Perilunate Injuries, Not Dislocated (PLIND)

Guillaume Herzberg, MD, PhD¹

¹ Pavillon T Upper Limb Surgery, Wrist Surgery Unit, Hopital Herriot, Lyon Cedex, France

J Wrist Surg 2013;2:337–345.

Address for correspondence Guillaume Herzberg, MD, PhD, Hopital Herriot, Wrist Surgery Unit, Pavillon T Upper Limb Surgery, 5 Place d'ARSONVAL, 69437 - Lyon Cedex 03, France
(e-mail: guillaume.herzberg@chu-lyon.fr).

Abstract

Purpose We reviewed a series of equivalents of perilunate dislocations and fracture-dislocations (PLDs–PLFDs) in which there was no dislocation of the capitate from the lunate on the initial radiographs. We propose to include these injuries as a variant of perilunate dislocations that we have termed a perilunate injury, not dislocated (PLIND) lesion in a modified classification of perilunate injuries.

Methods A review of the records of all acute perilunate injuries and displaced carpal fractures was done in a single-center university hospital wrist surgery unit over a 5-year period. All cases presenting at the acute stage with displaced fractures of scaphoid, lunate, triquetrum, or capitate along with scapholunate and/or lunotriquetral dissociation but no dislocation of the capitate from the lunate in the sagittal or coronal plane were reviewed and considered as PLIND lesions.

Results We identified 11 patients with PLIND lesions. Three cases with clinical and radiological follow-up are presented.

Discussion Equivalents of PLDs–PLFDs presenting without dislocation of the capitate from the lunate do exist. These injuries may be overlooked despite their severity. They require both osseous and ligamentous repair. Including them into an existing perilunate injuries classification highlights their recognition and enables a better understanding and treatment of both acute and chronic nondislocated perilunate injuries.

Level of Evidence Level IV, retrospective case series.

Keywords

- perilunate dislocations
- perilunate fracture
- dislocations
- greater arc
- lesser arc
- wrist

Perilunate dislocations and fracture-dislocations (PLDs–PLFDs) are a well-known clinical entity. These traumatic high-energy injuries present with a myriad of variants, degrees, and associations. Their classic common feature is a dislocation of the capitate from the lunate, most often in a dorsal direction.¹ The recent descriptions of several non-dislocated transcarpal injuries, in addition to a category of translunate perilunate injuries where there was no dislocation of the capitate from the lunate “per se,”^{2–7} led us to look for other acute nondislocated equivalents of PLDs–PLFDs within our acute wrist trauma database. We reviewed our experience with injuries that could be considered variants of PLDs–PLFDs in which there was a transcarpal path of trauma but no true dislocation of the capitate from the lunate on the emergency radiographs. We propose that these variants can be classified as perilunate injury, not dislocated (PLIND)

lesions as a modification of the classification that we published in 1993.^{1,8}

Materials and Methods

Over a 5-year period, a retrospective search was done within our emergency wrist cases database for injuries in which displaced scaphoid, lunate, triquetrum, or capitate fractures, apparently isolated or in conjunction with intracarpal ligamentous injuries, were identified. We used codes of each carpal bone fracture, scapholunate (SL) dissociation, and lunotriquetral (LT) dissociation, as well as a special code for possible spontaneously reduced perilunate dislocations. All cases with capitulunate dislocation on their initial lateral radiographs were excluded. We reviewed initial posteroanterior (PA) and lateral radiographs as well as computed

Table 1 Distribution of the Perilunate Injuries Non Dislocated (PLIND) identified over the index period.

Case	Pure ligamentous	Transscaphoid	Transcapitate	Trans-radial styloid	Trans-lunate	Clinical and radiological follow-up (months)
1	X					22
2		X				—
3		X				—
4		X	X			6
5		X	X			—
6		X	X			—
7				X	X	16
8					X	—
9					X	—
10					X	—
11		X			X	—

tomography (CT) scans when available to identify paths of injuries that could be similar to known PLD–PLFD paths of injury (Johnson's lesser or greater arc,⁹ Bain's translunate arc,^{10,11} or any variants or combinations¹). We reviewed the treatment of each case and the follow-up when available.

Results

A total of 11 wrists in 11 patients were identified over the index period (►Table 1), all young males. Their average age was 23 years (minimum 17, maximum 33 years). All cases were seen at the acute stage (i.e., within the first week following the accident). All patients had sustained a high-energy accident. Eight patients had CT scans at the acute period. All operative reports were available. Two patients were operated on using arthroscopic assistance. Three cases had adequate clinical and radiological follow-up, enabling a complete description. In the other eight cases, adequate clinical and radiological follow-up was not available. A total of seven cases, including the three reported cases, were operated on by the author of this paper. The other four cases were operated on under his supervision.

Case #1

A 24-year-old right-handed white-collar man who practiced judo at a high level for recreation fell from a 3-m-high stair onto his outstretched right wrist by accident. He was managed initially in a local hospital. The patient was referred to our wrist clinic one week later because he was seeking advice. Clinical examination revealed a markedly swollen, diffusely tender right wrist with no median nerve symptoms. PA and lateral standard radiographs (►Figs. 1a,b) demonstrated a typical SL dissociation pattern with an increased SL angle (90°) but without a marked dorsal intercalated segmental instability (DISI) pattern. The capitate and lunate were not dislocated nor subluxated. There was an osteocartilaginous loose body projecting at the midcarpal joint at the distal part of the lunotriquetral interval (►Fig. 1a). There was a rupture

of Gilula's proximal line indicating a possible LT tear (►Fig. 1a). CT scan of the wrist confirmed an equivalent of perilunate injury with an obvious SL dissociation (►Fig. 1c, SL arrow), and a lunotriquetral dissociation (►Fig. 1c, LT arrow). The patient did not have any previous history of wrist trauma.

Wrist arthroscopy was performed through the 3–4, 6-R, midcarpal radial (MCR), and midcarpal ulnar (MCU) portals. Arthroscopy through the midcarpal portals demonstrated a complete Geissler stage IV SL (►Fig. 2) and LT (►Fig. 3) dissociation. There was a hemorrhagic appearance of the interosseous ligament tears, consistent with an acute injury. The cartilaginous surfaces were assessed and loose bodies were removed. All of the articular surfaces were normal including the head of the capitate. Through a mini-open dorsal approach the dorsal part of the SL ligament was repaired using one bone anchor in the scaphoid, and the mattress stitches were sewn to the dorsal capsule to augment the SL ligament repair and reconstruct the dorsal intercarpal (DIC) ligament. A total of four 0.062-inch (1.6-mm) Kirschner wires (K-wires) were inserted after the carpus was reduced: one lunotriquetral, one radiolunate, and two SL (►Fig. 4a,b).

The closure was performed in layers. After surgery, the wrist was immobilized in an above-elbow dorsal splint for 3 weeks, followed by a short-arm splint for 3 weeks, with thumb immobilization. Gentle finger flexion and extension were encouraged. The K-wires were removed at 7 weeks and the patient was started on a home therapy program for 2 months. Unfortunately, the patient developed a complex regional pain syndrome (CRPS) beginning at the third post-operative month.

Clinical examination 22 months after the injury demonstrated that the CRPS had resolved. The pain on a Visual Analog Scale (VAS) was 0/10. The QuickDASH and Patient-Rated Wrist Evaluation (PRWE) scores were, respectively, 0 and 0. Examination revealed 40° of flexion, 40° of extension, and ulnar deviation of 20°. Grip strength was 96% of the normal contralateral side. The patient had returned to his job at 6 months after the operation. He had returned to judo one

Fig. 1a-d Case #1. (a) PA initial radiograph of a PLIND lesion. Note the scapholunate gap and chip fracture at the distal aspect of the lunotriquetral interval. The dotted line shows the path of trauma. (b) The scapholunate angle is increased on the initial lateral radiograph. (c) A 3D CT scan confirms the complete scapholunate dissociation (SL arrow) (d) The lunotriquetral dissociation is visible on the 3D CT scan (LT arrow) along with a chip fracture at the midcarpal level.

year after the operation. The Modified Mayo Wrist Score (MMWS) at follow-up was 88 points.

Follow-up standard radiographs showed slight increased density of the scaphoid and lunate (→Fig. 4c,d). There was

some mild radioscapoid and scaphocapitate narrowing. The alignment of the carpus was satisfactory on both PA and lateral radiographs. The SL angle was 70°. Magnetic resonance imaging (MRI) demonstrated some avascular changes of the scaphoid.

Fig. 2 Patient #1. Midcarpal arthroscopy confirmed a complete scapholunate dissociation (Geissler stage IV) and enabled joint cleaning.

Fig. 3 Patient #1. Midcarpal arthroscopy confirmed a complete lunotriquetral dissociation and enabled for joint cleaning. Osteochondral loose bodies were removed.

Fig. 4a–d Patient #1. (a,b) PA and lateral views showing K-wire fixation. (c,d) Radiological aspect at follow-up (22 months). Carpal alignment was satisfactory. There were avascular changes with some early arthritis.

Case #2

A 25-year-old right-handed blue-collar man fell from his motorbike onto his outstretched right wrist during training for recreational motorbike competition. He was managed initially in a local hospital and then referred to our wrist clinics 6 days later. Clinical examination revealed a markedly swollen and diffusely tender right wrist with no median nerve symptoms.

PA and lateral standard radiographs (► **Fig. 5a,b**) demonstrated a trans-radial styloid, translunate perilunate path of injury that had been missed at the acute stage. There was a rupture of Gilula's proximal arc, which highlighted the path of the trauma in the coronal plane. On the lateral view, there was a dorsal subluxation of the distal carpus relative to the radius and proximal part of the fractured lunate. However, there was no dislocation "per se" of the capitate with respect to the lunate. This was confirmed by a CT scan, which also demonstrated an extension of the radial styloid fracture into the dorsal rim of the radius along with a significant cartilage defect of the dorsal aspect of the scaphoid facet of the radius (► **Fig. 5c,d**).

Through a dorsal transverse approach, followed by a Z capsular opening, the proximal row was exposed. The lunate was judged irreparable, and an emergency proximal row carpectomy (PRC) was performed. We combined the PRC with a repair of the dorsal rim of the radius using a free osteocartilaginous graft harvested from the irreparable lunate. The fixation of the graft was done with four 0.062-inch K-wires (► **Fig. 6a,b**).

After surgery, the wrist was immobilized in a below-elbow dorsal splint for 3 weeks, followed by a short-arm splint for 3 weeks. Gentle finger flexion and extension were encour-

aged. The K-wires were removed at 6 weeks. Self-physiotherapy was then encouraged.

Clinical examination took place 16 months after the injury. The pain on a VAS was 0/10. The QuickDASH score was 2.2. Examination revealed a 45° of flexion, -15° of extension, radial deviation of 15°, and ulnar deviation of 10°. Grip strength was 68% of the normal contralateral side. The patient had returned to his job at 4 months after the operation. He had returned to motorbike competition at 6 months after the operation. His MMWS was 75 points.

Follow-up radiographs showed a typical aspect of PRC (► **Fig. 6c,d**). There were some early degenerative changes at the radiocapitate joint, but the joint space was still visible. There was incorporation of the osteocartilaginous graft at the dorsal aspect of the distal radius.

Case #3

An 18-year-old right-handed blue-collar man fell from a height onto his outstretched right wrist. He was referred to our emergency unit the same day. Clinical examination revealed a very swollen and diffusely tender right wrist with no median nerve symptoms.

PA and lateral standard radiographs and CT scan (► **Fig. 7a–e**) demonstrated a transscaphoid, transcapitate path of injury without a capitollunate dislocation, consistent with a PLIND lesion. There was also an intraarticular fracture of the distal aspect of the radius (► **Fig. 7a,e**) and a chip fracture of the ulnar styloid (► **Fig. 7c**).

A longitudinal wrist dorsal approach was done at day 2. The carpus was exposed through a dorsal Z capsular incision. The scaphoid and capitate fractures were exposed. The SL ligament was intact. The LT ligament was elongated but not

Fig. 5a–d Patient #2. (a,b) PA and lateral radiographs showing a trans-lunate, trans-radial styloid perilunate dislocation without capitoulunate dislocation (PLIND lesion). (c,d) A CT scan shows the details of the carpal and partial distal radius fractures.

Fig. 6a–d Patient #2. (a,b) A proximal row carpectomy was combined with repair of the dorsal rim of the radius using free osteochondral bone graft from the resected scaphoid fixed with K-wires. (c,d) Radiological aspect at follow-up (16 months).

Fig. 7a–e Patient #3 (a,b) Initial radiographs showing a transscaphoid, transcapitate PLIND lesion. (c–e) A CT scan provided the details of the scaphoid, capitate, ulnar styloid, and partial distal radius fractures.

completely torn. K-wires (0.062-inch) were used to fix the scaphoid fracture, the capitate, and the articular fracture of the distal radius (→ **Fig. 8a,b**).

After surgery, the wrist was immobilized in an above-elbow dorsal splint for 4 weeks, followed by a short-arm splint

for 1 month. Gentle finger flexion and extension were encouraged. The K-wires were removed at 8 weeks. Self-physiotherapy was then encouraged.

The patient was examined at 6 months after the injury. No outcome scores were available. The pain on VAS was 0/10.

Fig. 8a–d Patient #3 (a,b) Radiological aspect of carpal and distal radius fixation. (c,d) Radiological aspect at follow-up (6 months). Carpal alignment was satisfactory and all fractures were healed.

Examination revealed 15° of flexion, 65° of extension, 10° of radial deviation, and 15° of ulnar deviation. Grip strength was 83% of the normal contralateral side. The patient returned to his job at 6 months after the operation.

Follow-up standard radiographs showed healing of the scaphoid (→Fig. 8c,d). No degenerative changes were observed. The alignment of the carpus was satisfactory on

both PA and lateral radiographs despite a slight widening of the SL interval.

Discussion

We presented 11 patients with acute perilunate injuries where the capitate either had spontaneously reduced after

Fig. 9 Modified Perilunate Injuries Classification. In the “path of trauma” section, the dotted lines display the variants, including the trans-lunate type. PLIND***: Perilunate injury, Not dislocated. Stage II*: also called volar dislocation of the lunate. Stage II**: also called dorsal dislocation of the lunate.

dislocation or had never been dislocated. All exhibited features of a “perilunate-like” coronal path of injury. A total of 3 cases had adequate clinical and radiological follow-up, allowing for a complete description. The diagnostic and therapeutic issues raised by these cases were similar to those of classic acute PLDs–PLFDs. At operation, 10 of these acute cases displayed a combination of intracarpal osseous and ligamentous injuries that may have easily been missed at the acute stage. One case was missed and treated as an isolated displaced scaphoid fracture, which led to a very poor short-term (3 months) result. Other cases may have been missed during the index period of this paper. We propose that these variants can be classified as a perilunate injury, not dislocated (PLIND) as a modification of the classification that we published in 1993.^{1,8}

The terms “lesser and greater arc” perilunate injuries provide a very useful schematic picture of PLDs–PLFDs,⁹ yet they do not give a comprehensive description of the myriad of variants that were reported in the literature. This is particularly true for the term “greater arc.” In his landmark paper, Johnson defined “vulnerable zones of the carpus” in between the two lines of the greater and lesser arcs. Johnson stated that a “pure greater arc injury” would be a transscaphoid,

transcapitate, transhamate, transtriquetral fracture dislocation.⁹ This is a very unusual variant.¹² Actually the most frequent type of acute PLFD (i.e., a dorsal transscaphoid PLFD) is not defined by the term “greater arc.” Moreover, the terms “greater arc” and “lesser arc” do not provide information about the sagittal displacement of these complex injuries. Almost any combination of proximal and middle row fracture and/or dislocation is possible. This led us to propose a radiological classification of perilunate dislocations including both coronal and sagittal planes.¹ Only true dislocations of the capitate from the lunate were considered in this classification.

In their classic 1978 paper, Green and O'Brien¹³ alluded to the possibility of acute perilunate dislocations presenting after spontaneous reduction. There are several other case reports of perilunate injuries where the capitate was subluxated only from the lunate or not dislocated at all.^{2–7} Recently Bain et al described the perilunate translunate type of injury.^{10,11} They described a subcategory of translunate injuries (subluxation group) where there was no true dislocation of the capitate from the fractured lunate.¹¹ We consider a translunate carpal injury as a variant of a perilunate injury because the arc of injury in the coronal plane

Fig. 10 Diagnostic and therapeutic algorithm for PLIND lesions.

travels within and around the lunate. The arc may extend into the SL or LT ligaments or extend through the carpal bones, which would include a transscaphoid, translunate perilunate injury. A translunate injury of the subluxation group could be considered a PLIND lesion.

There are two published case reports describing a “floating lunate,” where complete SL and LT dissociations were demonstrated.^{14,15} This is another example of a PLIND lesion.

In a recent paper, Chee et al¹⁶ described a chronic perilunate injury, treated by trispiral tenodesis, that could also be consistent with a PLIND lesion that was missed at the acute stage.

The concept of a PLIND lesion enables to expand an existing PLD–PLFD classification^{8,17} by including nondislocated equivalents of PLDs–PLFDs whether they follow a radial-to-ulnar mechanism¹⁸ or a so-called reverse ulnar-to-radial mechanism.¹⁹ This modified classification of acute perilunate injuries could aid in the recognition of a more global but nondislocated type of perilunate injury that might otherwise be missed when one is faced with an apparently isolated proximal row bony fracture(s) or interosseous ligamentous dissociation(s).

The concept of the PLIND lesion is consistent with a lesser arc, greater arc, and translunate type of injury (►Fig. 9). The common features of a PLIND lesion include a history of high-energy trauma combined with the physical findings of marked wrist swelling and diffuse wrist tenderness that is suggestive of a more global injury. This type of lesion requires a high index of suspicion and demands further investigation. The primarily common radiographic feature would be a coronal perilunate-type path of injury on the PA view, whatever the variant and the degree (Geissler II, III, or IV, radial- or ulnar-sided mechanism). There would be no dislocation of the capitate from the lunate in the sagittal plane. This would be a secondary feature that would differentiate a “dislocated” perilunate injury from a PLIND lesion. A good clue is the presence of midcarpal osteochondral loose bodies as seen in Case #1. The use of arthroscopy is the preferred method to confirm the diagnosis of a PLIND lesion, although a mini dorsal capsulotomy will also suffice for diagnostic confirmation and treatment when there is a high index of suspicion. A treatment algorithm is outlined in ►Fig. 10.

Conflict of Interest

None

References

- 1 Herzberg G, Comtet JJ, Linscheid RL, Amadio PC, Cooney WP, Stalder J. Perilunate dislocations and fracture-dislocations: a multicenter study. *J Hand Surg Am* 1993;18(5):768–779
- 2 Conway WF, Gilula LA, Manske PR, Kriegshauser LA, Rholl KS, Resnik C. Translunate, palmar perilunate fracture-subluxation of the wrist. *J Hand Surg Am* 1989;14(4):635–639
- 3 Takase K, Yamamoto K. Unusual combined scaphoid and lunate fracture of the wrist: a case report. *J Hand Surg Am* 2006;31(3):414–417
- 4 Sabat D, Dabas V, Suri T, Wangchuk T, Sural S, Dhal A. Transscaphoid transcapitate transhamate fracture of the wrist: case report. *J Hand Surg Am* 2010;35(7):1093–1096
- 5 Briseño MR, Yao J. Lunate fractures in the face of a perilunate injury: an uncommon and easily missed injury pattern. *J Hand Surg Am* 2012;37(1):63–67
- 6 Buijze GA, Mudgal CS. Nondisplaced fractures of the proximal carpal row: case report. *J Hand Surg Am* 2011;36(8):1310–1312
- 7 van Leeuwen DH, Buijze GA, Ring D. Ulnar to radial dorsal fracture-dislocations of the wrist: a report of 2 cases. *J Hand Surg Am* 2012;37(3):500–502, e1
- 8 Herzberg G. Acute dorsal trans-scaphoid perilunate dislocations: open reduction and internal fixation. *Tech Hand Up Extrem Surg* 2000;4(1):2–13
- 9 Johnson RP. The acutely injured wrist and its residuals. *Clin Orthop Relat Res* 1980;149(149):33–44
- 10 Bain GI, McLean JM, Turner PC, Sood A, Pourgiezis N. Translunate fracture with associated perilunate injury: 3 case reports with introduction of the translunate arc concept. *J Hand Surg Am* 2008;33(10):1770–1776
- 11 Bain GI, Pallapati S, Eng K. Translunate perilunate injuries—a spectrum of this uncommon injury. *J Wrist Surg* 2013;2(1):63–68
- 12 Leung YF, Ip SP, Wong A, Ip WY. Trans-triquetral dorsal perilunate fracture dislocation. *J Hand Surg Eur Vol* 2007;32(6):647–648
- 13 Green DP, O'Brien ET. Open reduction of carpal dislocations: indications and operative techniques. *J Hand Surg Am* 1978;3(3):250–265
- 14 Badia A, Khanchandani P. The floating lunate: arthroscopic treatment of simultaneous complete tears of the scapholunate and lunotriquetral ligaments. *Hand (NY)* 2009;4(3):250–255
- 15 Yassa R, Syed MA, Smith A. Atraumatic dislocation of the lunate: floating lunate syndrome. *J Hand Surg Eur Vol* 2013;38(5):559–560
- 16 Chee KG, Chin AYH, Chew EM, Garcia-Elias M. Antipronation spiral tenodesis—a surgical technique for the treatment of perilunate instability. *J Hand Surg Am* 2012;37(12):2611–2618
- 17 Herzberg G. Acute perilunate dislocations and fracture-dislocations. *Surg Tech Ortho Trauma* 2000;55:370
- 18 Mayfield JK, Johnson RP, Kilcoyne RK. Carpal dislocations: pathomechanics and progressive perilunar instability. *J Hand Surg Am* 1980;5(3):226–241
- 19 Murray PM, Palmer CG, Shin AY. The mechanism of ulnar-sided perilunate instability of the wrist: a cadaveric study and 6 clinical cases. *J Hand Surg Am* 2012;37(4):721–728