

Functional and Radiological Outcomes of Perilunate Dislocations Managed by External Fixation and Percutaneous Pinning: A Retrospective Observational Study

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Abstract:

➤ Background:

Perilunate dislocations (PLDs) and perilunate fracture-dislocations (PLFDs) are rare wrist injuries usually caused by high-energy trauma, in which normal carpal alignment and the intercarpal ligaments are disrupted. Prompt anatomical reduction and secure fixation are important for recovering wrist function and reducing the risk of later complications. This study evaluated the clinical and radiological results of acute PLDs and PLFDs managed with external fixation and percutaneous Kirschner-wire (K-wire) fixation.

➤ Materials and Methods:

A retrospective review was conducted of forty patients presenting with acute PLDs or PLFDs. The cohort included 36 men and 4 women, and the mean age was 38 years (range, 18–59 years). Injuries comprised 24 PLDs, 14 transscaphoid PLFDs, and 2 transstyloid PLFDs. The median time from injury to surgery was 8 hours (range, 2–12 hours). Closed reduction by ligamentotaxis, bridging external fixation, and percutaneous K-wire stabilization of the intercarpal joints were undertaken. Indirect reduction succeeded in 34 patients; the remaining 6 required open reduction after indirect reduction failed (4 transscaphoid and 2 transstyloid PLFDs). No intercarpal ligament repair was performed. Wrist motion, grip strength, and Cooney's scoring system were used to assess function. Radiographs were examined for preservation of carpal alignment, fracture nonunion, and post-traumatic arthritis.

➤ Results:

Follow-up averaged 12 months (range, 10–14 months). At the final review, flexion-extension motion and grip strength in the affected wrist reached 80% and 88%, respectively, of the values on the opposite side. Among the 34 patients assessed with Cooney's scoring system, outcomes were excellent in 8, good in 16, fair in 8, and poor in 2. Thirty patients resumed their previous occupations. Scaphoid nonunion developed in 4 patients with transscaphoid perilunate injuries, and post-traumatic arthritis was identified in 4 patients. Overall, external fixation with percutaneous K-wire fixation maintained carpal alignment satisfactorily.

➤ Conclusion:

For selected patients with acute perilunate dislocations and fracture-dislocations, external fixation combined with percutaneous K-wire stabilization can produce satisfactory medium-term functional and radiographic results. Ligamentotaxis allows indirect reduction while limiting additional soft-tissue dissection, operative duration, and blood loss. If indirect reduction is unsuccessful, open reduction may be necessary, particularly in transscaphoid injuries or when the fracture is comminuted. This minimally invasive method may be especially appropriate for carefully selected patients, including those with polytrauma.

Keywords: Perilunate Dislocation; Perilunate Fracture-Dislocation; External Fixation; Kirschner Wire; Ligamentotaxis; Carpal Alignment; Wrist; Cooney Score.

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I. INTRODUCTION

Perilunate dislocations (PLDs) and perilunate fracture-dislocations (PLFDs) are rare yet serious wrist injuries, most often caused by high-energy events such as road traffic collisions, falls from a height, or sports trauma. Although they represent a small fraction of carpal injuries, disruption of the complex osseoligamentous structure can result in chronic instability, stiffness, post-traumatic arthritis, and impaired function when treatment is inadequate.¹ These injuries classically occur when the wrist is forcefully extended with ulnar deviation and intercarpal supination, leading to the progressive perilunar ligament failure described by Mayfield. Up to one-quarter of cases may be overlooked at the first assessment, delaying treatment and potentially worsening outcomes.^{1,2} Treatment aims to restore carpal alignment and stability while preserving wrist movement and function. Open reduction and internal fixation with ligament repair is widely considered the standard approach for acute injuries; however, additional soft-tissue dissection, possible compromise of residual carpal blood supply, postoperative stiffness, and prolonged rehabilitation remain concerns.^{3–6} Less invasive approaches using external fixation with percutaneous Kirschner-wire (K-wire) fixation have therefore been advocated to reduce surgical morbidity. External fixation applies ligamentotaxis to obtain and maintain carpal reduction, while percutaneous wires stabilize the scapholunate and lunotriquetral intervals without extensive soft-tissue stripping. Fernandez and Ghillani first described the benefits of external fixation for complex carpal dislocations,⁷ and Savvidou et al. subsequently reported satisfactory medium-term functional and radiographic outcomes using external fixation with percutaneous K-wires for acute perilunate injuries.⁸ Nevertheless, the best treatment strategy remains debated. Few studies have specifically assessed functional recovery and sustained radiographic carpal alignment after this method, and long-term evidence concerning wrist motion, grip strength, return to activity, and degenerative changes remains limited.^{8,9} Accordingly, this study evaluated functional and radiological outcomes after external fixation and percutaneous pinning for perilunate dislocations, hypothesizing that this minimally invasive method would restore carpal alignment, maintain wrist stability, and achieve favorable function with an acceptable complication rate.

II. METHODS AND MATERIALS

- This retrospective observational study was undertaken in the Department of Orthopaedics at RKDF Medical College Hospital & Research Centre, Bhopal, after approval by the Institutional Ethics Committee. Because the study used existing records, the committee waived the requirement for informed consent. Hospital records were reviewed to identify consecutive patients with acute perilunate dislocations (PLDs) or perilunate fracture-dislocations (PLFDs) managed using external fixation and percutaneous Kirschner-wire (K-wire) fixation. Patients were included only if they had completed at least 1 year of follow-up before August 2026. Additional inclusion requirements were age of 18 years or older, a closed injury, presentation within 3 weeks after trauma, and complete

clinical and radiographic records. Exclusion criteria comprised injuries older than 3 weeks, open injuries with extensive soft-tissue damage, prior injury or surgery involving the affected wrist, associated neurovascular injuries requiring separate surgery, pathological fractures, failure to complete 1 year of follow-up, and incomplete documentation.

- The cohort consisted of 40 patients—36 men and 4 women—with a mean age of 38 years (range, 18–59 years). Injury types included 24 PLDs, 14 transscaphoid PLFDs, and 2 transstyloid PLFDs. The median interval between trauma and surgery was 8 hours (range, 2–12 hours), while mean follow-up was 12 months (range, 10–14 months). Information collected from case records, operative reports, radiographs, outpatient notes, and rehabilitation documentation included age, sex, affected side, injury mechanism and type, associated fractures, injury-to-surgery interval, surgical details, and complications.
- Procedures were carried out under regional or general anaesthesia with image-intensifier guidance. Closed reduction was obtained through longitudinal traction and manipulation under fluoroscopy. A bridging external fixator connecting the distal radius to the second metacarpal was applied to maintain reduction through ligamentotaxis. Once carpal alignment had been verified, 1.6–2.0 mm K-wires were passed percutaneously to stabilize the scapholunate and lunotriquetral joints; additional carpal fixation was used when indicated. Fixation stability was checked fluoroscopically in multiple views. After surgery, intravenous antibiotics were administered for 24–48 hours, active finger movement was encouraged from postoperative day one, and pin sites received routine care. After stability was confirmed, the fixator and K-wires were removed at around 6–8 weeks, and a structured wrist physiotherapy programme followed.
- Records from follow-up visits at 2 weeks, 6 weeks, 3 months, 6 months, and 12 months, as well as the most recent available visit, were reviewed. Clinical assessment included pain using Cooney's Clinical Scoring Chart, wrist range of motion, grip strength as a percentage of the opposite wrist, the Modified Mayo Wrist Score, and the DASH score. Standard posteroanterior and lateral radiographs were examined for the scapholunate angle, radiolunate angle, carpal height ratio, maintenance of reduction, fracture union when relevant, avascular necrosis, and degenerative changes. Complications were identified from follow-up records. Continuous data are reported as mean $\pm$ standard deviation or as median and range, while categorical data are expressed as counts and percentages. Preoperative and postoperative radiographic measurements were compared with a paired t-test; $p < 0.05$ was taken to indicate statistical significance.

III. SURGICAL TECHNIQUE

A brachial plexus block was used in 16 procedures, while 24 were performed under general anaesthesia. Mean operative time was 24 minutes (range, 18–32 minutes).

For acute perilunate dislocations (PLDs), reduction was first attempted by applying longitudinal traction through the

external fixator to achieve ligamentotaxis. The fixator was inserted using a standard method. A small stab incision was made in the frontal plane over the flare of the second metacarpal tubercle. The soft tissues were bluntly separated to expose the bone, and a trocar was passed through the short screw guide of the fixation template to pierce the centre of the metacarpal. The trocar was removed and replaced with a drill guide. Both cortices were drilled with a 2.7-mm bit, after which the first screw was inserted into the second metacarpal in the frontal plane to a depth of approximately 10 mm. The distal metacarpal screw was placed in the same manner.

Both radial-side screws were inserted in the frontal plane through one incision measuring approximately 25 mm. Blunt dissection was carefully continued to the bone to reduce the chance of injuring the superficial branch of the radial nerve. Under image intensification, manual traction was applied gently and increased gradually until the dislocation or fracture-dislocation was reduced. After satisfactory reduction was confirmed and the distal ball joint was aligned with the capitate–lunate axis, the external fixator's double-ball joint was locked.

After reduction, further percutaneous Kirschner wires (K-wires) were placed under fluoroscopic guidance to stabilize the scapholunate and lunotriquetral intervals.

Among patients with perilunate fracture-dislocations (PLFDs), indirect closed reduction using ligamentotaxis succeeded in 10 of 14 cases. The scaphoid fracture was then fixed percutaneously under fluoroscopic guidance. With the wrist held in flexion, a K-wire was advanced along the scaphoid's central axis from dorsal to volar. Additional wires crossed the scapholunate and lunotriquetral intervals to preserve intercarpal stability.

Ligamentotaxis did not provide an adequate reduction in four patients with transscaphoid PLFDs, so open reduction was performed through a dorsal approach. In the one patient with a transstyloid PLFD, a volar approach was used for open reduction after an unsuccessful attempt from the dorsal side. Interosseous and capsular ligaments were left unrepaired and were not sutured, including in the cases that required open reduction.

➤ Clinical and Radiographic Assessment

At the last follow-up visit, wrist motion was measured with a handheld goniometer, and grip strength was recorded using a hydraulic hand dynamometer. Functional status was graded with the original Cooney clinical scoring system.

Treatment efficacy was evaluated by comparing radiographic measurements from the immediate postoperative images with those obtained at the final follow-up. Measurements included the scapholunate (SL) gap and angle, lunotriquetral (LT) gap, and carpal height ratio. Radiographic scaphoid nonunion and the presence of midcarpal or radiocarpal arthritis were also recorded.

A paired Student's t-test was used for statistical analysis, with $p \leq 0.05$ defined as the threshold for significance.

➤ Postoperative Management

Assisted active wrist movement was usually started once the external fixator had been removed. For isolated PLDs, wrist mobilization generally began at about 6 weeks; in transscaphoid and transstyloid PLFDs, it was postponed until approximately 8 weeks.

The K-wires across the scapholunate and lunotriquetral intervals were taken out at approximately 10 weeks after surgery. This interval was intended to provide sufficient time for intercarpal ligament healing and to reduce the possibility of delayed lunate subluxation.

When K-wires had been used to stabilize a scaphoid fracture, they remained in place until radiographs confirmed fracture union. Once union was established and the wires were removed, intensive physiotherapy was begun to improve wrist motion and functional strength.



Fig 1 Posteroanterior (A) And Lateral (B) Radiographs of a Patient with a Trans-Styloid Perilunate Fracture-Dislocation.



Fig 2 Postoperative Posteroanterior (C) And Lateral (D) Radiographs of the Same Wrist Following Open Reduction, External Fixation and Additional K-Wire Fixation.

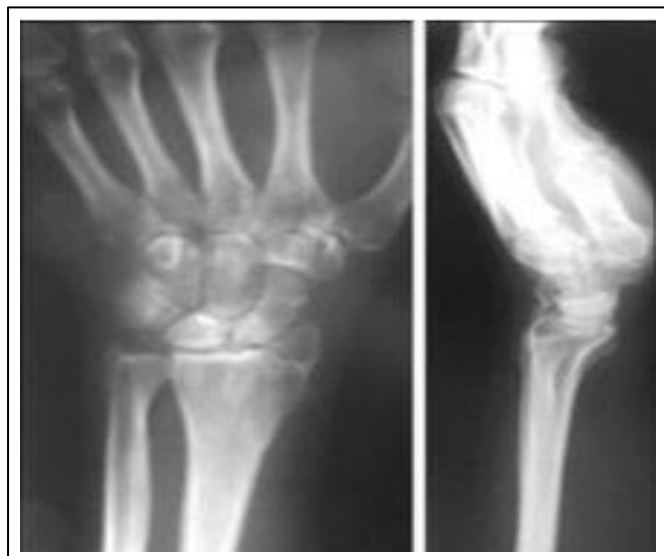


Fig 3 Posteroanterior (E) And Lateral (F) Radiographs Obtained 12 Months after Surgery, Showing Preserved Carpal Alignment and No Radiographic Evidence Of Arthritis.

IV. RESULTS

Among the 34 patients managed with indirect reduction, mean follow-up was 12 months (range, 10–14 months). At the most recent review, mean wrist motion measured 50° in flexion (range, 25–70°), 52° in extension (range, 30–70°), 30° in ulnar deviation (range, 18–42°), and 18° in radial deviation (range, 10–26°). These measurements represented 79%, 80%, 81%, and 89%, respectively, of the corresponding motion in the opposite wrist. Mean pronation was 74° (range, 50–90°), and mean supination was 80° (range, 55–90°). At final assessment, grip strength averaged 88% of the contralateral wrist (range, 62–94%).

Posteroanterior (PA) and lateral wrist radiographs were assessed immediately after surgery and at the latest postoperative review. The immediate postoperative mean SL gap was 1.5 mm (range, 1.3–2 mm), the mean LT gap was 1.6 mm (range, 1.3–2.2 mm), the mean SL angle was 56° (range, 48–61°), and the mean carpal height ratio was 0.54 mm (range, 0.52–0.54 mm). At the final follow-up, the mean SL gap

measured 1.9 mm (range, 1.4–2.6 mm), the mean LT gap was 1.8 mm (range, 1.3–2.2 mm), the mean SL angle was 58° (range, 48–64°), and the mean carpal height ratio was 0.52 (range, 0.49–0.55).

When final radiographic measurements were compared with the immediate postoperative values, the mean SL gap and SL angle had increased ($p = 0.038$ and $P < 0.001$, respectively), whereas the mean carpal height ratio had decreased significantly ($p = 0.038$). Over follow-up, the SL gap increased by a mean of 0.3 mm (range, 0–0.9 mm), and the SL angle rose by 3° (range, 0–8°). The mean carpal height ratio fell by 0.02 (range, 0–0.04). At the final review, 30 patients had an SL angle within the normal range of 30–60°28, and 32 had a carpal height ratio within the normal range of 0.51–0.57 [30] (► Table 1).

Radiographs showed arthritis in four patients at a mean of 12 months after surgery. Radiocarpal arthritis was present in two patients, while the other two had midcarpal arthritis. These radiographic findings did not correspond with the patients' symptoms.

Functional status was graded with the Cooney wrist score (► Table 2)10. Eight patients had excellent results, 16 had good results, 8 had fair results, and 2 had poor results.

Of the 14 scaphoid fractures, radiographic union occurred in 10 patients at a mean of 14 weeks after surgery (range, 9–21 weeks). The other four fractures, which were severely comminuted, did not unite. Two of these cases were fracture-dislocations managed with closed reduction and K-wire fixation; the remaining two underwent open reduction and internal fixation with a cannulated screw (Acutrak, Acumed Inc., Beaverton, OR, USA). These four patients had fair and poor functional outcomes, respectively. Because of carpal collapse, the first two patients underwent salvage surgery comprising scaphoid excision and midcarpal fusion. The other two patients refused further surgery.

In total, 30 of the 34 patients returned to their previous work activities at a mean of 22 weeks after surgery (range, 16–32 weeks). Sixteen of these patients were white-collar workers.



Fig 4 (a) Posteroanterior and (b) lateral radiographs of the left wrist in a male patient with a transscaphoid perilunate fracture-dislocation. (c) Posteroanterior and (d) lateral images after dorsal open reduction, wrist external fixation, and K-wire placement. The scaphoid was stabilized with K-wires. (e) At three months after surgery, radiographs showed scaphoid nonunion.

Table 1 Radiographic Outcomes in Perilunate Injuries Managed with External Fixation and Percutaneous K-Wire Pinning

Parameter	Postoperative Mean (range)	Follow-up Mean (range)	p value
Scapholunate gap	1.5 mm (1.3–2 mm)	1.8 mm (1.4–2.6 mm)	0.038
Lunotriquetral gap	1.6 mm (1.3–2.2 mm)	1.7 mm (1.3–2.2 mm)	0.295
Scapholunate angle	55° (48–61°)	57° (48–64°)	< 0.001
Carpal height	0.52 (0.52–0.54)	0.54 (0.49–0.54)	0.038

Table 2 Cooney's Clinical Scoring Chart for Patient Assessment

Parameter	Score	Criteria
Pain (25 points)	25	None
	20	Mild, occasional (climatic or with heavy use)
	10	Moderate (with normal use, not at rest)
	0	Severe, constant
Range of Motion (25 points) F + E (degrees)	25	140°
	20	100–140°
	15	70–99°
	10	40–69°
	0	<40°
Grip Strength (25 points)	25	Normal
	15	Diminished but ≥50% of normal
	0	<50% of normal
Activities (25 points)	25	Same activities
	15	Restricted activities caused by injured wrist
	0	Change of work or sports caused by injured wrist
Total	100	Maximum possible score

V. DISCUSSION

PLDs and PLFDs result from high-energy wrist trauma and can substantially compromise function through carpal instability and the development of radiocarpal or midcarpal arthritis. Early anatomical reduction of the carpal bones, open repair of interosseous and capsular ligaments, and fracture fixation are widely accepted as standard surgical treatment for these injuries.^{3,8,9,11,14–16} Minimally invasive techniques have also been adopted to limit operative trauma and the risk of subsequent joint stiffness.¹¹ In this series, acute PLDs and PLFDs were reduced and stabilized using a wrist external fixator and percutaneous K-wires. External fixation has been used for complex fracture-dislocations, including “greater arc” injuries involving fractures of two or more carpal bones, complete irreducible palmar dislocations associated with intra-articular distal-radius fractures, and open carpal injuries.^{10,12} Indirect reduction and stabilization with an external fixator may be particularly indicated in patients with polytrauma or ipsilateral limb fractures, when swelling makes cast application concerning, in neglected unreduced transscaphoid PLDs, and in lunate compression fractures.^{12,17} Ligamentotaxis allows the external fixator to facilitate indirect reduction. In this series, it was used to reduce and maintain alignment in all acute PLDs and in 10 of the 14 transscaphoid PLFDs. External fixation was supplemented with percutaneous K-wires to stabilize intercarpal intervals and scaphoid fractures in 34 wrists. The method failed in four transscaphoid PLFDs and two transstyloid PLFDs, and open reduction was required. Although some loss of reduction appeared to occur over time, this did not necessarily reflect instability: the changes in measurements were small, and final radiographic values for the SL gap and SL angle—used to evaluate scapholunate instability—remained within normal

limits in most patients. Mean flexion-extension motion and grip strength were 80% and 88%, respectively, of the values in the opposite wrists. External fixation restored carpal alignment effectively, and normal-range reduction was maintained in 34 patients at a mean follow-up of 14 months. The clinical outcomes were comparable to those reported for open and arthroscopically assisted methods.^{13,18,19} This approach may be particularly advantageous for patients with multiple injuries because it involves less operative time and blood loss when other urgent procedures may also be needed. While many surgeons stress interosseous ligament repair to restore carpal stability,^{6,16} others consider anatomical alignment alone sufficient to re-establish stability without repairing each ligament.^{3,8} The findings in this study suggest that interosseous ligaments and capsular structures may heal when brought into close apposition and protected for a period, and that open interosseous ligament repair may not always be necessary. All patients in this study were treated within 8 hours of injury (range, 2–12 hours). Although radiographic findings do not always correspond directly to functional outcomes, post-traumatic arthritis is a recognized long-term complication, with reported radiographic rates of 50–86% after open reduction and internal fixation.^{4,9,19} In this study, 2 of 17 injured wrists showed radiographic midcarpal and radiocarpal arthritis at a mean follow-up of 39 months. The affected patients had few symptoms despite these changes; however, the relatively brief follow-up prevents firm conclusions about their long-term clinical importance.

The main limitations of this study are its retrospective design, variation within the patient groups, and comparatively short follow-up. Even so, appropriate selection of patients remains important for successful use of this treatment method.

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