

Research Paper

Closed Reduction and Percutaneous Pinning Treatment for Dorsal Fracture-dislocation of the Proximal Interphalangeal Joint



Farid Najdmazhar¹, Hooman Shariatzadeh², Amrollah Roozbehi², Mohammad Reza Bahaeddini¹, Behnam Jafari³, Hosein Hamadiyan³, Reza Torab¹

1. Bone and Joint Reconstruction Research Center; Shafa Orthopedic Hospital, Iran University of Medical Sciences, Tehran, Iran.
2. Cellular and Molecular Research Center, Yasuj University of Medical Sciences, Yasuj, Iran.
3. Department of Orthopedic, School of Medicine, Shafa Orthopedic Hospital, Iran University of Medical Sciences, Tehran, Iran.



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ABSTRACT

Background: Previous studies have explored the outcomes of closed reduction and percutaneous pinning in managing dorsal fracture-dislocations of the proximal interphalangeal (PIP) joint, although these studies were limited in scope.

Objectives: This study aims to report this technique's clinical and radiographic outcomes in the treatment of PIP joint dorsal fracture-dislocation.

Methods: We conducted a retrospective review of twelve patients with unstable dorsal fracture-dislocations of the PIP joint that underwent closed reduction and percutaneous pinning. Parameters, including range of motion (ROM), grip strength, pinch strength, and PIP joint pain assessed via a visual analog scale (VAS). The PIP joint function was evaluated using quick disabilities of the arm, shoulder, and hand (Quick-DASH) questionnaire.

Results: At a mean follow-up of 18.6 months, the mean PIP ROM was 99±5.3 (range 90-110), representing 90.2% of the contralateral side (P=0.31). The mean flexion contracture and extension lag were 6.7±3.2° and 6.3±3.1°, respectively. Patients reported a mean VAS score of 3.3±1.5 and a mean quick disabilities of the arm, shoulder, and hand (Quick-DASH) score of 10.8±6.1 points. The mean pinch strength of the involved hand averaged 80.4% of the contralateral side (P=0.19), and the mean grip strength averaged 92.29% (P=0.28). All patients achieved union with radiographically concentric joints, and no subluxation or dislocation events occurred during follow-up. Although radiographic evidence of arthritic changes was observed in all patients, these changes were clinically asymptomatic.

Conclusion: Closed reduction and percutaneous pinning offer a simple, accessible, and minimally invasive technique for managing PIP joint dorsal fracture-dislocations. The observed clinical and radiographic outcomes demonstrate stability and concentricity of the joint, suggesting this technique as a valuable surgical option for such injuries.

* Corresponding Author:

Reza Torab, MD.

Address: Bone and Joint Reconstruction Research Center; Shafa Orthopedic Hospital, Iran University of Medical Sciences, Tehran, Iran.

Phone: +98 (914) 3179243

E-mail: rztb67@gmail.com



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1. Introduction

Dorsal fracture-dislocations of the proximal interphalangeal (PIP) joint are among the most common hand injuries, which can result in permanent disability, subluxation, decreased range of motion (ROM), stiffness, osteoarthritis, and severe pain [1-3].

The fracture of the middle phalanx (P2 volar base) is the main type of PIP joint dorsal fracture-dislocation injuries [4, 5]. Given that joint instability is a primary complication of these injuries, achieving concentric reduction and stable fixation of the fracture fragments is crucial to prevent subsequent complications [5-7].

The treatment approach for PIP joint dorsal fracture-dislocations largely depends on the size of the fracture fragments. Fracture-dislocation with volar fragments less than 30% of the articular surface is managed conservatively; mainly using PIP flexion and dorsal block splinting. Fractures involving 30%-50% of the articular surface are managed surgically only if the reduction is not achieved by PIP flexion or when increasing flexion is required to preserve the congruent reduction. For fractures involving more than 50% of the articular surface, surgical intervention is necessary [3].

Several surgical strategies have been introduced, including open reduction and internal fixation, extension block pinning, closed reduction percutaneous pinning, volar plate arthroplasty, and hemi-hamate arthroplasty [8-10]. Although various surgical techniques have been described, no clear consensus exists on the best surgical procedure for PIP joint dorsal fracture-dislocation treatment [8]. Closed reduction and percutaneous pinning is a simple and minimally invasive surgical option to achieve PIP joint reduction using a percutaneous Kirschner wire (K-wire) [11]. This study aims to evaluate the clinical and radiologic outcomes of closed reduction and percutaneous pinning in the treatment of unstable PIP joint dorsal fracture-dislocations.

2. Methods

We retrospectively reviewed the medical profiles of patients with dorsal fracture-dislocations of PIP joint, who were referred to our hospital between 2018 and 2021, and underwent closed reduction and percutaneous pinning for treatment. The inclusion criteria included treatment in the acute phase (within two weeks of injury) and a minimum follow-up of one year. The exclusion criteria included patients with prior injury or surgery on the affected digit, as well as those with concomitant fractures

on the same affected digit. Twelve patients who met the study criteria were included in the final analysis.

Surgical technique

All operations were performed by a single senior hand surgeon (Farid Najdmazhar). The procedure was conducted under fluoroscopic guidance. The PIP joint fracture-dislocation involved a fracture at the base of the P2 volar base, with the cortex remaining intact (Figure 1a). Closed reduction was achieved under general anesthesia or digital block by applying a dorsal to volar force while the PIP joint was flexed (Figure 1b). Subsequently, a K-wire as an extension block pin (one or one and a half millimeters K-wire), was inserted with an angle of 45 degrees, positioned at the dorsal cortico-articular junction of the distal end of the proximal phalanx (Figure 1c). Fractured fragments and depressed articular surfaces were restored through manipulation with a k-wire under fluoroscopic guidance (Figure 1d). The reduction was then maintained with gentle force using towel clips (non-tipped side) (Figure 1e). After achieving reduction, the fracture was fixed with two or three 1 mm K-wires inserted from dorsal to volar (Figure 1f). Patients were discharged with a static volar splint which they were instructed to wear for three to four weeks.

Outcome evaluation

The clinical evaluations included the assessment of PIP joint pain, function, ROM, grip strength, and pinch strength. The PIP joint pain was evaluated using a visual analog scale (VAS) for pain, scored between 0 and 10, representing “no pain” to “worst possible pain”, respectively. The PIP joint function was assessed with quick disabilities of the arm, shoulder, and hand (Quick-DASH) questionnaire, the validity and reliability of which were previously evaluated [12]. Each patient received a score between 0 and 100, with higher scores indicating worse function. Grip strength was measured using a standard dynamometer (Hydraulic Hand Dynamometer SH5001, Saehan Corporation, Masan, Korea). Pinch strength was assessed using a standard pinch gauge (Hydraulic Pinch Gauge SH5005, Saehan Corporation, Masan, Korea). All clinical evaluations were performed by an orthopedist who was not involved in the patient’s care. Radiographic evaluation was performed by a musculoskeletal radiologist and included the assessment of posttraumatic arthritis using the Kellgren and Lawrence classification [13]. Accordingly, the patients were classified into five grades ranging from 0 to 4, representing no PIP joint degeneration to the most severe degeneration, respectively.

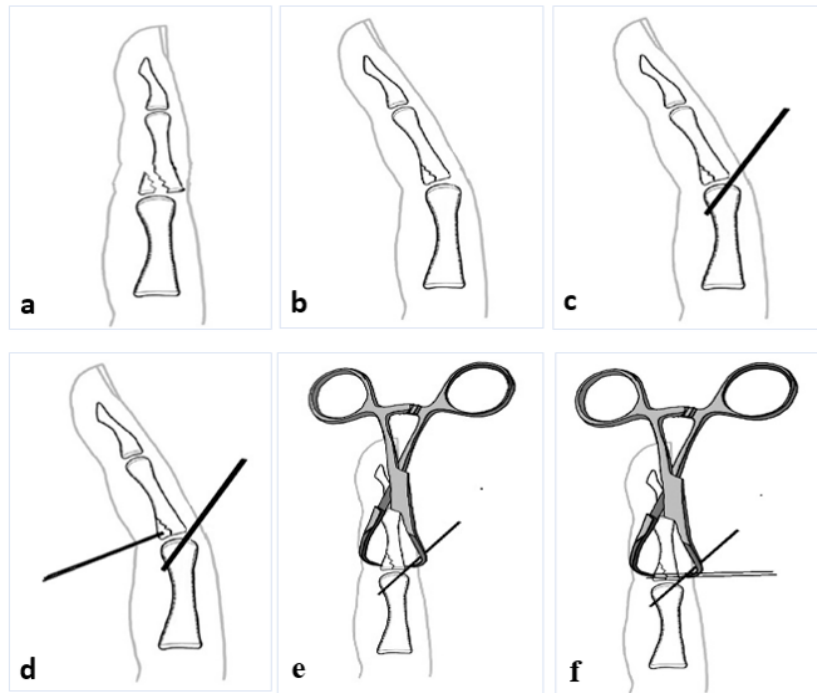


Figure 1. Schematic figure sequence of surgical technique steps

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For example, the treatment steps of one of the patients are depicted (Figures 2, 3 and 4).

Statistical analysis

Statistical analysis was conducted using SPSS for Windows, version 16 (SPSS Inc., Chicago, Ill., USA). Descriptive statistics were demonstrated by Mean±SD or numbers with percentages for quantitative and qualitative variables, respectively. The paired t test was utilized to compare pinch and grip strength relative to the opposite side. A $P < 0.05$ was considered statistically significant.

3. Results

In this study, 19 patients were initially included, based on the inclusion and exclusion criteria. However, three patients were excluded due to incomplete follow-up, two due to a change of address, one due to lack of consent to participate, and one due to simultaneous bony Mellet fracture. Therefore, the final study population included eight males and four females, with a mean age of 35 ± 14.33 years, ranging from 19 to 63 years. The injury affected the non-dominant hand in seven (58.3%) patients. The mean time from injury to surgery was 3.4 ± 2 days (range 2-9), and the mean follow-up period was



Figure 2. A 32-year-old man
Notes: Preoperative (A, B) and final follow-up (C, D) radiology.

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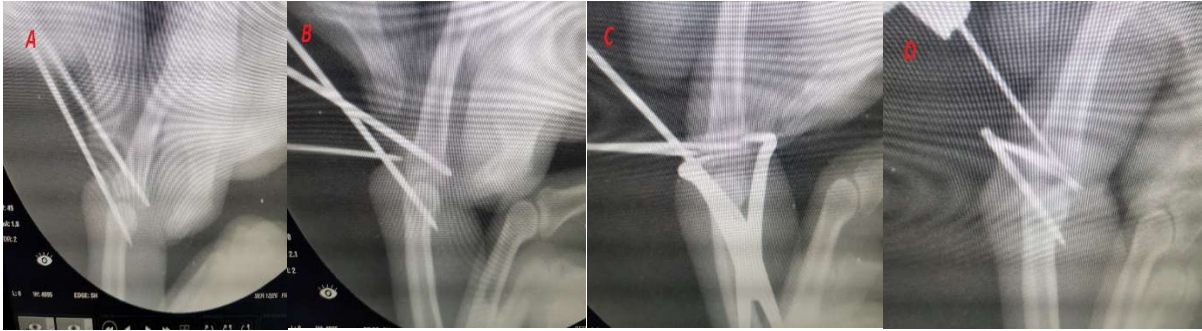
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Figure 3. A) Inserting dorsal ext block K.W size 1.5 mm, B) The reduction with 1.5 mm K.W and manipulation under fluoroscopic guidance, C) After the first dorsal K.W size 1 insertion, maintaining the reduction by towel clips and inserting 2 or 3 dorsal to volar K.W (1 mm)

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Figure 4. Early post-operative x-rays

18.5 months (range 12 to 37). [Table 1](#) presents further details regarding the baseline characteristics of the patients.

The mean PIP joint ROM was $99 \pm 5.3^\circ$ (range 90-110), representing approximately 90.2% of the contralateral hand ($P=0.31$). The mean flexion contracture was $6.7 \pm 3.2^\circ$ (range 5-15). The mean extension lag was $6.3 \pm 3.1^\circ$ (range 5-15). All patients experienced some degree of PIP joint, with a mean VAS score of 3.3 ± 1.5 (range 1-6). The mean Quick-DASH score was 10.8 ± 6.1 points (range 5-25). The mean pinch strength of the involved hand averaged 80.4% of the noninvolved hand ($P=0.19$), while the mean grip strength averaged 92.29% ($P=0.28$). [Table 2](#) presents further clinical outcomes.

Radiographic evaluation revealed a concentric reduction in all cases. The fracture union was evident in all patients. No patient experienced a subluxation or dislocation. Postoperative arthritic changes were observed in the final radiographs of the patients, which were grade 1 in seven patients (58.3%) and grade 2 in five patients

(41.7%). No other postoperative complications, such as wound infection, were recorded in this series.

4. Discussion

This study was conducted to evaluate the outcomes of close reduction and percutaneous pinning in the treatment of PIP joint dorsal fracture-dislocation. At the last follow-up, the PIP joint ROM was within an acceptable range compared to the contralateral hand. Also, the mean grip and pinch strength of the involved hand were not significantly different from the contralateral hand. All patients experienced some degree of PIP joint pain, which was mild in the majority of them. Degenerative changes were observed in the final PIP joint radiographs of all patients; however, they were clinically asymptomatic. No instances of subluxation or dislocation occurred during the mean follow-up of 18.6 months.

The outcomes of close reduction and percutaneous pinning in the treatment of PIP joint dorsal fracture-dislocation have been reported in a few earlier studies. Newington et al. reviewed the outcomes of closed reduction

Table 1. Baseline characteristics of patients managed with closed reduction and percutaneous pinning

Variables		Mean±SD/No. (%)
Age (y)		35±14.33
Sex	Male	8(66.7)
	Female	4(33.3)
Job	Salesperson	4(33.3)
	Housewife	4(33.3)
	Manual worker	2(16.8)
	Student	1(8.3)
	Unemployed	1(8.3)
Involved hand	Dominant	5(41.7)
	Non-dominant	7(58.3)
Involved finger	2	1(8.3)
	3	4(33.3)
	4	5(41.6)
	5	2(16.8)

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Table 2. Clinical outcomes of patients managed with closed reduction and percutaneous pinning

Variables		Mean±SD
Range of motion (°)	Involved	99±5.3
	Non-involved	110±3.2
Flexion contracture (°)		6.7±3.2
Extension lag (°)		6.3±3.1
Pinch strength (lb)	Involved	18.92±3.12
	Non-involved	23.53±4.53
Grip strength (lb)	Involved	46±11.03
	Non-involved	49.84±4.53
VAS		3.3±1.5
Quick-DASH score		10.8±6.1

Quick-DASH: Quick disabilities of the arm, shoulder, and hand.

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and percutaneous fixation (Trans-articular K-wire) in the treatment of 10 patients (11 fingers) with dorsal PIP joint fracture-dislocation [14]. At the 16-year follow-up, seven patients had no finger pain or stiffness, with a mean

flexion contracture of 8° and a mean ROM of 85°. Mild joint space narrowing was observed in some patients. They concluded that this technique is a reliable treatment providing satisfactory long-term results. Although the

mean follow-up in our study was significantly shorter (18.6 months), the mean flexion contracture and ROM of the PIP joint were superior to those reported by Newington et al.

Vitale et al. reported the short-term postoperative results of closed reduction, percutaneous fracture reduction, and pinning in the treatment of six patients with unstable dorsal PIP joint fracture-dislocation [15]. During the average 18.7-month follow-up, no subluxation or dislocation of the PIP joint was recorded. Radiographic evaluation revealed concentric reduction and union in all patients. The mean DASH score and VAS score were 8 and 1.4, respectively. They concluded that the percutaneous technique provides a stable PIP joint and results in excellent clinical and radiographic outcomes. Similarly, in the present study, the percutaneous technique yielded acceptable clinical and radiographic outcomes. However, the mean VAS score for pain was higher in our study.

Haseth et al. reported the outcomes of closed reduction and percutaneous pinning (Trans-articular K-Wire) in the treatment of nine patients with acute dorsal PIP joint fracture-dislocations [11]. At a mean follow-up of 6.5 months, all patients exhibited painless but fusiform and swollen PIP joints. The mean ROM of the PIP joint ranged from 4° extension to 106° flexion. The mean extension lag and flexion contracture were 10° and 15°, respectively. Radiographically, all patients had a concentric PIP joint with the union. Additionally, two patients showed radiographic evidence of PIP joint degenerative changes that were asymptomatic. They concluded that close reduction and percutaneous pinning, as a minimally invasive technique, provide satisfactory outcomes in the short to mid-term. The mean flexion contracture and extension lag were 6.7° and 6.3°, respectively, in the present study, which was remarkably lower than those reported by Haseth et al. However, all patients in our study exhibited radiographic evidence of joint degeneration that was asymptomatic.

Gianakos et al. systematically reviewed the outcomes of different surgical methods in the treatment of acute PIP joint fracture-dislocations [16]. They found that open reduction and internal fixation had the highest revision rate (19.7%), while closed reduction and percutaneous pinning, as well as volar plate arthroplasty, exhibited the lowest complication rates, alongside good clinical and functional outcomes. However, they also noted that the overall outcomes of PIP joint dorsal fracture-dislocations remarkably depend on the severity of the injury.

We believe that closed reduction and percutaneous pinning represent a valuable minimally invasive method in the treatment of PIP joint dorsal fracture-dislocation. However, the present study was not without limitations. These included its respective design, a small study population, and the absence of a control group of patients treated by other methods. Therefore, future prospective studies involving larger patient populations and adequate control groups are required to further explore the value of the present technique in the treatment of PIP joint fracture-dislocation.

5. Conclusion

Closed reduction and percutaneous pinning is a simple, accessible, and minimally invasive method for managing the PIP joint dorsal fracture-dislocations. Clinical and radiographic outcomes range from good to excellent, providing a stable and concentric joint, at least in mid-term follow-up, with a low rate of postoperative complications. Therefore, this technique can be considered a valuable surgical option in the treatment of PIP joint dorsal fracture-dislocations.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the ethical board of [Iran University of Medical Sciences](#), Tehran, Iran (Code: IR.IUMS.FMD.REC.1401.71).

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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