Patient-Reported Outcomes Following Surgically Managed Perilunate Dislocation: Outcomes After Perilunate Dislocation

HAND
2016, Vol. 11(1) 22–28
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Hand Surgery 2016
DOI: 10.1177/1558944715617222
hand.sagepub.com

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Abstract

Background: Perilunate dislocations (PLDs) are uncommon high-energy injuries that may result in significant morbidity if inadequately treated. We report the midterm outcomes following surgical intervention and the validity of the Patient-Rated Wrist Evaluation (PRWE) score as an assessment tool post injury. **Methods:** We prospectively present outcomes in 16 patients with perilunate injuries. Definitive surgical management comprised fixation of all fractures and anatomical reconstruction of ruptured ligaments where possible. All patients completed the Disabilities of the Arm, Shoulder and Hand (DASH), 12-Item Short-Form Health Survey, and PRWE, for which internal consistency and construct validity were assessed. **Results:** At 24 months, the mean grip strength was 59% of the uninjured side (range 33%-85%) and the mean range of flexion was 71% and extension was 58%. Eighty-eight percent of patients returned to work within 6 months and 63% to sport within 1 year. The PRWE score was 36.2 (range 14.5-77.3) and DASH 25.2 (range 7.5-91.7). The mean visual analog scale (VAS) satisfaction score was 7.9 (range 0-10), VAS pain at rest 1.9 (range 0-6) and on activity 3.3 (range 1-6). DASH and PRWE demonstrated similar internal consistencies with Cronbach alphas of .98 and .91, respectively, and a strongly positive correlation coefficient of $r = +.7$ ($P < .05$). **Conclusions:** Surgical treatment of PLDs can provide good clinical outcomes allowing patients to return to normal activities in a reasonable timescale when delays to surgery are kept to a minimum. The PRWE demonstrated high internal consistency and was found to be a valid questionnaire with advantages over the DASH for use following severe carpal injuries.

Keywords: perilunate dislocation, perilunate fracture, greater arc injury, patient-reported outcome measures

Introduction

Perilunate dislocations (PLDs) and perilunate fracture-dislocations (PLFDs) are uncommon injuries that may lead to significant patient morbidity. Typically resulting from high-energy trauma, up to 25% are missed due to distracting injuries, delayed presentation, and poor radiograph interpretation.¹ The mechanism of injury follows a predictable course leading to progressive perilunate instability, whereby wrist hyperextension causes intrinsic carpal ligament disruption and ultimately instability—be it between or within the proximal and distal rows.^{5,6}

Despite recent studies indicating favorable results with closed reduction,⁴ current trends are still for the operative restoration of anatomical alignment and ligamentous repair where necessary.^{23,30} Depending on the injury pattern, a singular dorsal or volar approach can be utilized, though combining approaches takes advantage of both exposures.^{7,9,10}

There is a poor correlation between radiographic indices and functional outcomes,^{9,10,28} but with the development of

a number of patient-rated outcome scores, it is now possible to elucidate the impact of injuries on health, quality of life, and wrist disability specifically. Previous reviews of PLD and PLFD management have utilized the Mayo wrist scores, grip strength, range of motion, and the Disability of the Arm, Shoulder and Hand (DASH) scores among others.^{10-17,19,20,24-28} However, to date no study has compared the validity of the Patient-Rated Wrist Evaluation (PRWE) score in this context. The PRWE score was developed to practically measure functional outcomes after hand surgery, with quicker and easier assessment than seen with the DASH or 36-Item Short-Form Health Survey (SF-36), specifically following distal radius fracture¹⁸; the 15-point

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Figure 1. All patients had an extended carpal tunnel decompression incision exposing the bottom of carpal tunnel, showing rupture of the volar wrist capsule. The nerve was then explored and released if necessary. The volar capsule and volar portion of the luno-triquetral ligament were repaired in bulk. If it was obvious that the scapholunate ligament was damaged, a dorsal approach was used.

questionnaire has shown high reliability and responsiveness in relation to wrist injuries.⁸

We report the outcomes of surgically managed PLDs and PLFDs at midterm follow-up, specifically investigating the validity and consistency of the PRWE in comparison with the commonly used DASH and 12-Item Short-Form Health Survey (SF-12).

Materials and Methods

Between 2009 and 2012, all patients with PLDs and PLFDs were treated with definitive surgical fixation of all fractures and ligamentous repair where possible. A dorsal approach was used for the fixation of carpal fractures and an anchor supplemented repair of the scapholunate (SL) ligament. A volar approach was used for direct repair of the luno-triquetral ligament and decompression of the median and ulnar nerves as appropriate. Ligamentous repairs were protected with 1.6-mm intercarpal Kirshner wires for 6 to 8 weeks (see Figures 1 and 2). Postoperatively, all patients had their wrists splinted until wire removal but early finger movement with hand therapy was initiated.

Nineteen patients were identified for the study. Three were deemed unfit for surgical intervention due to other injuries, leaving 16 patients available for analysis. All

patients were male, the average age at time to surgery was 34 years (range 15-58), and there were no bilateral injuries. Three patients were treated for dorsal PLDs and 13 for dorsal PLFDs, of which 9 were trans-scaphoid and 4 radial trans-styloid. The mechanism of injuries were falls from a height,⁹ road traffic accidents,²³ and sporting injuries.⁶

Patients were followed up at an average of 24 months (range 12-44 months). We assessed wrist range of movement (both flexion-extension and supination-pronation arcs) using a handheld goniometer and grip strength using a JAMAR dynamometer (isometric measurement, Jamar dynamometer on level II; Biometrics Ltd, Gwent, United Kingdom); values were taken as absolutes and as a percentage of the contralateral side. Comparison was made between PRWE scores, visual analog scale (VAS) pain (at rest and activity) and satisfaction scores, SF-12 (physical and mental), score and the DASH hand score, in addition to data regarding return to work and sporting activities. Internal consistency of the DASH and PRWE were assessed by calculating the Cronbach alpha, and the construct validity of the PRWE assessed by comparison of correlation coefficients with the DASH score.

Radiographs were evaluated to measure the SL angle (lateral view), carpal height index, McMurty's translation index for carpal ulnar deviation,²¹ and SL diastasis (postero-anterior view).

Figure 2. These operative photographs demonstrate the dorsal approach to repair the scapholunate ligament. K wires used as joysticks are manipulated to correct the dorsal intercalated segment instability and hold the scapholunate ligament reduced as the ligament is repaired using Mini Mitek anchor sutures.

Table 1. Range of Movement and Grip Strength at an Average Follow-Up of 24 Months.

Outcome	Range of movement	Range	% of noninjured hand	Range (%)
Extension	33	7-80	58	33-84
Flexion	54	40-85	71	36-100
Ulnar deviation	16	5-25	70.5	20-100
Radial deviation	14	0-30	62	20-100
Flexion-extension arc	70	29-125	61	36-75
Ulnar-radial deviation arc	30	10-55	69	45-85
Pronation	90	80-90	100	—
Supination	87	80-90	100	—
Grip strength	29	14-44	59	33-84

Results

Preoperatively, 13 patients had documented altered sensation in the median nerve distribution and 1 patient had documented altered sensation in the ulnar nerve distribution. Ten patients had staged treatment, with initial reduction and open nerve decompression followed by subsequent stability surgery at a later sitting. Definitive fixation occurred on average 4 days post injury (range 1-10).

Functional Outcomes and Wrist Scores

Fourteen of the 16 patients returned to work, with 12 reporting returning to the same level of work at an average of 6.4 months (range 3-12 months). Ten of the 16 patients returned to sport at an average of 8 months, 7 of whom reported return to play at the same level.

The range of movement and grip strength at an average follow-up of 24 months is shown in Table 1. The average grip strength was 58.7 kg (range 33.3-84.6). There was no clinically significant correlation between any questionnaire score and changes in grip strength. Five patients had 1-mm difference in 2-point discrimination for median nerve function, and 3 for ulnar nerve at an average of 24 months. No

patients required revision surgery or secondary procedures. There were no postoperative complications.

At average follow-up, the mean PRWE score was 36.2 (range 14.5-77.3) and DASH score 25.2 (range 7.5-91.7). The mean VAS satisfaction score was 7.9 (range 0-10), VAS pain at rest 1.9 (range 0-6), and on activity 3.3 (range 1-6). The average SF-12—physical score was 55.1 (range 38-66) and SF-12—mental was 49.4 (range 29.7-64.6). The Cronbach alpha scores with standardized variables of the DASH and PRWE were .98 and .91, respectively. A positive Pearson correlation coefficient between DASH and PRWE was calculated at $r = +.7$ ($P < .05$). There was no clinically significant correlation between the PRWE and VAS ($r = .39$, $P < .1$) or PRWE and SF-12—health ($r = .07$, $P < .8$).

Radiological Follow-Up

The mean SL angle at the average follow-up was 66° (range 42° - 82°) with a mean SL diastasis for lesser arc injuries of 4.38 mm (range 1.6-6 mm; see Figures 3 and 4). Five patients showed radiographic degenerative changes at the last follow-up, though there was no correlation between arthritic changes, functional outcome, or wrist scores. Average McMurty's translation index was 0.29 ± 0.05 SD.

Figure 3. Radiographic evidence of lesser arc perilunate dislocations.

Note. Top (a) and (b): preoperative images on the left showing a lesser arc injury. Top (c) and (d): postoperative follow-up at 18 months after scapholunate ligament and luno-triquetral repair using wires shows a scapholunate angle of 81° with 4.6 mm diastasis. Bottom (e) and (f): preoperative images on the left showing a complex lesser arc injury. Bottom (g) and (h): postoperative images at 14 months after scapholunate ligament and luno-triquetral repair again with a scapholunate angle of 51° and diastasis of 5.6 mm.

Discussion

Success in managing PLDs depends on the severity of the initial injury, correct diagnosis, and the quality of the surgical reduction.¹¹ Poorly managed injuries can lead to a decreased range of motion, chronic carpal tunnel syndrome, and posttraumatic arthritis.^{5,6} This study is similar to previously published outcome reports of PLDs with respect to patient demographics, DASH scores, and clinical and radiological evaluation following surgical management. In addition, we present PRWE and VAS satisfaction scores.

Comparisons of the loss in the range of movement following surgical management with previously reported studies illustrate a similar flexion-extension arc and radioulnar arc as shown in Table 2. There was no loss following surgery on supination and pronation in our cohort of patients, in keeping with findings reported by Kremer et al¹⁶ from a series of 31 patients. Similarly Chou et al⁵ also found less than 5° difference in supination and pronation at 45 months following surgical treatment within 7 days of injury.

Median and ulnar sensory function in the injured hand at 24 months was affected by 1-mm 2-point discrimination in

Figure 4. Radiographic evidence of greater arc perilunate dislocations.

Note. (a) and (b): preoperative images on the left of a greater arc injury. (c) and (d): postoperative images at 36 months after luno-triquetral and scapholunate ligament wire repair and scaphoid fixation using screws showing a scapholunate angle of 76°.

Table 2. Range of Movement at Follow-Up of 24 Months.

Study	Flexion-extension arc	Flexion-extension arc (% of normal)	Radial-ulnar deviation arc	Radial-ulnar deviation arc (% of normal)	Grip strength	Grip strength (% of normal)	DASH score	Follow-up (years)
Forli et al	95	76	—	—	39	87	—	13
Kormurcu et al	96-130	—	—	—	26.3-34	—	—	3.8
Martinage et al	91	74	—	—	34	77	—	2.1
Souer et al	87-73	71-55	—	—	—	76-77	11-31	3.7
Knoll et al	113	83	40	89	38	80	—	37
Trumble and Verheyden	106	80	36	79	35	77	—	4.1
Hezberg et al	112	—	—	—	—	79	—	8.6
Hildebrand et al	82	57	—	58	3	73	16 ± 13	3.1
Soteranos et al	89	71	—	—	23	77	—	2.5
Kremer et al	77	63	42	60	36.6	71	23	3.3
Chou et al	—	—	—	—	28.6	—	—	3.7
Griffin et al	70	36-75	30	45-85	29	59	25	2

Source. Adapted from Forli et al.⁷

Note. DASH, Disabilities of the Arm, Shoulder and Hand.

less than half the cohort. Kremer et al¹⁶ similarly showed that 60% of patients had a minimal 2-point discrimination reduction. Grip strength was reduced to 59% in this study, which is slightly lower than previous studies, which reported 70% to 87% grip strength compared with the contralateral hand and may be due to the shorter follow-up time (see Table 2). Despite this, early therapy allowed 88% patients to get

back to work within 6 months and 63% back to sport in less than 1 year. Knoll et al¹⁴ found similar results with 23 of the 25 patients returning to their preoperative function. However, previous studies have also shown a decreased rate of return to work following injury with only 69% of patients returning to their prior occupation after surgical intervention¹⁶; similarly, Trumble et al²⁹ as well as Soteranos et al²⁶ also found

that only 45% of patients returned to previous occupations. These differences may reflect differing injury severity and work demands.

The level of pain at rest was acceptable in our patient cohort and only slightly increased on activity, with similar outcomes in larger scale studies. In our study, the DASH score and VAS satisfaction were found to significantly decrease as the time to surgery was delayed illustrating that earlier surgery may permit better patient outcomes. Other reports within the literature compared surgery performed at more than 1 week and less than 1 week illustrating no difference for 31 surgically managed PLDs.¹⁶ Therefore, though studies have illustrated that acute management is optimal, there is still no clarity about the exact time point after which outcomes are detrimentally affected. We would recommend surgery be carried out as soon as the patient is medically stable and appropriate expertise is available.

The mean DASH score was 25, which is similar to previous studies with similar follow-up (see Table 2). The average PRWE score of 36.2 following PLDs in this cohort is indicative of moderate function but further studies using this outcome are required for a more accurate comparison. As a measure of the overall effect on patient mental and physical health, SF-12 scores were recorded, with SF-12–physical score as 55.1 and SF-12–mental score 49.4. Hildebrand et al¹¹ illustrated similar SF-36 scores at 27-month follow-up, with a mental score of 55 ± 8 and physical 45 ± 10 . These SF-12 scores illustrate moderate well-being in a normal patient population.

The internal consistency of the DASH and PRWE were similar with Cronbach alphas of .98 and .91, respectively, suggesting a lack of bias in both questionnaires in this context. Similarly, the construct validity of the PRWE was acceptable, with a strongly positive correlation coefficient of $r = .7$ with the DASH score. Multiple studies have investigated the validity of the DASH when translated to other languages and applied to other cultures, be it for carpal injuries or distal radius fractures²; yet, to date no study has explored the validity of the PRWE in the context of perilunate injuries.

The QuickDASH has been suggested as an alternative patient-reported outcome questionnaire for carpal injuries, yet some authors have identified inherent bias in the function and disability domains, and the underestimation of symptoms when using this score.³ We found no such bias when using the PRWE following perilunate injuries; moreover, the PRWE holds a number of advantages over the DASH, including reduced respondent burden, ease and speed of administration, and overall higher response rate.^{18,22} Consequently, we believe the PRWE to be an effective and appropriate questionnaire following severe carpal injuries.

A major limitation of our study is the small cohort and limited follow-up; this may explain the limited radiographic evidence of posttraumatic arthritis, as authors suggest that

midcarpal collapse and degeneration is not seen until a mean of 8 years from injury.¹¹ However, our numbers are similar to those seen in other small series in the literature. In addition, although we illustrate the validity of the PRWE in the context of severe perilunate injuries, further test-retest analysis and investigation into the domain standard response means would serve to further support the use of this questionnaire in this context.

In conclusion, we report good patient function and satisfaction following these difficult and high-energy injuries. We recommend that patients with a PLD should have all injured structures anatomically repaired and nerve compression relieved at the earliest possible opportunity to maximize good outcomes. Moreover, we found the easily administered PRWE to be a valid and consistent questionnaire for the measure of patient-reported outcomes following PLDs.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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