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Case Report

Traumatic Volar Carpal Instability Nondissociative: A Case Series

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Carpal instability nondissociative (CIND) involves disruption between carpal rows from injury to extrinsic and intrinsic wrist ligaments. CIND traumatic (CINDT) highlights the posttraumatic etiology of some of these cases and has been gaining increasing attention in the literature. We present four cases of CINDT-volar intercalated segmental instability (VISI). We diagnosed two adults with distal radius fractures and two adolescents with Galeazzi fractures, all treated surgically, who developed CINDT-VISI with radiolunate angles greater than 15° at 2 weeks after surgery. One adult had progressive deformity but was asymptomatic at 33 months. The other underwent volar capsular release at 1 year to improve alignment. One adolescent with a fixed deformity required soft tissue releases and temporary pinning to restore alignment at 7 months. We treated the other successfully with early physiotherapy. No patient had radiographic signs of arthritis at 1–2 years. This is the first reported association between Galeazzi fractures and CINDT-VISI. Contrary to existing literature, we report successful outcomes with nonsurgical and delayed nonfusion surgery of CINDT-VISI.

Carpal instability nondissociative (CIND) involves disruption of the relationship between carpal rows at the radiocarpal, midcarpal, or both articulations. In contrast to carpal instability dissociative, in which there is disruption between the bones within a single carpal row (eg, scapholunate or lunotriquetral disruption), each carpal row continues to move as a unit.[1] The deformity may be volar (CIND-volar intercalated segmental instability [VISI]) or dorsal (CIND-dorsal intercalated segmental instability [DISI]).[1]

Posttraumatic CIND deformity has been described in several case reports in the last four decades.[2–8] Injuries associated with CIND include distal radius fractures,[5,6,8] radiocarpal fracture dislocations,[6] triangular fibrocartilage complex injuries,[8] scaphoid fractures,[2,7] and capsular and/or ligamentous wrist injuries.[2,3,8] Recently, Loisel et al[7] and Fok et al[6] coined the term CIND traumatic (CINDT) to highlight the traumatic origin of these injuries. They defined CINDT-DISI as a radiolunate angle of more than 15° extension and CINDT-VISI as a radiolunate angle of more than 15° to 20° flexion with no scapholunate and lunotriquetral interosseous ligament disruption, as indicated by a normal (30° to 60°) scapholunate angle.[6,7]

In accordance to CAse REport (CARE) guidelines and with approval from our institutional review board, we report four cases of CINDT-VISI that developed after distal radius or Galeazzi fractures. Written informed consent was obtained from all patients for publication of this case series and the accompanying images. To our knowledge, this is the first report of an association between Galeazzi fractures and CINDT-VISI. Additionally, in contrast to previous literature, we report two cases of persistent CINDT-VISI deformity after distal radius fracture, which were successfully managed nonsurgically, with no evidence of clinical or radiographic arthritis at final follow-up.

Case Reports

Case 1

A 29-year-old left hand–dominant healthy man fell on his outstretched hand while playing cricket, sustaining an isolated, closed, neurovascularly intact left distal radius fracture (Fig. 1). Four days later, we performed volar locked plating, and he was immobilized in a splint for 6 weeks. A CINDT-VISI deformity was noted at

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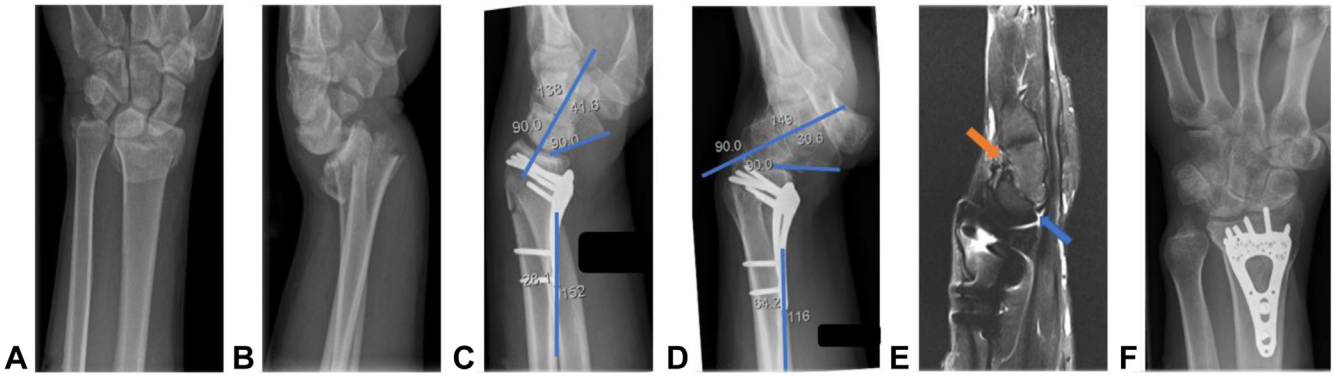

Figure 1. Case 1: **A** AP and **B** lateral initial injury films of case 1, demonstrating a comminuted, dorsally angulated, intra-articular distal radius fracture with extension into the sigmoid notch and ulnar styloid fracture. Lateral radiographs at **C** 2 weeks and **D** 33 months after surgery, demonstrating radiolunate angles of 28.1° and 64.2°, respectively, with normal scapholunate angles of 41.6° and 30.6°, respectively. **E** Magnetic resonance arthrography shows disruption of the dorsal radiocarpal ligament (orange arrow) and lunocapitate capsule (blue arrow); metal artifact limits assessment of the lunotriquetral ligament. **F** AP and **D** lateral radiographs at final follow-up (33 months) show no signs of arthritis. AP, anteroposterior.

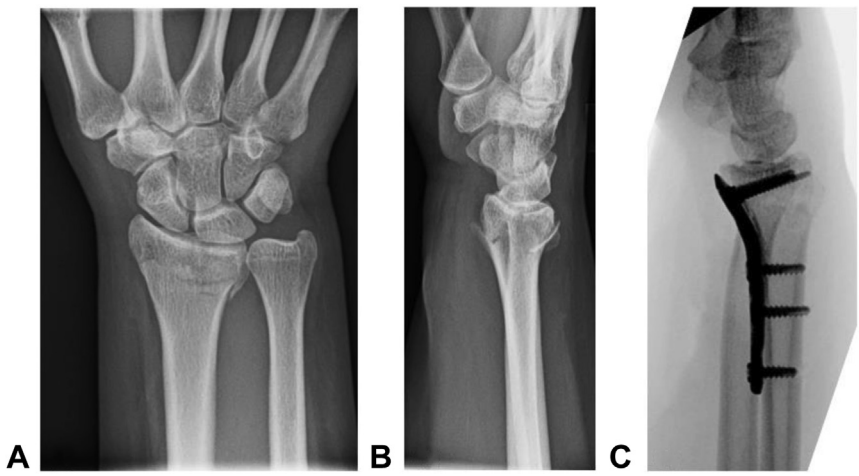

Figure 2. Case 2, part 1: **A** anteroposterior and **B** lateral initial injury films of case 2, showing a comminuted, dorsally angulated, intra-articular distal radius fracture with extension into the sigmoid notch. **C** Intraoperative image after volar locked plating demonstrating normal carpal alignment.

2 weeks after surgery with a radiolunate angle of 28.1°, which progressed to 64.2° by 33 months (Fig. 1). Scapholunate angle was preserved (Fig. 1). Magnetic resonance arthrography showed disruption of the dorsal radiocarpal ligament and volar lunocapitate capsule (Fig. 1). At final follow-up 33 months after surgery, his range of motion was 45° wrist flexion and 30° extension with full pronosupination. He reported no pain and was able to return to all activities and was, therefore, not interested in further treatment.

Case 2

A 52-year-old right hand–dominant woman with ankylosing spondylitis slipped and fell on ice, sustaining an isolated, closed, neurovascularly intact right distal radius fracture (Fig. 2). Three days later, we performed volar locked plating, and she was immobilized in a splint for 6 weeks (Fig. 2). A CIND-VISI deformity was noted at 2 weeks after surgery, which progressed to a radiolunate angle of 29.2° by 1 year (Fig. 3). Scapholunate angle was preserved (Fig. 3). She underwent early, aggressive physiotherapy and achieved 80° of wrist extension and 75° flexion with full pronosupination. One year after initial surgery, she underwent hardware removal because of irritation. Volar capsular release has been shown to be safe[9,10] and was concurrently performed in this patient to improve her CINDT-VISI deformity from a radiolunate angle of 32.5° to 28.7° (Fig. 3). Her radiolunate angle was 26.6° at 1 year after hardware removal, with no radiographic signs of arthritis 2 years after initial injury (Fig. 3). She did not have significant limitation of motion or functional limitations, and no further intervention was performed.

Case 3

A 14-year-old right hand–dominant healthy boy fell off his bike, sustaining an isolated, closed, neurovascularly intact left Galeazzi fracture (Fig. 4). Four days later, we performed volar locked plating of the radius; open reduction and pinning of the ulnar head, neck, and ulnar styloid; and pinning of the distal radioulnar joint for 6 weeks (Fig. 4). He was immobilized above elbow for 2 weeks, followed by a Muenster cast for 4 weeks. A CINDT-VISI deformity was noted at 2 weeks after surgery, which progressed to a radiolunate angle of 63.8° by 6 months (Fig. 5). Scapholunate angle was preserved (Fig. 5). Despite a course of physiotherapy, his range of motion remained at 25° wrist extension and 65° flexion with full pronosupination. Magnetic resonance arthrography showed extensive intra-articular adhesions and volar capsular contracture with dorsal radiocarpal ligament disruption but no lunotriquetral

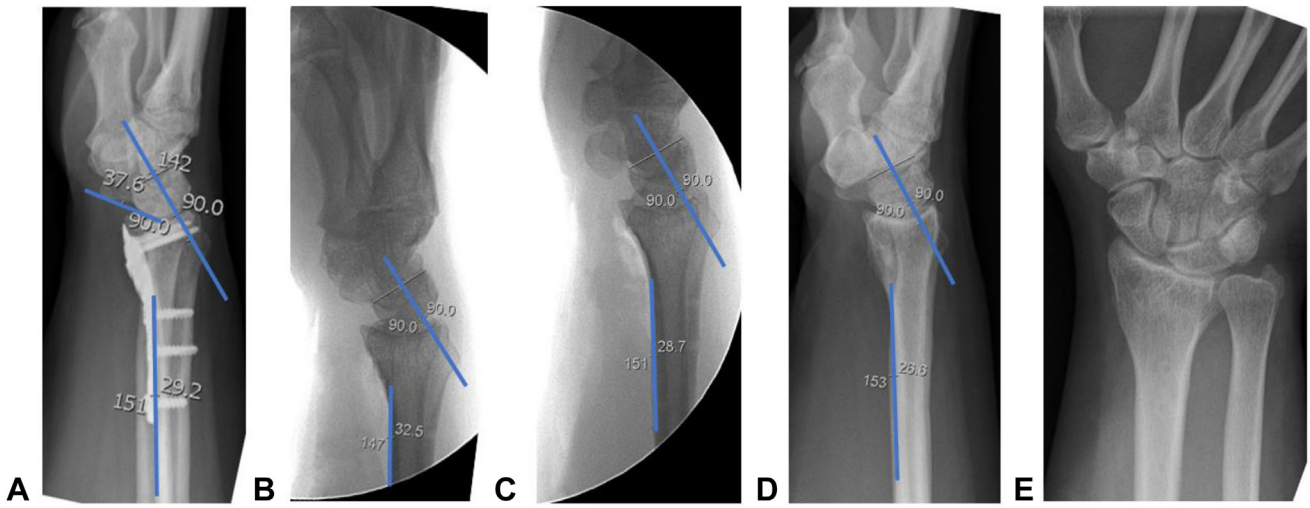

Figure 3. Case 2, part 2: **A** lateral wrist radiographs of case 2, demonstrating a CIND-VISI deformity, with a radiolunate angle of 29.2° with a normal scapholunate angle of 37.6° at 1 year after surgery. The patient underwent **B** hardware removal and **C** volar capsular release at 1 year, resulting in improvement of the radiolunate angle from 32.5° to 28.7°. This improvement remained stable at 1 year after hardware removal, with a radiolunate angle of 26.6°. **E** Anteroposterior and **D** lateral radiographs at final follow-up (2 years) show no signs of arthritis. CIND, carpal instability nondissociative; VISI, volar intercalated segmental instability.

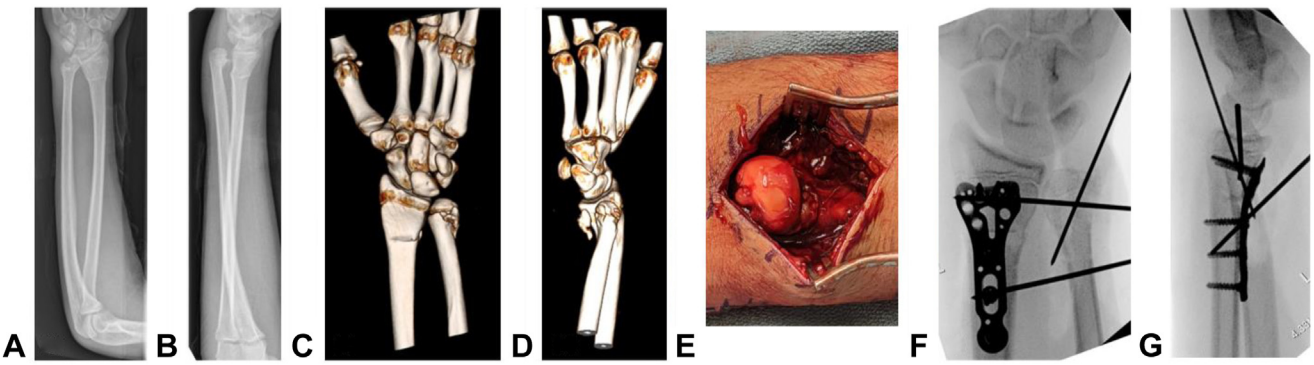

Figure 4. Case 3, part 1: **A** AP and **B** lateral initial injury films and **C** and **D** select computed tomography three-dimensional reconstructions of case 3, demonstrating a Galeazzi variant with a radial shaft buckle fracture and complete dislocation of the distal radioulnar joint and ulnar styloid fracture. **E** Intraoperative photo and **F** fluoroscopic AP and **G** lateral images of case 3 showing initial distal radioulnar joint dislocation and subsequent fixation and reduction of the Galeazzi fracture. AP, anteroposterior.

ligament injury (Fig. 5). Seven months after surgery, he underwent further surgery. Intraoperatively, fluoroscopic examination revealed a fixed CINDT deformity (Fig. 6). Arthroscopic debridement of intra-articular adhesions, removal of the volar locking plate with volar capsular release, and manipulation under anesthesia restored carpal alignment, which was maintained with pinning of the radiocarpal and midcarpal joints for 8 weeks (Fig. 6). At 1-year follow-up, his radiolunate angle was 18.3° and his range of motion was 50° extension and 50° flexion (Fig. 6). He did not have any functional limitations other than doing push-ups.

Case 4

A 14-year-old right hand–dominant healthy boy fell off his bike, sustaining an isolated, closed, neurovascularly intact left Galeazzi fracture (Fig. 7). His initial injury was missed; at 1 month, we performed osteotomy and volar locked plating of the radial shaft buckle fracture, open reduction and pinning of the ulnar styloid, and pinning of the distal radioulnar joint (Fig. 7). He was immobilized above elbow for 2 weeks, followed by a Muenster cast for 3 weeks. A CIND-VISI deformity was noted at 2 weeks after surgery, which progressed to a radiolunate angle of 40.4° at 5 weeks (Fig. 8). Scapholunate angle was preserved (Fig. 8). Owing to our experience with cases 2 and 3, we initiated aggressive active and active-assisted range of motion exercises without restrictions at 5 weeks, upon pin removal, and progressed to passive stretching at 8 weeks. At 1 year follow-up, his radiolunate angle improved to 19.1° (Fig. 8) and his range of motion to 90° wrist extension, 95° flexion, 45° supination, and 70° pronation. He had no activity restriction and was back to playing basketball without difficulty.

Discussion

We report a series of four patients with CINDT-VISI, two after distal radius fractures and two after Galeazzi fractures. The pathoanatomy of CINDT has been attributed to injury to the dorsal and volar "mooring lines" (extrinsic and intrinsic wrist ligaments other than the scapholunate and lunotriquetral interosseous ligament, Fig. 9).[6,7] Similar to previous studies,[6,7] our two patients with magnetic resonance imaging exhibited injuries to the dorsal radiocarpal ligament and/or lunocapitate capsule, whereas the scapholunate and lunotriquetral interosseous ligament remained intact. We further posit that, in the setting of dorsal radiocarpal ligament disruption, thickening of volar capsule and extrinsic

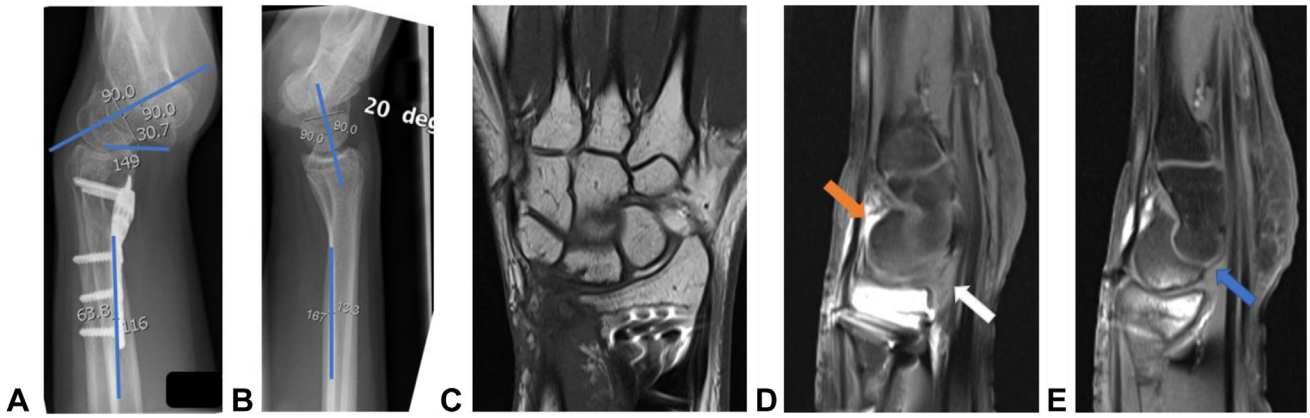

Figure 5. Case 3, part 2: comparative lateral radiographs of the **A** affected and **B** unaffected wrists of case 3, demonstrating a CIND-VISI deformity with radiolunate angles of 63.8° (affected side) and 13.3° (unaffected side) at 6 months after surgery, with a normal scapholunate angle of 30.7°. **C** Magnetic resonance arthrography of case 3 demonstrates no contrast extension into the ulnar aspect of the joint, suggestive of intra-articular adhesions. The lunotriquetral ligament remains intact. **D** Sagittal magnetic resonance arthrography demonstrates disruption of the dorsal radiocarpal ligament (orange arrow) and thickening of the volar wrist joint capsule (white arrow); **E** the lunocapitate capsule (blue arrow) remains intact. CIND, carpal instability nondissociative; VISI, volar intercalated segmental instability.

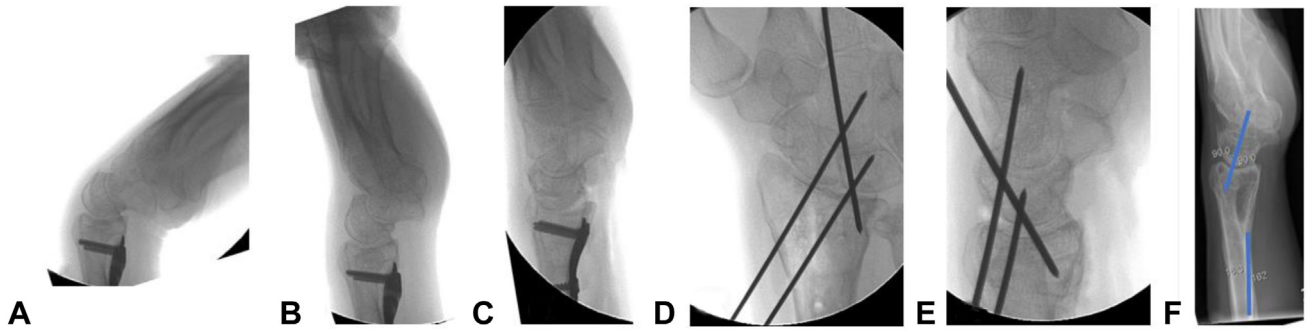

Figure 6. Case 3, part 3: intraoperative fluoroscopic images of case 3, demonstrating initial examination under anesthesia with **A** wrist flexion and **B** extension, with no correction of the CIND-VISI deformity, **C** followed by restoration of normal radiolunate alignment after arthroscopic debridement of intra-articular adhesions, volar capsular release, and manipulation under anesthesia. Removal of the volar locking plate, followed by **D** and **E** radiocarpal and midcarpal pinning was then performed. **F** Follow-up radiographs at 1 year demonstrate a radiolunate angle of 18.3°. CIND, carpal instability nondissociative; VISI, volar intercalated segmental instability.

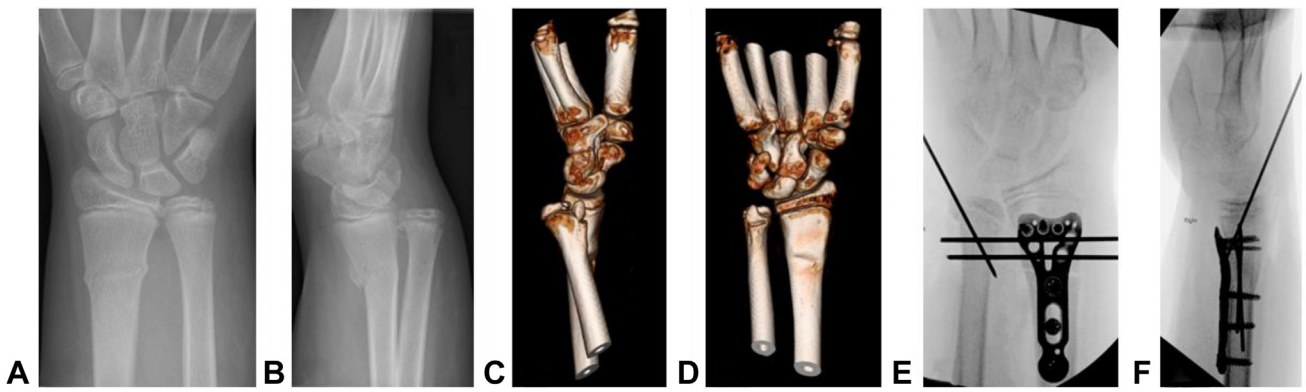

Figure 7. Case 4, part 1: **A** AP and **B** lateral initial injury films and **C** and **D** 4-week select computed tomography three-dimensional reconstructions of case 4, demonstrating a Galeazzi variant with a radial shaft buckle fracture and complete dislocation of the distal radioulnar joint and ulnar styloid fracture. Intraoperative fluoroscopic **E** AP and **F** lateral images of case 4, showing fixation and reduction of the Galeazzi fracture. AP, anteroposterior.

ligaments exacerbates the VISI deformity by rotating the proximal carpal further into flexion (Fig. 9); therefore, volar capsular release was performed in two of our operatively treated patients (cases 2 and 3).

Treatment of CINDT-VISI is highly heterogeneous in the literature. In the 12-patient series after distal radius fracture or radiocarpal fracture dislocation by Fok et al[6], eight patients required surgery: three reducible CINDT-VISI patients underwent open capsular repair, four underwent irreducible CINDT-VISI, and one CINDT-DISI underwent radioscapholunate arthrodesis.[6] In the eight-patient series after scaphoid fracture by Loisel et al[7], all patients required surgery. Acute injuries (average of 5 weeks) were managed with ligament repair, whereas delayed injuries (average of 14 weeks) were treated with ligament reconstruction, which was

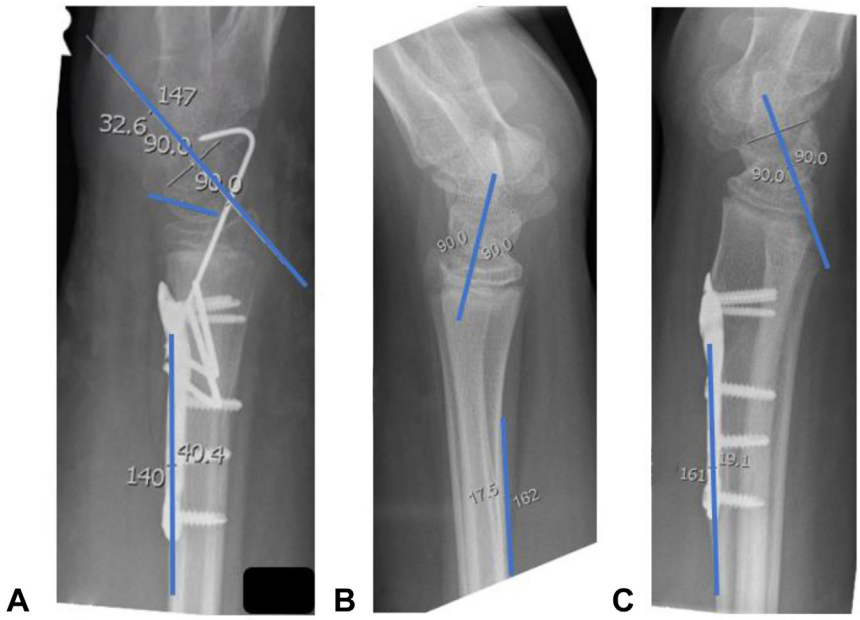

Figure 8. Case 4, part 2: comparative lateral radiographs of the **A** affected and **B** unaffected wrists of case 4, demonstrating a CIND-VISI deformity with radiolunate angles of 40.4° (affected side) and 17.5° (unaffected side) at 5 weeks after surgery, with normal scapholunate angle of 32.6°. **C** Final follow-up (1 year), showing a radiolunate angle of 19.1°. CIND, carpal instability nondissociative; VISI, volar intercalated segmental instability.

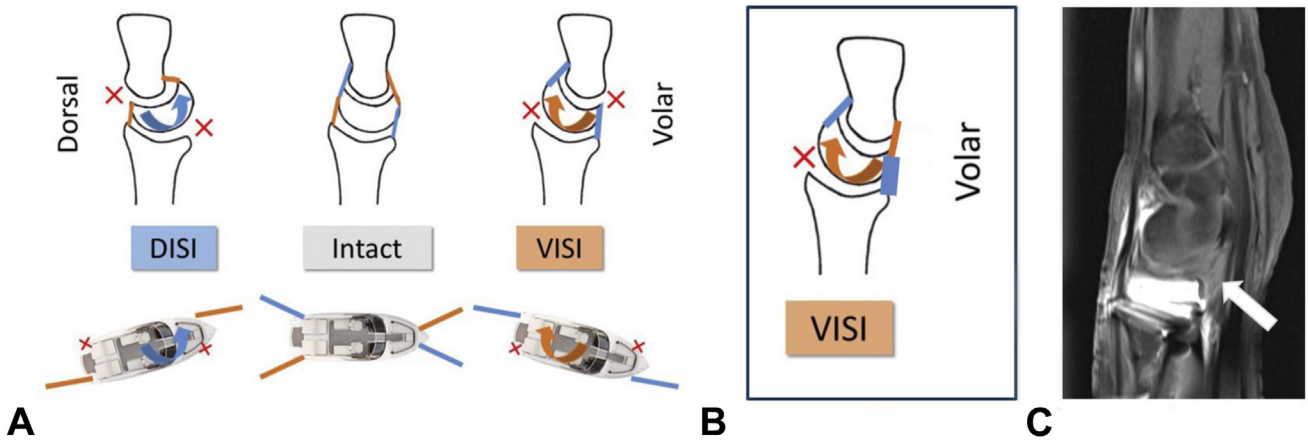

Figure 9. Mooring lines concept of CIND. **A** Disruption of dorsal and volar ligamentous restraints lead to CIND-DISI or -VISI. In case 3, the lunocapitate capsule was intact, represented by **B** the orange line, but thickening of the volar capsule, represented by the emphasized blue line and **C** white arrow, exacerbated flexion of the proximal carpal row. Adapted from Loisel et al[7] with permission. CIND, carpal instability nondissociative; DISI, dorsal intercalated segmental instability; VISI, volar intercalated segmental instability.

unsuccessful in maintaining carpal alignment.[7] In both case series, delayed diagnosis (beyond 12 weeks) was associated with worse outcomes.[6,7]

In our study, we observed that despite significant deformity in case 1, the patient was not functionally limited by his CINDT-VISI deformity. Similarly, in case 2, the patient experienced hardware irritation but did not have radiocarpal or midcarpal pain or restrictions in range of motion. These findings are in keeping with those of Fok et al[6] and Urbanschitz et al[8], who reported that asymptomatic patients can be treated nonsurgically with good functional outcomes. Case 4 further highlights that initiation of early, aggressive physiotherapy, when appropriate depending on the injury and fixation, may play a role in achieving good functional results.

In contrast to previous studies,[6,7] despite delayed diagnosis at 7 months after initial surgery and an irreducible deformity, we elected for a soft tissue procedure rather than a salvage arthrodesis in case 3, given our patient's young age. Although we did not repair or reconstruct ligaments, maintaining proper radiocarpal and midcarpal joint alignment with pinning likely allowed scarring of volar and dorsal ligaments in appropriate tension to prevent significant recurrence of the deformity.

Our study is limited by its small sample size and relatively short follow-up durations, which precludes the ability to determine the long-term consequences of untreated or residual CINDT-VISI. At final follow-up of 33 and 48 months after surgery, neither case 1 nor 2 demonstrated clinical or radiographic signs of arthritis, in contrast to previous literature.[5,8]

Overall, our treatment algorithm involves initiation of aggressive range of motion as early as permitted by the injury pattern. Patients who can achieve functional range of motion with no limitations can continue to be managed conservatively. If surgical intervention is required, then soft tissue releases (including volar

capsular release and intra-articular adhesions) to realign the proximal carpal row, followed by temporary pinning of the radiocarpal and midcarpal joints, can be considered even in cases of irreducible deformity. Based on our results, pinning for a minimum of 8 weeks is required to allow scarring of the injured intrinsic and extrinsic ligaments and may obviate the need for ligament repair or reconstruction. This approach allows preservation of joint motion, particularly in young patients, and does not preclude future salvage fusion options unless there is pre-existing cartilage degeneration at the time of surgery.

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