Perilunate Dislocations Treated with External Fixation and Percutaneous Pinning

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Abstract

Background The purpose of this study was to review clinical and radiographic outcomes of perilunate dislocations (PLDs) and fracture-dislocations (PLFDs) treated with external fixation and Kirschner wires (K-wires).

Materials and Methods Twenty patients (18 males and 2 females) with a mean age of 38 years (range 18–59) with an acute PLD or PLFD were treated with external fixator and K-wires. There were 12 PLDs and seven transscaphoid and one transstyloid PLFDs. The median time from trauma to operation was 8 hours (range 2–12 hours).

Indirect reduction via ligamentotaxis was achieved in 17 patients with a mean age of 38 years (range 18–59). There were 12 PLDs and 5 trans-scaphoid PLFDs; however, in three cases (two transscaphoid and one transstyloid PLFDs), indirect reduction failed and an open reduction was required. The intercarpal ligaments were not repaired even after open reduction.

Results The mean follow-up was 39 months (range 18–68 months). The flexion-extension range of motion (ROM) and grip strength of the injured wrist averaged 80% and 88%, respectively, of the corresponding values for the contralateral wrists. According to Cooney's scoring system, overall functional outcomes of the 17 patients were rated as excellent in 4 patients, good in 8, fair in 4, and poor in 1. Fifteen patients returned to their former occupations. Two patients with a trans-scaphoid perilunate injury developed nonunion of the scaphoid, and two developed posttraumatic arthritis.

Conclusion External fixation plus percutaneous K-wires for the treatment of acute PLDs has satisfactory midterm functional and radiographic outcomes. When successful, this minimally invasive technique is simple and provides restoration of the carpal alignment. It may especially be useful in the polytrauma patient, thanks to its decreased operative time and diminished blood loss, when other emergent surgical procedures may be necessary. An open reduction with possible fixation may be necessary for PLDs and PLFDs, especially in the presence of polytrauma and scaphoid comminution.

Level of evidence: IV.

Keywords

- carpal dislocation
- wrist external fixation
- percutaneous pinning
- ligamentotaxis

Perilunate dislocations (PLDs) and fracture-dislocations (PLFDs) are unusual high-energy injuries that occur only in

young people and may lead to considerable long-term morbidity due to the development of carpal instability and

radiocarpal and midcarpal arthritis. They are often misdiagnosed as simple wrist sprains, and they may be missed at the acute stage.^{1,2}

The goal of treatment is reduction of the carpal dislocation, internal fixation of the fractures, and ligamentous repair.³⁻⁸ However, an open reduction can introduce further surgical trauma to ligamentous structures.^{3,9} On the other hand, closed reduction and stabilization with cast and percutaneous pinning has been associated with a high incidence of recurrent instability, carpal incongruity, and scaphoid nonunion.

The purpose of our study was to evaluate the clinical and radiographic outcomes related to the use of wrist external fixator supplemented with percutaneous Kirschner wires (K-wires) for the treatment of PLDs and PLFDs of the wrist. Moreover, we assessed whether this minimally invasive technique can provide proper restoration and stable fixation of carpal alignment.

Patients and Methods

We performed a retrospective study in a cohort of 20 patients (18 male and two female), presenting with PLD or PLFD of their wrist between April 2002 and November 2008, who were managed operatively with the use of a bridging wrist external fixator (Pennig Dynamic Wrist Fixator, Orthofix, Italy, and DFS Distal Radius Fixator, Biomet, NJ, USA) and K-wires. The mean age of these patients was 38 years (range 18–59). The median time from injury to operation was 8 hours (2–12 hours). There were 16 right and four left wrists, with the dominant hand involved in 16 cases. The etiology of wrist injury was motor vehicle accident in 10 cases and fall from height in the other 10 cases.

There were 12 dorsal PLDs, seven transscaphoid PLFDs, and one transstyloid PLFD. Two PLFDs were open, Gustillo II, with an open wound on the dorsum of the carpus. Nine patients had concomitant injuries that included olecranon and radial head fracture in one patient, elbow dislocation in five patients, and clavicle fracture in one patient. Three patients suffered from multiple skeletal injuries. Acute posttraumatic median nerve dysfunction was clinically evident in four patients.

Radiographic assessment was performed using blinded calibrated radiographs by two different observers twice

within a period of 2 weeks. The interobserver variability and intraobserver variability (*k* values) were 0.79 and 0.81, respectively. The radiographic evaluation included comparison of preoperative and postoperative scapholunate (SL) gap, scapholunate (SL) angle, lunotriquetral (LT) gap, and carpal height ratio.¹⁰⁻¹² Cases with radiographically evident scaphoid nonunions and midcarpal and radiocarpal arthritis were also recorded. Statistical analysis was performed using a paired *t* test, with the level of significance set at *p* = 0.05 (SPSS software, version 16.0; SPSS, Chicago, IL).

Surgical Technique

The surgery was performed with the patient under brachial plexus block in eight cases and general anesthesia in 12 cases. The mean operative time was 24 minutes (range 18–32). In all acute PLDs, the reduction was achieved via ligamentotaxis by applying longitudinal traction using the external fixator. The external fixator was applied using a standard surgical technique. A stab incision was made in the frontal plane over the flare of the tubercle of the second metacarpal. Soft tissues were separated down to bone, and the center of the bone was pierced with a trocar inserted into the short screw guide in the template (with a handle). The trocar was removed, and a drill guide was inserted into the screw guide. We drilled both cortices with a 2.7-mm drill bit. We inserted the first screw into the second metacarpal in the frontal plane to a depth of ~10 mm. We repeated this procedure for the distal metacarpal screw. The two radial screws were inserted in the frontal plane through a single 25-mm incision, after blunt dissection down to the bone to avoid injury to the superficial branch of the radial nerve. We applied gentle, gradually increasing manual traction to reduce dislocation and fracture-dislocation under image intensification. The double ball joint was locked after we confirmed that the distal ball joint was aligned with the capitate-lunate axis. As reduction was achieved, additional K-wires were inserted under fluoroscopic guidance to transfix the scapholunate and lunotriquetral intervals (→ Figs. 1a–f, 2a–e).

Closed indirect reduction via ligamentotaxis was achieved in five out of seven PLFDs. Percutaneous fixation of the scaphoid fracture with K-wires was then attempted, under fluoroscopic control, by flexing the wrist and inserting a

Fig. 1 (a) Posteroanterior and (b) lateral radiographs of a 19-year-old male patient showing a transscaphoid transtriquetral perilunate fracture-dislocation of the left wrist joint. Postoperative (c) posteroanterior and (d) lateral projections of the left wrist after reduction of the fracture-dislocation and stabilization using an external fixator augmented with percutaneous K-wires. The scaphoid and the triquetral fractures were fixed with K-wires. (e) Posteroanterior and (f) lateral views of the same wrist 10 months postoperatively showing preservation of normal carpal alignment.

Fig. 2 (a) Posteroanterior and (b) lateral views of the left wrist of a 35-year-old male patient with a transscaphoid perilunate fracture-dislocation. (c) Posteroanterior and (d) lateral radiographs after open reduction through a dorsal approach and application of a wrist external fixator and K-wires. The scaphoid was fixed with K-wires. (e) Three months postoperatively, a scaphoid nonunion was radiographically evident.

K-wire from dorsal to volar along the central axis of the scaphoid. The scapholunate and lunotriquetral joints were also stabilized with additional K-wire fixation under fluoroscopy. In two out of seven transscaphoid fracture-dislocations, the ligamentotaxis effect was unsuccessful and an open reduction through a dorsal approach was necessary. In the transstyloid PLFD, an open reduction was performed through a volar approach, after an unsuccessful dorsal approach (→Fig. 3a–f). The interosseous and capsular ligaments were not sutured, even after open reduction of the dislocations.

At the latest follow-up, range of motion (ROM) was measured using a handheld goniometer, and grip strength was measured using a hydraulic dynamometer (JAMA; Asimov Engineering, Los Angeles, CA). Functional evaluation was performed according to the original clinical scoring system of Cooney.^{4,10} For the assessment of the effectiveness of this method, we compared the radiographic parameters measured on initial postoperative radiographs with those of final radiographs. The radiographic evaluation included a comparison of the preoperative and postoperative scapholunate (SL) gap, scapholunate (SL) angle, lunotriquetral (LT) gap, and carpal height ratio.^{11–13} Cases with radiographically evident scaphoid nonunions or with midcarpal or radiocarpal arthritis were also recorded. A statistical analysis was performed using a paired *t* test, with the level of significance set at $p = 0.05$ (SPSS software, version 16.0; SPSS, Chicago, IL).

Postoperative active-assisted wrist motion was usually allowed at 6 weeks, after removal of the external fixator, for PLDs and at 8 weeks for the transscaphoid PLFDs and the

transstyloid PLFD. The K-wires transfixing the scapholunate and lunotriquetral intervals were removed at 10 weeks to prevent late lunate subluxation and allow intercarpal ligamentous healing. In patients with a scaphoid fracture that had been fixed with K-wires, the K-wires were left in place until there was radiographic evidence of union. Intensive physiotherapy was started after the scaphoid united and K-wires had been removed.

Results

The average follow-up of the 17 patients treated with indirect reduction was 39 months (range 18–68 months). At the latest follow-up, the wrist ROM revealed a mean flexion of 52° (range 25–70°), a mean extension of 54° (range 30–70°), a mean ulnar deviation of 31° (range 18–42°), and a mean radial deviation of 18° (range 10–26°), which were 79%, 80%, 81%, and 89%, respectively, compared with the contralateral wrist. The mean pronation and supination was 72° (range 50–90°) and 80° (range 55–90°) respectively. The mean grip strength was 88% (range 62–94%) of the contralateral wrist at the final evaluation.

The radiographic measurements were done immediately after surgery and on the latest postoperative with posteroanterior (PA) and lateral projections of the wrist. Postoperatively, the mean SL gap was 1.6 mm (range 1.3–2 mm), the LT gap was 1.7 mm (range 1.3–2.2 mm), the SL angle was 55° (range 48–61°), and the carpal height was 0.54 mm (range 0.52–0.54 mm). At the latest follow-up the mean SL gap was 1.9 mm (range 1.4–2.6 mm), the mean LT gap 1.8 mm (range 1.3–2.2 mm), the mean SL angle 58° (range 48–64°), and the

Fig. 3 (a) Posteroanterior and (b) lateral radiographs of a 33-year-old female patient showing a transstyloid perilunate fracture-dislocation. Postoperative (c) posteroanterior and (d) lateral views of the same wrist after open reduction and application of external fixator and additional use of K-wires. (e) Posteroanterior and (f) lateral radiographs 12 months postoperatively showing normal carpal alignment with no signs of arthritis.

mean carpal height ratio was 0.52 (range 0.49–0.55). When the measurements of the final radiographs were compared with those of the initial postoperative radiographs, the mean SL gap and SL angle had increased ($p = 0.038$ and $P < 0.001$, respectively), and the mean carpal height ratio had decreased statistically significantly ($p = 0.038$). The increase in SL gap during the follow-up period averaged 0.3 mm (range 0–0.9 mm). The mean SL angle had increased by 3° (range 0° – 8°), and the mean carpal height ratio had decreased by 0.02 (range 0–0.04). At the final follow-up, 15 patients had a normal SL angle (normal range 30° – 60°)¹⁴ and 16 patients had a normal carpal height ratio (normal range 0.51–0.57) [30] (► **Table 1**).

Two patients developed radiographic arthritis (one radiocarpal and the other one midcarpal) at a mean of 34 months postoperatively, without correlated with patients' symptoms. The functional outcomes were assessed according to Cooney wrist score (► **Table 2**)¹⁰. Four patients had an excellent outcome, eight good, four fair, and one poor. Five of seven scaphoid fractures showed radiographic union at a mean 14 weeks (range 9–21 weeks) postop; the other two were severely comminuted and failed to unite. Of those, one was a fracture-dislocation that was treated with closed reduction and K-wire fixation, while the second one had an open reduction and internal fixation using a cannulated screw (Acutrak, Acumed Inc., Beaverton, OR, USA). These two cases showed fair and poor results, respectively. The first one required a salvage operation because of carpal collapse, which consisted of a scaphoid excision and midcarpal fusion. The second patient declined. Fifteen out of seventeen patients were able to return to their previous work-related duties (eight were white-collar workers) at a mean of 11 weeks (range 8–16 weeks) postoperatively.

Discussion

PLDs and PLFDs are injuries related to high-energy trauma of the wrist and may lead to significant functional impairment due to the development of carpal instability and radiocarpal and midcarpal arthritis. The combination of early anatomic reduction of the carpal bones, open repair of interosseous and capsular ligaments, and internal fixation of the fracture has been accepted as a standard surgical method for the treatment of a PLD or PLFD.^{3,8,9,11,14–16}

Minimally invasive procedures have been used to minimize surgical trauma and subsequent development of joint stiffness.¹¹ We attempted to reduce and fix acute PLDs or PLFDs using a wrist external fixator and percutaneous K-wire fixation. External fixators have been used in difficult fracture-dislocations, such as

injuries to the “greater arc” with fracture of two or more carpal bones, complete irreducible palmar dislocations associated with intra-articular fractures of the distal radius, and open carpal injuries.^{10,12} The main indication of indirect reduction and stabilization using external fixation is polytrauma patients, with associated ipsilateral extremity fractures, when swelling causes concern about placing the wrist in a cast, with old neglected unreduced transscaphoid PLDs, as well as compression fracture of the lunate.^{12,17} External fixation facilitates indirect reduction via ligamentotaxis.

In our series, ligamentotaxis was used to reduce and maintain carpal alignment in all of the acute PLDs and in five out of seven transscaphoid PLFDs. In 17 wrists, external fixation was augmented with percutaneous K-wires for fixation of intercarpal intervals and scaphoid fractures.

In two transscaphoid PLFDs and in one case of transstyloid PLFD the technique was unsuccessful, and open reduction was necessary.

Although the results showed a tendency toward a loss of reduction with time, this did not indicate loss of stability, because a small change in parameters was observed and because the final radiologic values (the final SL gap and SL angle), which are the parameters for assessing the scapholunate instability, were also within normal ranges in most patients. Moreover, the mean flexion-extension ROM and grip strength in our series were both ~ 80 and 88% of the corresponding values for the contralateral wrists. Carpal alignment could be effectively restored with an external fixator, and reduction was maintained within normal ranges in 17 patients at a mean follow-up of 39 months. The clinical results of our series compare favorably with those of open and arthroscopically assisted techniques.^{13,18,19}

This procedure may especially be useful in the polytrauma patient because of its decreased operative time and diminished blood loss, when other emergent surgical procedures may be necessary.

Many surgeons have emphasized the need for repair of the interosseous ligament to stabilize the carpal architecture,^{6,16} whereas some investigators suggest that maintenance of the anatomic position is sufficient to reestablish carpal stability without individual ligament repair.^{3,8} The results of our study suggest that the interosseous ligaments and the capsular structures can heal when they are approximated and protected for some period and that an open repair of the interosseous ligaments may not be necessary. In this study, all the patients were treated within 8 hours (range 2–12 hours) from the injury.

Table 1 Results of radiographic measurements after external fixation and percutaneous K-wire fixation

Parameter	Postoperative Mean (range)	Follow-up Mean (range)	<i>p</i> value
Scapholunate gap	1.6 mm (1.3–2 mm)	1.9 mm (1.4–2.6 mm)	0.038
Lunotriquetral gap	1.7 mm (1.3–2.2 mm)	1.8 mm (1.3–2.2 mm)	0.295
Scapholunate angle	55° (48– 61°)	58° (48– 64°)	< 0.001
Carpal height	0.54 (0.52–0.54)	0.52 (0.49–0.54)	0.038

Table 2 Cooney's clinical scoring chart used for clinical assessment of our patients

Cooney's Clinical Scoring Chart	
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:	Less than 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

Excellent: 100–90 points; Good: 90–80 points; Fair: 80–65 points; Poor: less than 65 points.

*Normal is contralateral side (minus or plus 10% depending on dominance) if not disabled. If disabled, then reference is made to normal estimated values with respect to age.

Although the functional outcomes are not always correlated with the radiologic results, posttraumatic arthritis has been reported to be common after these injuries, with rate of radiographic arthritis from 50 to 86% after open reduction and internal fixation.^{4,9,19} In our study, two of 17 injured wrists had radiographic evidence of midcarpal and radiocarpal arthritis at a mean follow-up of 39 months. Although these patients were minimally symptomatic, the follow-up was too short to assess this adequately.

The retrospective nature, the different cohorts of patients, and the short follow-up are the the main limitations of our study. In order for this approach to be successful, however, proper patient selection is paramount.

Conflict of Interest
None

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