Percutaneous Pinning of Fractures in the Proximal Third of the Proximal Phalanx: Complications and Outcomes

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Purpose Two common techniques for fixation of extra-articular fractures at the proximal phalanx base are transarticular (across the metacarpophalangeal joint) and extra-articular cross-pinning. The aim of this study was to assess the complications and outcomes of these 2 techniques. Our hypothesis was that transarticular and extra-articular closed reduction and percutaneous pinning of base of proximal phalanx fractures have similar complication rates and outcomes.

Methods A retrospective chart review identified 338 patients with base of proximal phalanx fractures. We treated 50 isolated fractures with closed reduction and percutaneous pinning using 1 of 2 techniques: transarticular (25 fractures through the metacarpal head) or extra-articular (25 fractures cross-pinned through the base of the proximal phalanx). Outcome measures included total active motion and complications.

Results We found a substantial overall complication rate in both groups. The mean total active motion for the transarticular group and cross-pinning group was 201° and 198°, respectively. Proximal interphalangeal joint motion was notably affected; nearly half of the patients in each group had flexion loss greater than 20° (average, 27°) at the proximal interphalangeal joint. Nearly a third of patients in both groups had fixed flexion contracture greater than 15° at the proximal interphalangeal joint. There were more secondary procedures in the transarticular group (6) than in the cross-pinning group (2). There was no statistical significance between groups in any of the outcome parameters used.

Conclusions Closed pinning minimizes additional soft tissue injury and allows for early motion, but neither fixation method was superior in terms of the measured parameters. In addition, overall results were not as good as what has been reported in the literature. *(J Hand Surg 2012;37A:1342–1348. Copyright © 2012 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic III.

Key words Complication, percutaneous, phalanx, proximal, outcome.

PHALANX FRACTURES ACCOUNT for 23% of all below-elbow fractures in the United States; most occur in the proximal phalanx.[1] Proximal phalanx fractures can be the source of considerable morbidity. Coonrad and Pohlman[2] reported that 7 of 27 adults required corrective osteotomy after closed reduction and splinting. Treatment depends on several factors, including fracture location, fracture type, patient factors, and surgeon preference and experience.

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Percutaneous pinning is a suitable method of fixation for these fractures.[3–5] Two common techniques for extra-articular proximal phalangeal base fractures are transarticular (pin crosses the metacarpophalangeal [MCP] joint) and extra-articular cross-pinning. Advocates for percutaneous pinning have reported excellent results, with advantages including early active motion and minimal soft tissue damage.[5,6] This retrospective study assessed the complications and clinical outcomes of using these 2 techniques. Our hypothesis was that transarticular and extra-articular closed reduction and percutaneous pinning of base of proximal phalanx fractures would have similar complication rates and outcomes.

MATERIALS AND METHODS

After we obtained institutional review board approval, we performed a retrospective chart review for 2005 to 2010 in a large hand surgery practice, to identify fractures of the base of the proximal phalanx. We found a total of 338 patients using a Current Procedural Terminology code search that included codes 26727 and 26735. Inclusion criteria included acute (within 2 wk of injury), isolated, transverse or short oblique, extra-articular fractures in the proximal third of the proximal phalanx in skeletally mature patients. All fractures were considered unstable and therefore not amenable to closed treatment. Unstable fractures were defined as any angulation greater than 5° to 10° in the coronal plane and greater than 20° in the sagittal plane with pseudoclawing on clinical examination. We excluded open injuries, more than 1 fracture, skeletally immature patients, presentation later than 2 weeks after injury, and proximal phalanx fractures of the thumb. We also excluded fractures distal to the proximal third of the proximal phalanx because these fractures are often treated in an open fashion with either pins or plates. Conversely, proximal-third, extra-articular fractures are almost exclusively pinned, and hence were the focus of this study. There were 25 fractures in each group, which represented all includable fractures from the Current Procedural Terminology code search that met the inclusion criteria. Within the transarticular group, there were 17 fractures in the little finger, 3 in the ring finger, and 5 in the index finger. The cross-pinning group included 20 fractures in the little finger, 4 in the ring finger, and 1 in the index finger.

We reduced closed and percutaneously pinned all fractures using 1 of 2 methods: transarticular (through the metacarpal head) or extra-articular cross-pinning from the base of the proximal phalanx. Eight fellowship-trained, orthopedic hand surgeons performed all procedures. Surgeon preference dictated which particular technique was used. The mean age was 45 years for both groups (range, 18–89 y). The average follow-up time was 8 months (range, 6–11 mo). Mean time to surgery was 6 days for both groups (range, 1–14 d).

We treated all patients in the operating room using either regional or general anesthesia. In both groups, we treated all fractures with 2 Kirschner wires. We used modified transmetacarpal head fixation as described by Belsky et al[3] for all transarticularly pinned fractures. We placed longitudinal traction on the affected finger and flexed the MCP joint 60° to 80°, and the proximal interphalangeal (PIP) joint to 45°. We corrected angulation and rotation, and drove 2 antegrade 1.1-mm (0.045-in) Kirschner wires across the flexed MCP joint into the subchondral bone of the proximal phalangeal head (Figs. 1, 2). Fractures in the extra-articular cross-pinning group were similarly reduced and then had cross-pins placed from the radial and ulnar base of the proximal phalanx (Figs. 3, 4). We attempted to consistently insert the Kirschner wire as radial and ulnar as possible, to decrease the chance of piercing the lateral bands. In both groups, we left Kirschner wires outside the skin and splinted the fractures for 3 to 7 days. Within 1 week, a certified hand therapist initiated early active range of motion of the interphalangeal joints, including early active tendon gliding exercises. The therapist also addressed edema control with compressive dressings within a week after surgery. The MCP joint was protected with a dorsal extension block splint for 4 weeks. We removed the Kirschner wires at 3 to 4 weeks, at which time we encouraged aggressive active range of motion. Gentle passive range of motion was initiated at 6 to 8 weeks under the supervision of a hand therapist.

The operating surgeon assessed and recorded outcome measures, including total active motion as measured with a goniometer (Patterson Medical, Bolingbrook, IL) and complications. Total active motion of the digit was defined as the sum of active flexion measurements of the MCP, and PIP and distal interphalangeal (DIP) joints of a digit minus the active extension deficits of the same 3 joints (normal is between 260° and 270°).[6] Complications were defined as pin loosening, pin track infection, flexion loss, or extensor lag (defined as greater than 15°) at any joint, residual flexion contractures (defined as greater than 15°) at any joint, malunion, nonunion, and any secondary procedures. Secondary procedures included tenolysis, capsulotomy, osteotomy, and open reduction internal fixation.

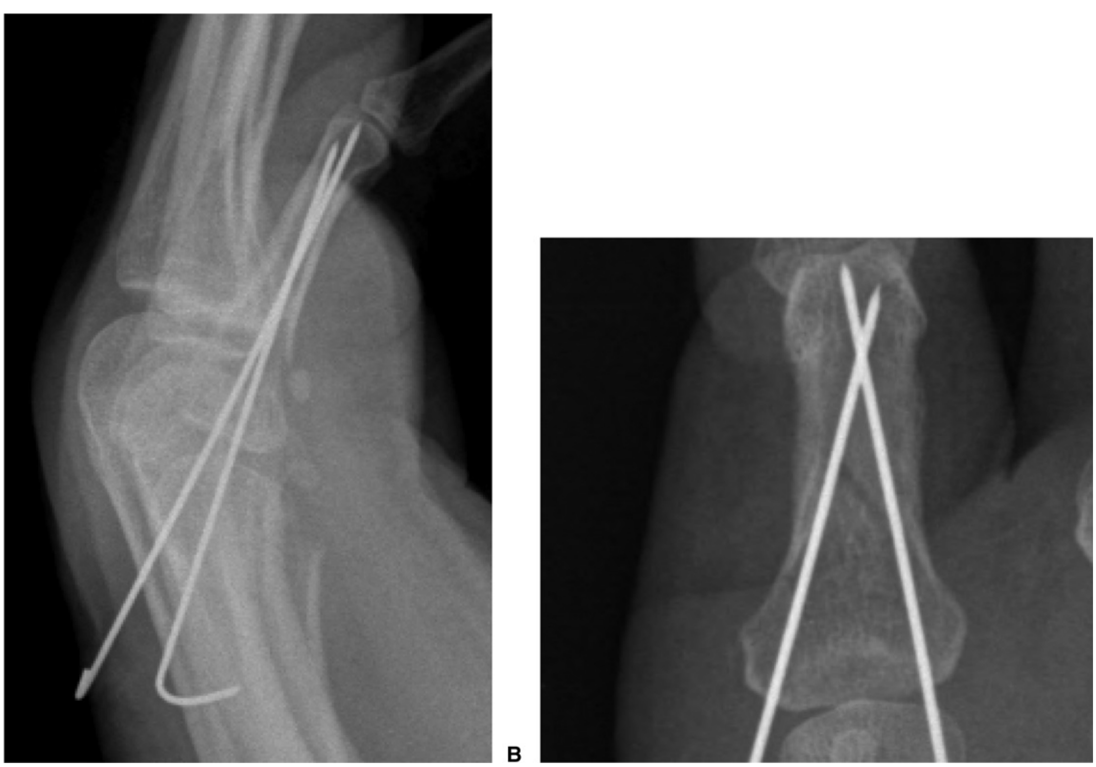
FIGURE 1: Transarticular technique: preoperative radiographs. **A** PA radiograph. **B** Oblique radiograph. **C** Lateral radiograph.

FIGURE 2: Transarticular technique: postoperative radiographs. **A** PA radiograph. **B** Lateral radiograph.

We calculated descriptive statistics including mean, median, standard deviation, minimums, and maximums for all outcome measures in both groups. We used an independent *t*-test to assess the average degree of contracture and extensor lags for the MCP, PIP, and DIP joints. We used the chi-square test for homogeneity to compare complication and contracture rates between groups.

A B

FIGURE 3: Cross-pinning technique: preoperative radiographs. **A** PA radiograph. **B** Lateral radiograph.



A B

FIGURE 4: Cross-pinning technique: postoperative radiographs. **A** Lateral radiograph. **B** PA radiograph.

TABLE 1. Range of Motion and Complications in Transarticular and Cross-Pinning Groups

	Transarticular	Cross-Pinning
Range of motion (°)		
Total active motion	201	198
Arc of motion MCP joint (mean)	0–79	3–81
Arc of motion PIP joint (mean)	11–83	7–79
Arc of motion DIP joint (mean)	4–54	2–51
Complications (patients [n])		
Flexion loss at MCP joint*	11	5
Flexion loss at PIP joint*	13	12
Flexion loss at DIP joint*	5	9
Flexion contractures of MCP joint*	0	4
Flexion contractures of PIP joint*	8	8
Flexion contractures of DIP joint*	3	1
Extensor lag at PIP joint*	2	3
Pin track infection	1	0
Malunion	1	0
Nonunion	1	0
Secondary procedures (patients [n])		
Flexor tenolysis	4	1
Extensor tenolysis	1	0
Capsulotomy	1	1

*Greater than 15°.

RESULTS

Table 1 lists the results. None of these differences was statistically significant.

Contractures, extensor lag, flexion loss, and motion are tabulated at the PIP joint for each group (Table 2). Two patients had an extensor lag at the PIP joint in the transarticular group, measuring 15° in each. Three patients in the cross-pinning group had extensor lags at the PIP joint, measuring 20°, 30°, and 35°. We found no statistical significance between the 2 groups in any outcome category at the PIP joint.

In the transarticular group, the mean range of motion at the DIP joint was 4° to 54° (range, 0° to 60°), with 1 contracture of 25°. In the cross-pinning group, the mean range of motion at the DIP was 2° to 51° (range, 0° to 60°). Mean flexion loss in both groups was negligible. We noted no statistical significance between the groups at the DIP joint for any of the outcome measures.

There were more secondary procedures (n = 6) in the transarticular group (Table 1). In this group there was also 1 nonunion and 1 malunion attributed to a lost reduction. Both patients declined additional treatment. Fracture reduction was maintained until bony union in all other patients. There was also 1 superficial pin track infection that resolved with oral antibiotics. In the cross-pinning group, 1 patient required a flexor tenolysis and a PIP capsulotomy. We found no infections, malunions, or nonunions in the cross-pinning group. Fracture reduction was maintained until bony union in all patients in the cross-pinning group.

There was a trend for an overall higher complication rate in the transarticular group, but this did not reach statistical significance. In this group, the overall complication rate was 56% (14 of 25 patients). There was an overall complication rate of 48% for the cross-pinning group (12 of 25 patients).

DISCUSSION

One of the most common problems in fractures of the phalanges is stiffness. Immobilization of the finger for more than 3 weeks has been shown to lead to unfavorable clinical results.[7,8] Extra-articular fractures of the base of the proximal phalanx are common, and whereas many authors have reported favorable outcomes,[3,6,9] others have reported morbidity and poor results.[2],12 These fractures typically displace with an apex palmar angulation configuration as the central slip extends the distal fragment and the intrinsic muscles flex the proximal fragment. Malunion may result in pseudoclawing of the affected digit.[4] This angulation can also result in skeletal shortening and extensor tendon lengthening,[10] which can lead to a PIP joint extensor lag. Vahey et al[10] reported a linear relationship between skeletal shortening and PIP joint extensor lag. If allowed to heal in this apex palmar angulation, the estimated subsequent extensor lags can be 10° at 16° of angular deformity, 24° at 27° of deformity, and 66° lag 46° of deformity.[11] Despite this possibility of morbidity and a high incidence of injury, the literature lacks strong evidence guiding treatment.

As noted above, percutaneous fixation of proximal phalanx fractures has been reported to achieve good clinical results. Joshi[11] reported a retrospective series of 62 proximal phalanx fractures in 53 patients treated with closed reduction and extra-articular percutaneous pinning, and had a 90% overall satisfaction rate. Green and Anderson[5] retrospectively assessed 26 fractures in 21 patients treated with closed reduction and extra-articular percutaneous pinning. An early motion program was initiated, and 18 of 21 patients regained full

TABLE 2. Loss of PIP Joint Motion

	Transarticular	Cross-pinning
Fixed flexion contracture >15°	8/25 (32%) (mean, 34°)	8/25 (32%) (mean, 28°)
Extensor lag	4/25 (16%) (mean, 11°)	6/25 (24%) (mean, 18°)
Flexi loss > 20°	13/25 (52%) (mean, 27°)	12/25 (48%) (mean, 27°)
Mean PIP arc of motion	11° to 83° (range, 0° to 110°)	7° to 79° (range, 0° to 110°)

motion. Belsky and colleagues[3] prospectively reported 100 proximal phalangeal fractures treated with closed reduction and trans-articular percutaneous pinning. All patients were protected in a splint for at least 3 weeks. Over 90% achieved excellent or good results, with 61% achieving a total active movement of 215° or more. Hornbach and Cohen[6] also reported excellent results using the transarticular techniques. In a retrospective review of 12 transarticular pinnings, they reported an average total active motion of 265° and had only 1 PIP joint flexion contracture and 1 rotational deformity.

The potential for complications and poor results using these techniques has also been reported.[8] Elmaraghy et al[9] reported 35 transarticular pinnings of proximal phalanx fractures in 24 patients. A total of 32% of digits developed a PIP joint flexion contracture averaging 18°. There were 7 secondary procedures in 6 patients. The authors also noted loss of reduction with rotational deformity in 4 digits and 1 nonunion.

In this study, there was a substantial complication rate in both groups: 56% in the transarticular group and 48% in the cross-pinning group. This is considerably higher than what is reported in the literature. Our range of motion data revealed considerable loss of total active motion, with 201° in the transarticular group and 198° in the cross-pinning group. Although we found a moderate loss of MCP motion in both groups, there was also a substantial loss of PIP flexion (27°. Although we used Kirschner wire fixation to minimize soft tissue damage and initiated early range of motion, total active motion was substantially less than what has been reported in the literature regardless of fixation technique. When we reviewed loss of motion at the PIP joint, the results were also discouraging. Nearly half the patients in each group had a flexion loss greater than 20°. There were more secondary procedures in the transarticular group than in the cross-pinning group. Indications for tenolysis and capsulotomies included refractory adhesions and capsular contractures after 6 months of supervised rehabilitation. The transarticular group had 4 tenolyses, 1 PIP joint capsulotomy, and 1 extensor tenolysis. One possible explanation is that a transarticular pin prevents MCP joint motion and skewers the extensor mechanism, which may contribute to adhesion and scar formation on both the flexor and extensor surfaces of the proximal phalanx, as well as diminished gliding of the dorsal apparatus. There were no contractures of the MCP joint in the transarticular group, even with the MCP joint being held in flexion for 3 weeks. The transarticular group also had the only malunion and nonunion in this study, which contributed to the overall higher complication rate in this group. Both of these patients were offered further treatment but declined.

It is difficult to assess potential causes for such poor outcomes. Patient compliance with rehabilitation protocols cannot be controlled and could be a potential source of such results. Lack of motion at the DIP joint could potentially cause adhesions of the flexor digitorum profundus tendon to fracture callus. Tethering of the extensor tendons also likely contributed to adhesion formation and difficulties with PIP joint motion. Advanced patient age also may have been a contributing factor.

This study has several limitations. It is retrospective, and it is likely that there was surgeon selection bias toward 1 technique or the other. In addition, follow-up was relatively short, and it was difficult to determine whether final outcome measures would have changed substantially had it been longer. Finally, lack of power analysis and a small subgroup size may have contributed to our lack of statistical significance in measuring outcomes.

Nevertheless, the overall complication rate was much higher than that reported in the literature. There were considerable problems with range of motion at the MCP and PIP joints regardless of the technique selected. Despite operative intervention minimizing soft tissue injury and initiating early range of motion protocols, total active motion for both groups was substantially lower than what has been previously reported. Unfortunately, we were unable to identify specific factors that account for our increased rate of complications. Therefore, we have not altered our fixation methods or rehabilitation protocols. We were disappointed with our findings; for us, the ideal method for fixation of these fractures is unclear.

REFERENCES

1. Chung KC, Spilson SV. The frequency and epidemiology of hand and forearm fractures in the United States. J Hand Surg 2001;26A: 908–915.
2. Coonrad RW, Pohlman MH. Impacted fractures in the proximal portion of the proximal phalanx of the finger. J Bone Joint Surg 1969;51A:1291–1296.
3. Belsky MR, Eaton RG, Lane LB. Closed reduction and internal fixation of proximal phalangeal fractures. J Hand Surg 1984;9A: 725–729.
4. Day CS, Stern PJ. Fractures of the metacarpals and phalanges. In: Green DP, ed. Operative hand surgery. Vol. 1. 6th ed. New York: Churchill Livingstone, 2011:695–758.
5. Green DP, Anderson JR. Closed reduction and percutaneous pin fixation of fractured phalanges. J Bone Joint Surg 1973;55A:1651–1652.
6. Hornbach EE, Cohen MS. Closed reduction and percutaneous pinning of fractures of the proximal phalanx. J Hand Surg 2001;26B: 45–49.
7. Green DP. Complications of phalangeal and metacarpal fractures. Hand Clinics 1986;2:307–328.
8. Agee J. Treatment principles for proximal and middle phalangeal fractures. Orthop Clin North Am 1992;23:35–40.
9. Elmaraghy MW, Elmaraghy AW, Richards RS, Chinchalkar SJ, Turner R, Roth JH. Transmetacarpal intramedullary K-wire fixation of proximal phalangeal fractures. Ann Plast Surg 1998;41:125–130.
10. Vahey JW, Wegner DA, Hastings H III. Effect of proximal phalangeal fracture deformity on extensor tendon function. J Hand Surg 1998;23A:673–681.
11. Joshi BB. Percutaneous internal fixation of fractures of the proximal phalanges. Hand 1976;8:85–92.