Journal of Hand Surgery Global Online 7 (2025) 103–108

Contents lists available at ScienceDirect

Journal of Hand Surgery Global Online

journal homepage: www.JHSGO.org

Case Report

Pediatric Lunotriquetral Dissociation and Static Volar Intercalated Segmental Instability After Radial Neck Fracture

Lauren E. Tagliero, MD, * William J. Shaughnessy, MD, * Alexander Y. Shin, MD *

* Department of Orthopedic Surgery, Mayo Clinic, Rochester, MN

ARTICLE INFO

Article history:
Received for publication August 12, 2024
Accepted in revised form September 24, 2024
Available online November 7, 2024

Key words:
Carpal instability nondissociative
Essex-Lopresti
Lunotriquetral ligament instability
Pediatric wrist
Volar intercalated segmental instability

Pediatric patients can pose challenges with regard to both diagnosis and obtaining an accurate history and physical examination, as well as in treatment strategies, as options become limited when physes remain open. This case report examines a 12-year-old boy who sustained a radial neck fracture after a ground-level fall. Although his elbow injury was treated appropriately, he developed wrist pain that progressed to static volar intercalated segmental instability deformity in the context of a carpal instability nondissociative wrist. A paucity of cases of pediatric patients with open physes and static volar intercalated segmental instability deformity exists. Adult treatment typically consists of some form of arthrodesis; however, this should be approached with caution in young patients. This case highlights the importance of careful wrist examination in all elbow injuries, as well as the challenges in surgical treatment options for pediatric patients.

Nondissociative carpal instability (CIND) was first described in 1985 by Dobyns and Linscheid as a form of intercarpal instability in the setting of normal intrinsic interosseous ligaments.[1] Although it typically occurs secondary to generalized ligamentous laxity, it can occur secondary to trauma. Treatment is initially nonsurgical and includes proprioceptive training.[2] Failure of conservative modalities often leads to consideration of surgical intervention, which varies from soft-tissue reconstruction to partial wrist arthrodesis. Surgical outcomes first described by Wright in 1994 have been imperfect and unpredictable.[3] Nearly all reports are in the adult population, typically after patients have had years of subclinical instability and chronic wrist complaints. A paucity of reports of pediatric patients requiring surgical intervention for CIND and even fewer reports detailing the appropriate treatment options on how to address static volar intercalated segmental instability (VISI) deformities in this patient population with open physes exist.

The purpose of this report was to highlight the case of a pediatric patient who developed a post-traumatic static VISI deformity with underlying CIND. This case is particularly perplexing as the initial injury was at the elbow, not at the level of the wrist. The question as to whether the CIND VISI deformity at the wrist occurred at the time of trauma or whether it was exacerbated during treatment for his elbow injury is reviewed. Of note, the patient and their guardian provided written consent for the use of their information for this research report.

Case Report

The patient is a right-hand–dominant 12.75-year-old boy who presented for evaluation of left wrist and elbow pain after a ground-level fall. He was diagnosed with a displaced radial neck fracture. At the time of injury, wrist radiographs were obtained and interpreted as negative (Fig. 1). The following day, a closed reduction with percutaneous pinning of the radial neck fracture was unsuccessfully attempted, resulting in retrograde intramedullary nail placement (Fig. 2). He was immobilized with an above-the-elbow cast for 6 weeks. After cast removal, he complained of wrist pain, which was attributed to hardware irritation at the intramedullary nail insertion site at the distal radius. He underwent hardware removal at approximately 9 weeks after surgery. The radial neck fracture was assessed via intraoperative fluoroscopic imaging and was deemed stable after the nail was removed. After surgery, his wrist pain improved, and physical therapy commenced to address elbow stiffness.

Corresponding author: Alexander Y. Shin, MD, Department of Orthopedic Surgery, Mayo Clinic, 200 First St SW, Rochester, MN 55905.
E-mail address: shin.alexander@mayo.edu (A.Y. Shin).

https://doi.org/10.1016/j.jhsg.2024.09.005

Figure 1. **A** Initial anteroposterior wrist radiograph at time of injury (11/25/2019). **B** Initial lateral wrist radiograph at the time of injury.

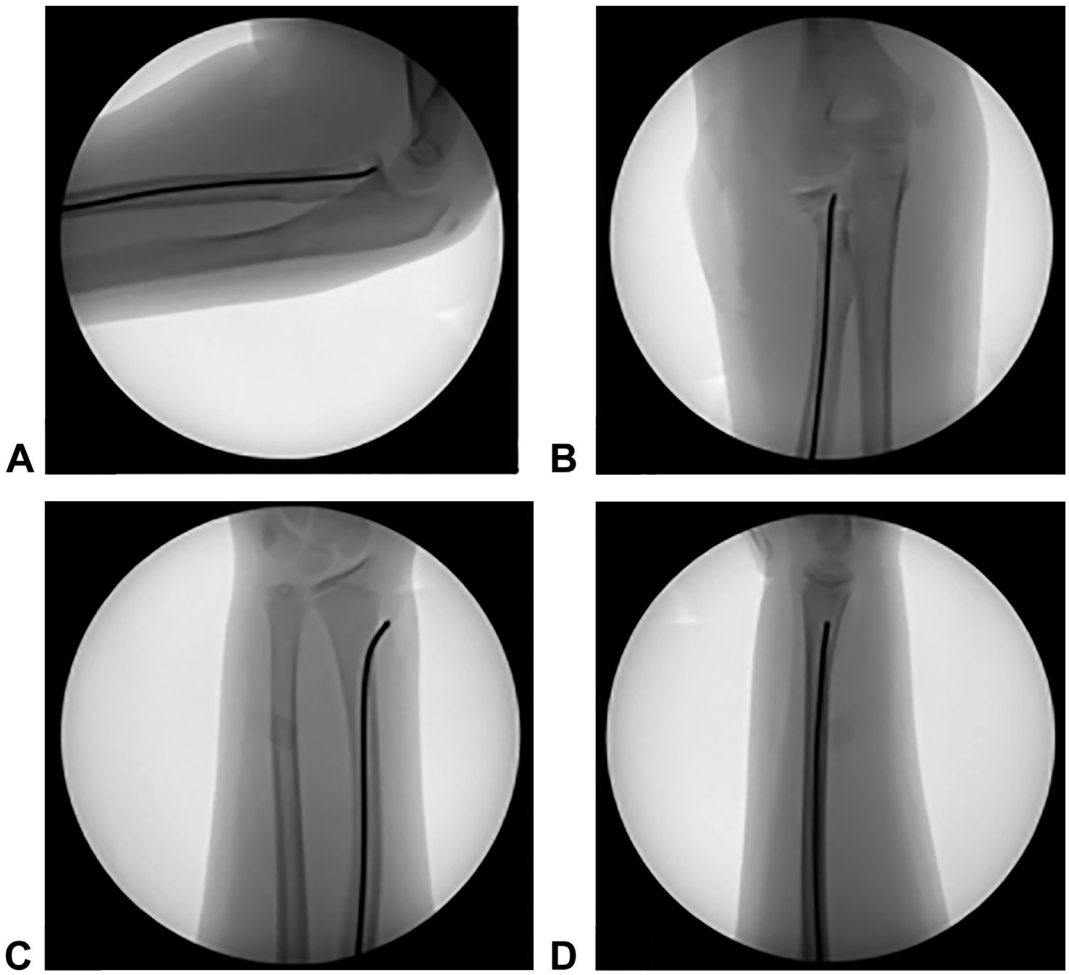

Figure 2. **A** Intraoperative fluoroscopy of the lateral elbow (11/26/2019). **B** Intraoperative fluoroscopy of the anteroposterior elbow. **C** Intraoperative fluoroscopy of the anteroposterior wrist. **D** Intraoperative fluoroscopy of the lateral wrist.

Figure 3. **A** Anteroposterior wrist radiograph obtained 8 months after initial injury, status post-hardware removal (7/6/2020). **B** Lateral wrist radiograph obtained 8 months after initial injury, highlighting VISI deformity. **C** Anteroposterior elbow radiograph obtained 8 months after initial injury, showing nonunion and avascular necrosis of the radial head. **D** Lateral elbow radiograph obtained 3 months after initial injury, showing nonunion and avascular necrosis of the radial head.

Five months after nail removal, the patient returned with complaints of ongoing left wrist pain with a sag-like deformity. Wrist radiographs demonstrated flexion of the lunate (Fig. 3), and the patient was referred to physical therapy. Nonunion of the radial neck and subsequent avascular necrosis were noted on his elbow radiographs (Fig. 3). Three days after this appointment, his surgeon recommended further imaging and evaluation of the VISI deformity. The patient was lost to follow-up for 9 months and re-presented to his surgeon with continued wrist pain and increased deformity, now 14 months after the initial trauma. Repeat radiographs confirmed static VISI deformity with an ulnar positive variance of 5 mm, and he was referred to a hand surgeon. The patient complained of persistent midvolar wrist pain, worse with weight bearing and extension. Longitudinal traction radiographs reduced the VISI deformity and restoration of ulnar variance to neutral. Given the concern for interosseous membrane disruption and concomitant lunotriquetral (LT) ligament injury, magnetic resonance imaging was obtained, which demonstrated that both were intact.

Radial lengthening was performed to restore the tension across the interosseous membrane at 1.5 years after index injury. Intraoperative fluoroscopy confirmed improvement of negative ulnar variance from 5 mm to 2 mm after radial lengthening. Intraoperatively, the VISI deformity was reducible, and a radiolunate wire was placed to hold the lunate in a neutral position. After 6 weeks of cast immobilization, the K-wire was removed (Fig. 4). Ten weeks after radial lengthening, radiographs demonstrated a recurrence of the VISI deformity (Fig. 5). He was referred for a second opinion.

Two years after the initial injury, he presented to us with continued wrist pain. Despite his pain, he was able to participate in all desired activities, including sports. On examination, he was noted to be hypermobile on the right, unaffected side, with midcarpal clunk with circumduction maneuvers and with axial load in radioulnar deviation. On the injured left side, he also had midcarpal clunk present, in addition to significant tenderness to palpation at the dorsal lunotriquetral ligament and pain with lunotriquetral instability maneuvers, including the Kleinman shear test. This test is performed by placing the examiner's contralateral fingers on the dorsal aspect of the lunate and ipsilateral thumb on the pisotriquetral joint. The examiner then loads the pisotriquetral joint in a palmar to dorsal direction, causing a shear and pain at the LT joint. Radiographs of his injured left side demonstrated LT dissociation, with static VISI deformity (Fig. 6). Contralateral radiographs were obtained to rule out pre-existing VISI deformity; however, these showed neutral carpal alignment. Clinically, this resulted in the classic "silver fork" deformity of the injured left wrist (Fig. 7). His elbow had near full range of motion; however, radiographs of his elbow demonstrated avascular necrosis of the radial head/neck.

This patient, unfortunately, has multiple complex problems at both the wrist and the elbow, and given the patient's age and open physes, the treatment options available are subpar. With regard to his radial head/neck nonunion and avascular necrosis, options would consist of excision versus arthroplasty. Given his minimal symptoms, this was not recommended. Treatment of his static VISI deformity and LT dissociation would likely consist of either a radiocarpal or midcarpal arthrodesis based on adult literature.[4,5] This was deferred until at least skeletal maturity, as he was intermittently symptomatic; however, the concern that he may progress to pancarpal arthritis and require a more extensive arthrodesis in the future was discussed in detail. An open discussion concluded with the recommendation of yearly follow-up and radiographs until skeletal maturity.

Currently, the patient is 3 years after injury and doing well overall. He continues to have intermittent wrist pain, particularly

Figure 4. **A** Anteroposterior radiograph of the radius and ulna status post-radial lengthening and radiolunate pinning (6/22/2021). **B** Lateral radiograph of the radius and ulnar status post-radial lengthening and radiolunate pinning.

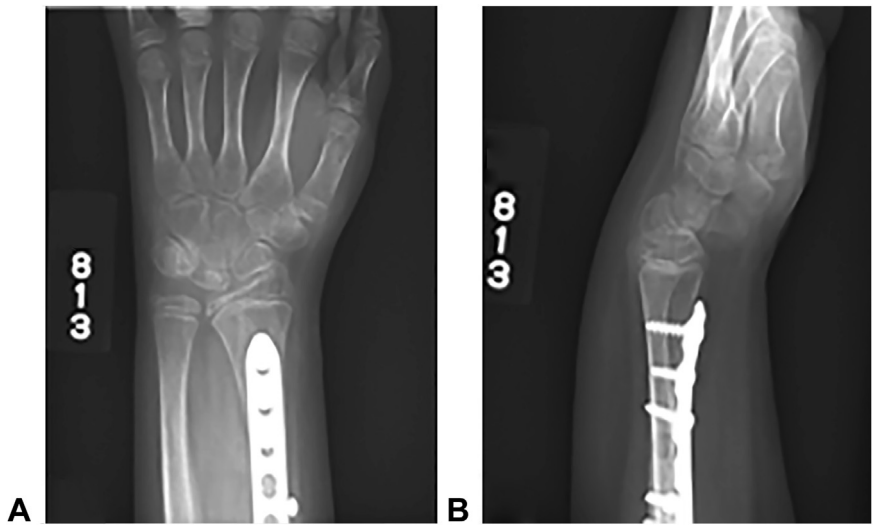

Figure 5. **A** Anteroposterior wrist radiograph after pin removal and beginning wrist motion (7/20/2021). **B** Lateral wrist radiograph after pin removal showing recurrence of VISI deformity.

with activity but denies any elbow pain. He is able to play basketball, and his only functional limitation is with activities that require loadbearing while the wrist is in extension, such as push-ups. His wrist radiographs remain unchanged from 2 years prior.

Discussion

This particular case is unique as the etiology of the non-dissociative carpal instability leading to VISI deformity in this

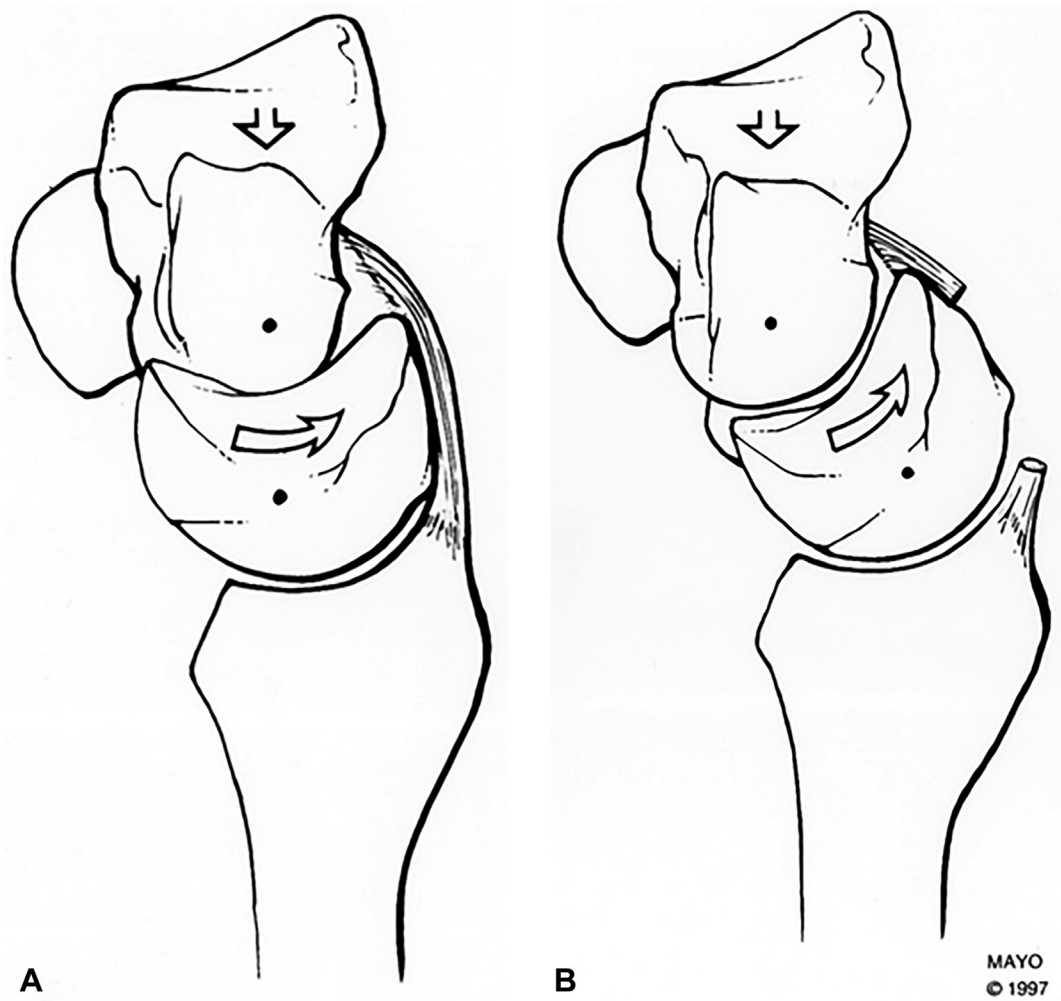

Figure 6. **A** Normal wrist kinematics showing axial loading of the capitate attempting to push the lunate into flexion; however, the LT ligament prevents this from happening. **B** When the LT ligament is disrupted, the lunate falls into a relatively flexed position. (Reprinted with permission from the Mayo Foundation.)

patient is complex and unclear. Volar intercalated segmental instability deformity is defined by flexion of the lunate, leading to a decreased scapholunate angle. In patients with radial head deficient forearms, proximal migration of the radius can lead to ulnar positive variance and subsequent ulnocarpal impaction at the wrist, in addition to radiocapitellar impingement and arthrosis.[6] It is known that ulnocarpal impaction can result in LT ligament attrition, and in this case, it is suspected that this leads to incompetence of the LT ligament stability.[7] His concomitant generalized ligamentous laxity (including laxity of the dorsal radiotriquetral ligament) altered his carpal mechanics, thus leading to the fixed VISI deformity. Given this patient's intact interosseous membrane on magnetic resonance imaging, it is plausible that the radial neck fracture nonunion behaved in a similar biomechanical fashion as a radial head deficient forearm. Prior studies have shown that interosseous membrane attenuation can occur gradually, presenting up to 9 months after injury, emphasizing the importance of continued examination of the entire upper extremity, despite normal wrist radiographs at the time of injury.[6] Unfortunately, these patients who are found to have an Essex-Lopresti injury late (>4 weeks) typically have unpredictable results, as there is no singularly accepted standard treatment.[8] The attempt to restore interosseous membrane stability with a radial lengthening osteotomy and radiolunate pinning in this patient ultimately failed.

The treatment of CIND and static VISI deformity is challenging. This problem is amplified in pediatric patients with open physes, as options for arthrodesis will not only limit their range of motion and functional capabilities but may also impact their long-term growth potential. Literature regarding the treatment of pediatric CIND is sparse and widely varied, with less than 20 cases reported.[3,9] Rao and Culver treated two pediatric patients with partial arthrodesis, both of whom went on to nonunion. Others have attempted soft-tissue procedures. Wright et al[3] performed soft-tissue reconstruction in seven patients under the age of 17 without any significant difference compared with patients who were treated non-operatively. More recently, Chou et al[9] performed soft-tissue reconstruction on a 6-year-old patient with post-traumatic CIND, which, per their report, is the youngest treated patient with this problem. This patient was an avid gymnast who presented with a traumatic inability to extend her wrist. She was noted to have a VISI deformity and was treated with open reduction, pinning of the capitolunate, scaphocapitate, and triquetrocapitate joints, followed by dorsal and volar capsulodesis. At the last follow-up, nearly 8 years after surgery, she had approximately 50% wrist extension compared with her normal side, without instability; however, she was no longer participating in gymnastics. The authors suggest that soft-tissue reconstruction is a viable option in the pediatric population, despite the numerous reported failures of soft-tissue

Figure 7. Current clinical photograph of patient showing visible silver-fork deformity of the left wrist (2.5 years from initial injury).

reconstruction for adult static VISI deformity[5,9,10] and pediatric static VISI deformity.[3]

In the adult population, some variation of carpal arthrodesis is indicated in adults with static VISI deformity; however, it has had variable results.[4,5] A previous study by Shin et al found that 78% of patients who had LT arthrodesis required reoperation, with a 41% nonunion rate.[5] As such, radiolunate, midcarpal, or total wrist arthrodesis remains the recommended treatment of static VISI deformity.[10]

This case report highlights the importance of examining both the wrist and elbow for all forearm injuries. We suspect that this patient has bilateral ligamentous laxity with a predisposition to CIND posture. The elbow trauma, resulting ulnar impaction with LT attenuation, and generalized ligamentous laxity may have predisposed this patient to a fixed VISI deformity, which exacerbated the predisposition for CIND, resulting in pain and fixed VISI deformity of the lunate. Examination of the wrist at the time of elbow injury would have helped elucidate this and potentially allowed for splinting of the wrist in a neutral position to allow the ligaments to heal. There should be a low threshold for obtaining additional imaging. Acute treatment of these injuries is ideal, as missed or delayed care can lead to additional pathologies such as the ulnocarpal impaction and VISI deformity seen in this case. Limited surgical options are available in pediatric patients with midcarpal instability and static VISI deformity, and further studies with larger cohorts are necessary to make sound decisions.

Conflicts of Interest

A.Y.S. is a paid consultant for Integra Life Sciences, receives intellectual property (IP) royalties from Mayo Medical Ventures, is on the editorial board of Techniques in Hand and Upper Extremity Surgery, and receives IP royalties from Trimmed. W.Y.S. and L.E.T. declare that they have no conflict of interest.

Statement of Informed Consent: Informed consent was obtained from all individual participants included in the study.

Acknowledgments

We thank the patient and their family for allowing us to share this interesting case and partake in their care.

References

1. Dobyns J, Linscheid R, Macksoud W. Proximal carpal row instability-non dissociative. *Orthop Trans*. 1985;9:574.
2. Zelenski NA, Shin AY. Management of nondissociative instability of the wrist. *J Hand Surg Am*. 2020;45(2):131–139.
3. Wright TW, Dobyns JH, Linscheid RL, Macksoud W, Siegert J. Carpal instability non-dissociative. *J Hand Surg Br*. 1994;19(6):763–773.
4. Reagan DS, Linscheid RL, Dobyns JH. Lunotriquetral sprains. *J Hand Surg Am*. 1984;9(4):502–514.
5. Shin AY, Weinstein LP, Berger RA, Bishop AT. Treatment of isolated injuries of the lunotriquetral ligament. A comparison of arthrodesis, ligament reconstruction and ligament repair. *J Bone Joint Surg Br*. 2001;83(7):1023–1028.
6. Sheth M, Mitchell S, Bell B, Wu C. Essex-Lopresti lesions and longitudinal radioulnar instability: a narrative review. *JBJS Rev*. 2022;10(3):e21.00212.
7. Shin AY, Battaglia MJ, Bishop AT. Lunotriquetral instability: diagnosis and treatment. *J Am Acad Orthop Surg*. 2000;8(3):170–179.
8. Schnetzke M, Porschke F, Hoppe K, Studier-Fischer S, Gruetzner P-A, Guehring. Outcome of early and late diagnosed Essex-Lopresti injury. *J Bone Joint Surg Am Vol*. 2017;99(12):1043–1050.
9. Chou KH, Chou FH, Goitz RJ. Surgical treatment of pediatric posttraumatic palmar midcarpal instability: case report. *J Hand Surg Am*. 2010;35(3):375–378.
10. Ritt MJ, Linscheid RL, Cooney WP 3rd, Berger RA, An KN. The lunotriquetral joint: kinematic effects of sequential ligament sectioning, ligament repair, and arthrodesis. *J Hand Surg Am*. 1998;23(3):432–445.