wrist fusion. The disadvantages of this technique are that it may cause nonunion, hardware failure, or degenerative changes of the adjacent joints [15,22].

This case report describes a rare and complex injury of a traumatic pure unstable radiocarpal dislocation associated with ulnar impingement syndrome, extensively arched carpus and medially rotated scaphoid. To the best of our knowledge, this is the first case report of this injury in the literature.

Conclusion

We report a rare and complex case of a traumatic pure unstable radiocarpal dislocation associated with ulnar impingement syndrome, extensively arched carpus and medially rotated scaphoid in a 32-year-old male patient who sustained a high velocity motor vehicle accident. The patient underwent a staged surgical management consisting of a closed reduction and radio-metacarpal external fixation, followed by a Sauvé-Kapandji procedure, ulnolunate and ulnotriquitral ligamentoplasty using palmaris longus tendon, and scapholunate fusion. The patient had a satisfactory recovery with good functional and pain outcomes at short and mid term follow-up. To our knowledge, this is the first case report of such a combination of injuries and surgical procedures in the literature. This case illustrates the importance of a thorough clinical and radiological evaluation of the wrist in cases of radiocarpal dislocation, as well as the need for a tailored surgical approach that addresses the specific features and challenges of the distal radioulnar joint and the intercarpal joints. This case also demonstrates the feasibility and effectiveness of a staged surgical approach that allows for adequate reduction and fixation of the radiocarpal joint, followed by a definitive reconstruction of the distal radioulnar joint and the scapholunate joint.

Statement of human and animal rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5). Informed consent was obtained from the patient for being included in the study.

Statement of informed consent

Written informed consent was obtained from the patient for his anonymized information to be published in this article.

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CRediT authorship contribution statement

Chabihi Zakaria: Writing – review & editing, Writing – original draft, Resources, Methodology, Investigation, Data curation, Conceptualization. **Tariq Aalil:** Data curation. **Brahim Demnati:** Validation. **Yassine Fath El Khir:** Supervision. **Benhima Mohamed Amine:** Supervision. **Abkari Imad:** Supervision.

Declaration of competing interest

The authors declare that there is no conflict of interest.

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