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Original Research

## Risks of Reoperation in Surgically Treated Fractures of the Proximal Phalanx



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**Purpose:** The objective of this study was to determine the risk factors and the rate of reoperation after closed reduction percutaneous pinning (CRPP) of isolated closed single-digit proximal phalanx fractures.

**Methods:** A retrospective cohort study was conducted for patients who underwent CRPP of non-thumb closed proximal phalanx fractures between 2010 and 2020 at two level-I trauma centers and two community teaching hospitals. Demographics, fracture, and treatment characteristics were collected. The primary outcome measure was reoperation. Secondary outcome measures were complication and reoperation specifically for digital stiffness.

**Results:** Of the 115 patients who underwent surgical treatment, 46 patients (40.0%) had a complication and 13 patients (11.3%) underwent reoperation at a mean of 6.7 months—most of which (84.6%) were for digital stiffness.

**Conclusions:** Surgeons and patients may be aware that CRPP of closed extra-articular proximal phalanx fractures carries considerable rates of complication and reoperation.

**Type of study/level of evidence:** Therapeutic III.

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Proximal phalanx fractures of the hand are a common injury, accounting for 10% of all fractures in the body. Surgery is generally indicated for open fractures, unstable fractures, articular incongruity, rotational malalignment, and significant displacement.<sup>1,2</sup> However, no consensus has been established on the ideal surgical technique, which includes closed or open reduction, and fixation options include percutaneous pinning, extra- or intra-osseous wiring, lag screws, intramedullary devices, plate- and screw constructs, and external fixation.<sup>3–10</sup>

The surgical treatment of proximal phalanx fractures is associated with notable rates of complication and reoperation.<sup>11</sup> Digital stiffness, particularly affecting the proximal interphalangeal joint, is the most frequent postoperative complication and can limit patients' daily activities and quality of life.<sup>12</sup> Faruqui et al<sup>11</sup> reported

that almost one-third of the patients treated with closed reduction percutaneous pinning (CRPP) of proximal third proximal phalanx fractures developed a subsequent flexion contracture at the proximal interphalangeal joint of greater than 15°. Secondary surgical options for digital stiffness include tenolysis, capsulectomy, and/or manipulation under anesthesia. Plate fixation has been previously suggested to have a higher secondary tenolysis rate compared with K-wire pinning and lag-screw fixation, although this remains a point of controversy with some studies showing comparable complication rates across fixation methods.<sup>4,12–17</sup>

Elucidating risk factors for postoperative complications and reoperations may enable surgeons to have a more evidence-based treatment selection process and help inform preoperative counseling. The primary objective of this study was to determine the rate of reoperation after the CRPP of isolated closed single-digit non-thumb proximal phalanx fractures and identify the risk factors for reoperation. The secondary objectives of this study were to determine the rates of reoperation for digital stiffness and complications after CRPP of these fractures and identify their associated risk factors.

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## Materials and Methods

### Patient identification

This study was approved by our Institutional Review Board. A retrospective study was performed of all patients who underwent either CRPP for proximal phalanx fractures from January 1, 2010 to January 28, 2020 at an integrated health system consisting of two level-I trauma centers and two community teaching hospitals. Patients were identified through query of the institutional billing database, using the following Common Procedural Terminology codes: 26727 (percutaneous skeletal fixation of the unstable phalangeal shaft fracture, proximal or middle phalanx, finger or thumb, with manipulation, each) and 26735 (open treatment of phalangeal shaft fracture, proximal or middle phalanx, finger or thumb, with or without internal or external fixation, each). Inclusion of the Common Procedural Terminology code for open treatment in the initial broad query helped ensure the capture of all patients of interest.

Our initial query resulted in 803 patients. Our exclusion criteria included concomitant fractures of the middle and/or distal phalanx ( $n = 153$ ), fractures in multiple digits ( $n = 145$ ), intra-articular fractures ( $n = 64$ ), proximal phalanx fracture of the thumb ( $n = 57$ ), other concomitant fracture of the upper extremity ( $n = 13$ ), incomplete records ( $n = 86$ ), miscoded procedure ( $n = 41$ ), associated tendon ( $n = 40$ ) or nerve injury ( $n = 3$ ), time to surgery greater than 14 days from the date of injury ( $n = 33$ ), age younger than 18 years ( $n = 4$ ), follow-up less than 6 weeks ( $n = 11$ ), open fracture ( $n = 26$ ), fracture through an enchondroma ( $n = 1$ ), and treatment with open reduction internal fixation ( $n = 11$ ). A final cohort of 115 patients with isolated non-thumb closed extra-articular proximal phalanx fractures treated with CRPP was included in this study (Fig. 1).

### Outcome variables

The primary outcome variable of this study was reoperation. Secondary outcome variables included reoperation specifically for digital stiffness and other complications (malunion or malrotation, infection or wound necrosis, symptomatic hardware, and fixation failure). Complications, reoperations, and indications for reoperations were obtained through electronic medical record review. Since some degree of motion loss is common after these injuries, patients were defined to have stiffness as a complication for the purposes of our study if it was documented at a follow-up clinical examination or they underwent a subsequent surgery for contracture release, capsulectomy, or tenolysis. Malunion was identified on a review of the medical record and confirmed by radiographic review.

### Explanatory variables

Our patient-related explanatory variables included age, sex, hand dominance, diabetes mellitus, and smoking. Our injury-related explanatory variables included affected digit, articular involvement (intra-articular or extra-articular fracture), and fracture location (distal, middle, or proximal). Our treatment-related explanatory variable was time from injury to surgery in days. A radiographic review was performed by a single author (C.N.). Injury and postoperative radiographs were used in conjunction with operative reports to assess fracture location, articular involvement, and surgical technique.

### Statistical analysis

Descriptive statistics for explanatory variables and outcome variables were calculated. Parametric continuous variables were

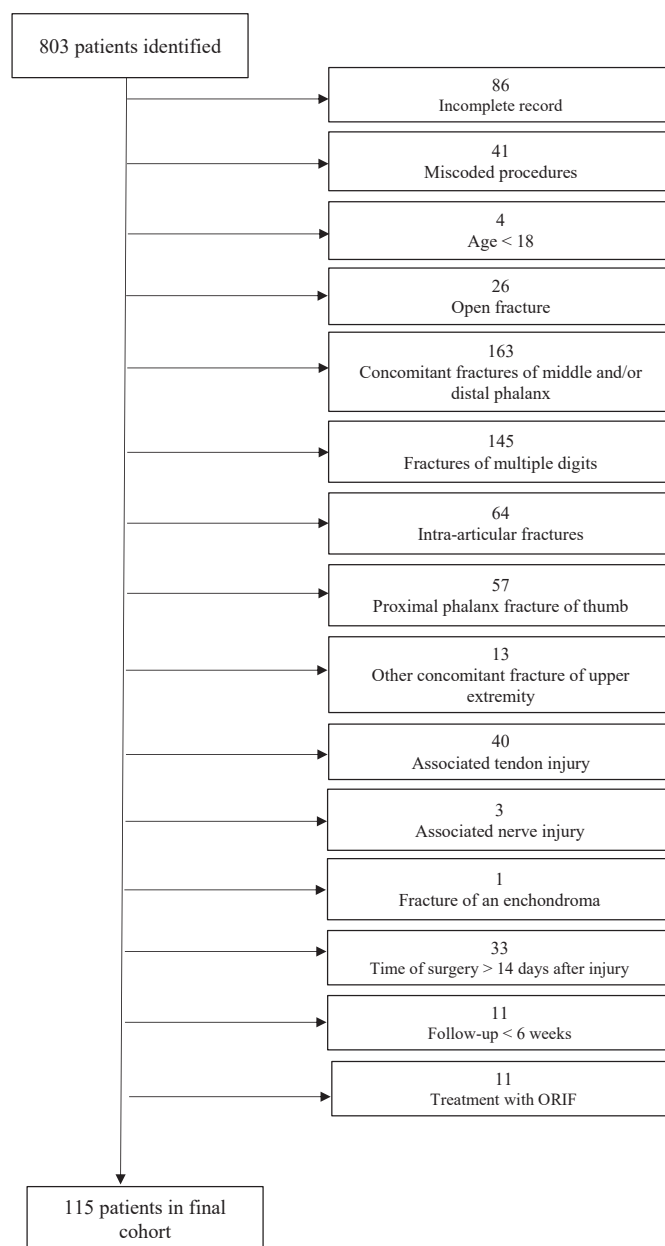


Figure 1. Flowchart of exclusions from the initial dataset.

expressed as mean (standard deviation [SD]), ordinal variables were expressed as median (interquartile range), and categorical variables were expressed by percentages. Bivariate analyses were performed to assess for factors associated with reoperation, using Student  $t$  tests for the comparison of parametric variables, Mann-Whitney U tests for the comparison of ordinal variables, and Fisher exact tests for the comparison of categorical variables. A convenience sample was used. The standard significant criterion of  $\alpha = 0.05$  was used.

## Results

Of the cohort of 115 patients with percutaneously treated isolated closed non-thumb extra-articular proximal phalanx fractures, 71 patients (61.7%) were female, with an average age of 48 (SD 17). The index finger was affected in 3.5% of fractures, the middle finger in 4.4%, the ring finger in 23.5%, and the small finger

in 68.7%. Therefore, CRPP pins were removed in the clinic at a mean of 26 days (SD 7 days; median 25 days, range 11–48) after surgery (Table 1).

A total of 67 complications were observed in 46 patients, including 25 cases of stiffness, 19 of flexion contracture, 9 of extensor lag, 4 of poor range of motion, 3 of infection, and 1 each of nonunion, hardware failure, malunion, malrotation, flexor digitorum superficialis adhesion, loss of extension, and swan neck deformity (Table 2). The overall rate of complication was 40.0%. Complication rates were found to be higher among smokers (87.5%) compared with nonsmokers (38.8%) ( $P = .01$ ). No other factors were associated with complications in the bivariate analysis.

Thirteen patients (11.3%) underwent reoperation at a mean of 6.7 months (SD 4.5 months) after surgery. Three of these patients had more than one procedure performed at the time of reoperation, resulting in a total of 23 reoperations in 13 patients (Table 3). Two patients underwent a second reoperation at a mean of 29.7 months (SD 17.3 months) after their first reoperation. One patient underwent a third reoperation at 1.8 months after their second, and a fourth reoperation at 3.7 months after the third. Most of the reoperations (84.6%) were for digital stiffness at a mean of 5.9 months (SD 1.7 months) from the index surgery. In the bivariate analysis, no factors were associated with reoperation in general or reoperation for stiffness specifically.

## Discussion

Fractures of the phalanges are a common injury that account for 23% of all hand, wrist, and forearm fractures, with the proximal phalanx being the most commonly affected.<sup>18,19</sup> Therefore, CRPP is a common management strategy for these fractures, but the rates of complications and reoperations after CRPP and the associated risk factors are not well-characterized.<sup>4</sup> In this study of 115 isolated single-digit non-thumb closed proximal phalanx fractures with no tendon or nerve injury treated with CRPP, we have found a rate of reoperation of 11% and a considerable complication rate of 40%.

Previous studies have looked at reoperation after surgery for proximal phalanx fractures and the role of surgical technique. Kootstra et al<sup>13</sup> showed that unplanned reoperation was more prevalent after plate fixation of proximal phalanx fractures compared with K-wire and lag-screw fixation. Similarly, another study by von Kieseritzky et al<sup>16</sup> found that open reduction with plate fixation was associated with a higher reoperation rate. Carpenter and Rohde argued that the lower reoperation rate associated with CRPP is related to less disruption of the soft tissue envelope and less adhesion formation.<sup>1</sup> Our findings suggest that CRPP for the surgical fixation of closed proximal phalanx fractures has a low associated rate of reoperation, comparable with previously published rates in the literature, and when reoperations are performed, they are primarily for stiffness.<sup>4</sup>

Our study has several limitations. First, the study is limited by its retrospective design. Under-documentation of complications and reoperations and loss to follow-up may lead to an underestimation of their true incidences. The study is also underpowered for assessing outcomes of complication and reoperation. In particular, for proximal phalanx fractures, previous literature and our experience concur that a significant percentage of patients lose some degree of motion. Our retrospective methodology did not allow for the final analysis of range of motion, and therefore, we only classified stiffness as a complication in patients who underwent secondary surgery. Second, the surgical treatment, postoperative immobilization, and rehabilitation protocol were nonstandardized and at the discretion of the treating surgeon. Third, a heterogeneous group of proximal phalanx fractures was studied, including fractures of the proximal portion, shaft, and distal portion of the

**Table 1**  
Characteristics of the Study Group

Variables	Patients (n = 115)
	<b>Mean (SD)</b>
Age (y)	48 (17)
	<b>n (%)</b>
Female sex	71 (61.7)
Diabetes mellitus	(3.5)
Current smoker	8 (7.0)
<b>Digit</b>	
Index	4 (3.5)
Middle	5 (4.4)
Ring	27 (23.5)
Small	79 (68.7)
<b>Dominant hand injured</b>	51 (44.7)
<b>Fracture location</b>	
Distal	14 (12.2)
Middle	36 (31.3)
Proximal	65 (56.5)
	<b>Median (IQR)</b>
<b>Time to surgery (d)</b>	7 (5–10)

**Table 2**  
Postoperative Complications After Proximal Palanx Closed Reduction Percutaneous Pinning (67 Complications in 46 Patients)

Complication	n = 67
Stiffness	25
Flexion contracture	19
Extensor lag	9
Infection	3
Poor range of motion or loss of motion	4
Nonunion	1
Hardware failure	1
Malunion	1
Malrotation	1
Flexor digitorum superficialis adhesion	1
Loss of extension	1
Swan neck deformity	1

**Table 3**  
Reoperations After Proximal Phalanx Closed Reduction Percutaneous Pinning (23 Reoperations in 13 Patients)

Reoperation	n = 23
Operations for stiffness	16
Tenolysis	11
Tenolysis and capsulectomy	3
Manipulation under anesthesia	1
Contracture release	0
Pulley release	1
Amputation	1
Wound debridement	1
Rotational flap	1
Osteotomy	1
Repeat open reduction and internal fixation or CRPP	1
Carpal tunnel release	2

phalanx. This limits our ability to draw conclusions specifically about a particular fracture pattern. Fourth, the reoperations in our study were mostly elective, and the decision for reoperation involved multiple patient and surgeon factors, which were not controlled in this retrospective study. Finally, most of the secondary surgeries were for limited range of motion, but we were unable to assess range of motion as an outcome variable. Nonetheless, these limitations provide future directions for studies to optimize the data on the comparative efficacy of these two surgical fixation approaches.

Fractures of the proximal phalanx are common, and the rates of complications and reoperations after surgical management are

notable. We have shown that the risk for postoperative complications and reoperations after CRPP of closed proximal phalanx fractures is considerable, and surgeons should counsel patients before surgery about these risks. The comparative risks of adverse events with various surgical techniques, such as open reduction and internal fixation versus CRPP, remain an important area of future research. Randomized controlled studies with larger sample sizes comparing techniques and fixation methods are necessary to provide a more evidence-based decision process for the surgical treatment of proximal phalanx fractures.

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