



Treatment of proximal phalanx fractures: transarticular pinning the metacarpophalangeal joint or cross pinning from the base of the proximal phalanx—a prospective study

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Abstract

Introduction For extraarticular proximal phalanx fractures, two methods are employed, transarticular fixation in which the metacarpophalangeal joint is crossed and the extraarticular method in which the pins are introduced through the base of the proximal Phalanx.

Materials and methods This study was a prospective one on patients with proximal phalanx transverse or short oblique fractures. In one of the groups we used parallel pins from metacarpal head through MCP joint to proximal phalanx. In the second, we used two cross pins from proximal phalanx the base of the proximal phalanx to fix the fracture. We evaluated metacarpophalangeal, proximal and distal interphalangeal joints active range of motion and how long it took the patient to resume their daily activities and work without difficulty, as well as post-operative complications such as wound infection, malunion, and nonunion in 3 and 6 months follow-up.

Results Ultimately, 61 people entered the study, 29 in the parallel pins and 31 in the cross pins group. There was no significant difference between the two groups, but the improvement in all of the joints range of motion showed a statistically significant difference ($P < 0.0001$) from the 3 to 6 months follow-up. The final range of motion showed an inverse correlation with age of the patient ($P < 0.05$). Most of the patients were in the excellent grade of range of motion class and no serious complication was observed in any of them.

Conclusion The results of treatment in proximal phalangeal fractures with both methods were comparable and so the surgeon may select each based on the experience and training.

Keywords Fracture · Proximal phalanx · Pin

Introduction

Belsky et al. [1] proposed a less invasive method than open reduction and internal fixation for proximal phalanx fractures in which a Kirschner wire was inserted into the phalanx

from the metacarpal head after closed reduction. In a retrospective study, 14 years later Elmaraghy et al. [2], presented their experience with this method and found it easy and associated with good results. Hornbach et al. [3] tried to prevent potential instability of this method and inserted two Kirschner wires instead of one. Good results of this method have been mentioned [4] and nowadays they are the choice in treatment of proximal phalanx fractures [5]. Despite this Al Qattan, in 2011, proposed a new method in which the pins were introduced through phalangeal, the base of the proximal Phalanx, so as the metacarpophalangeal joint is spared [6]. This is a good note, as at least theoretically the metacarpophalangeal joint should be spared whenever possible and crossing it may damage the cartilage, lead to infection and stiffness. Al Qattan compared his results with his previous experience with the standard method and also with open reduction and internal fixation [7] and found his

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new method superior. Up to the best of our knowledge, no prospective study has compared these two methods, which is the purpose of the present study.

Patients and methods

This prospective study was performed on patients referred to our emergency department from July 2014 to September 2015 with proximal phalanx fractures. Ethics Committee approved the study, number K/93/701.

Inclusion criteria were as follows:

1. Informed consent for participation.
2. Fe/male above 18 and less than 50 y/o.
3. Extraarticular short oblique or transverse proximal phalanx fracture in the fingers.

Exclusion criteria were as follows:

1. More than one finger fracture.
2. Comminuted fractures.
3. Associated tendon injury, requiring repair.
4. Soft tissue injury requiring reconstruction.
5. More than one week since initial injury.

The patients were treated by percutaneous pin fixation based upon the decision of on call attending surgeon in one of the two methods: in the first group, the MCP joint was flexed to 90 degrees and 2 parallel Kirschner wires were inserted into the metacarpal head and then the proximal phalanx base, while in the second group the two pins crossed each other, introduced through the base of the proximal phalanx, after the fracture was reduced by flexing the MCP Joint and manipulating the phalanx (Figs. 1, 2). All surgeries were performed by one orthopedics resident. All patients, in both groups received prophylactic antibiotic (cephazolin) for 24 h and then were discharged. Active motion of the free joints was encouraged after discharge, though a dorsal splint was used for comfort in both groups. Dressing and local pin care was advised once a day for all patients. In both groups the pins were extracted after 3 weeks, without anesthesia. The patients were followed at 1-month intervals by a thorough face-to-face history and physical examination, concerning and emphasizing the study protocol and targets. The aim of the study was a 6-month follow up. Range of motions (ROM) of the metacarpophalangeal (MCP), proximal (PIP) and distal interphalangeal (DIP) joints and also the time that has passed for the patient to return to his daily activities without any difficulty were recorded alongside with the complications of surgery which might include malunion, nonunion, infection, wire breakage, complex regional pain syndrome (CRPS), skin loss or any other unpredictable complications.

For range of motion measurement, a specialized goniometer was used (Fig. 3). Total active range of motion was defined as the sum of flexion in any joint minus the extension lag and was classified as excellent (TAM > 240°), good (TAM 220°–240°), fair (TAM 180–219) and poor (TAM < 180°). The data were analyzed with Computer Pentium 4 and SPSS 19 using Student t and Chi-square tests.

Results

Ultimately, 61 individuals reached the 6-month follow-up aim of the study including 50 men and 11 women, 29 in the first (pins through metacarpal head) and 32 in the second group (pins from the base of the proximal Phalanx). At this time no cases of malunion, nonunion or CRPS were found. Two patients from the first group showed evidence of superficial and pin tract infection, in both resolving after pin removal and local wound care.

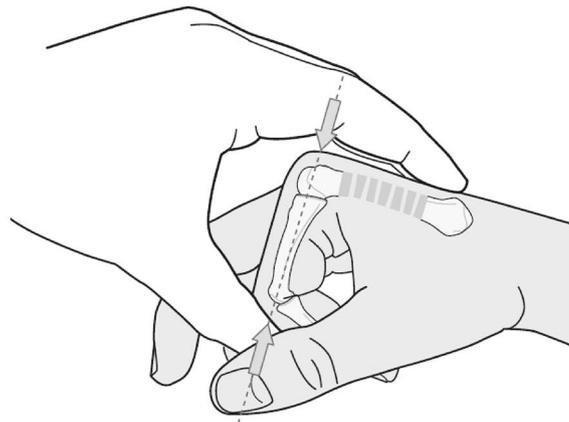
Of the 61 fingers, in 15 the fracture was in the ring (6 in group 1), 17 in middle (10 of group 1), ring in 15 (7 in group 1) and fifth in 14 (6 group 1). The time to work return varied from 1 to 8 weeks, but the difference was not statistically significant between the 2 groups ($P > 0.05$) and most of the patients had been able to retain their usual daily activities after 4 weeks (24 and 25 days in the 1st and 2nd groups, respectively).

Total active range of motion (TAM) was compared in the two groups for the 3 and 6 months follow-up, and did not show a statistically significant difference (Tables 1, 2), but ROM in all of the joints (MCP, PIP and DIP) showed a statistically significant improvement from 3 to 6 months follow-up ($P < 0.0001$ for all of them).

The correlation among variables was studied by a linear regression model. The ROM in MCP, PIP and DIP joints showed a strong correlation with age and return to work time ($P < 0.05$), so that the higher the age of the patient, the lower would be the final ROM and again the higher the ROM the sooner had the patient returned to work and daily activities. There was no correlation with sex and education level and the final results.

The surgeon performing all of the surgeries was an orthopedics resident, familiar with both methods. When he was asked about the pros and cons of the two methods, he mentioned the need for experience and expertise alongside with a higher number of X-ray exposures for pin insertion from the base of the proximal Phalanx. The number of exposures had not been documented, but he would remember that in the majority of cases of the first group the first try was obviously successful and C-Arm was used for confirmation, while in the second group multiple attempts under fluoroscopy were necessary.

Fig. 1 Parallel pins from metacarpal head, the above diagram shows the position of phalanx after reduction in addition to pin direction. Intraoperative X-ray and the position of hands of the patient and the surgeon are shown. In the last part, preoperative and postoperative X-Rays of a patient treated in this way have been presented. The diagram has been reproduced with permission from “AO Handbook—Nonoperative Fracture Treatment”, Copyright by AO Foundation, Switzerland



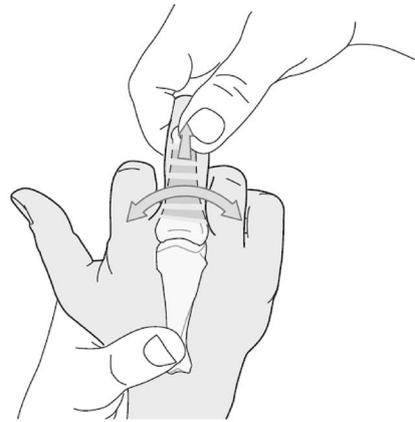
Discussion

In the present study, we prospectively compared two methods of treatment of phalangeal proximal fractures and ultimately concluded that no one has obvious superiority over the other, except being more simple and the less X-ray exposure in the transarticular method.

Hand fractures and dislocations are among the most common in musculoskeletal system [5] and their epidemiology has been the center of attention several times [8–12]. Proximal phalanx fractures are one of the very common ones and among the most common [11, 13] and may be associated

with high morbidity [14]. Treatment of these fractures, like any other, depends upon the experience and expedition of the surgeon, fracture type, associated injuries and the patient, but in closed transverse or short oblique, non-comminuted fractures of the proximal phalanx percutaneous pin fixation seems a “good” choice and the two methods described in the present study are in common use. Up to the best of our knowledge, this is the first time that these two methods are compared in a prospective manner. In fact, these two methods, again up to the best of our knowledge, have been compared retrospectively two times: Al Qattan compared his results with his own description of closed

Fig. 2 Cross pins from the base of the proximal Phalanx, the diagram shows the maneuver for reduction before pinning. Two examples of the preoperative and postoperative X-rays have been shown. The diagram has been reproduced with permission from “AO Handbook—Nonoperative Fracture Treatment”, Copyright by AO Foundation, Switzerland



reduction and percutaneous pin fixation from the base of the proximal Phalanx with his experience from closed reduction and transarticular fixation of these fractures and found the results of the new method “significantly better” [6]. The second, was a retrospective study that compared these two methods in treatment of proximal phalanx “base” fractures and found both associated with significant complications, however, no one was superior [14].

We encountered no serious complications in our series, no significant infection, return to work for all of our patients, functional Rom in nearly all and no need for reoperation in any patient. Previous papers on percutaneous pin fixation of proximal phalanx fractures have reported diverse results: some have reported excellent results with rapid union and

return of range of motion [3, 4, 15–17], while others have encountered complications such as nonunion, pin loosening, infection and the need for capsulotomy or osteotomy [14, 18–21]. Perhaps one of the reasons for good results of the present study may be the strict inclusion criteria: only one injured finger, closed noncomminuted fractures, only transverse or short oblique pattern fractures and finally entrance of nondisplaced fractures to the study, as in our opinion, all proximal phalanx fractures are inherently unstable and even the nondisplaced ones require internal fixation. In the past the two important factors leading to unfavorable results have been comminution and open fractures [13]. Also considering solely, the fractures of base of proximal phalanx may have been the reason for poor results in previous reports [14].

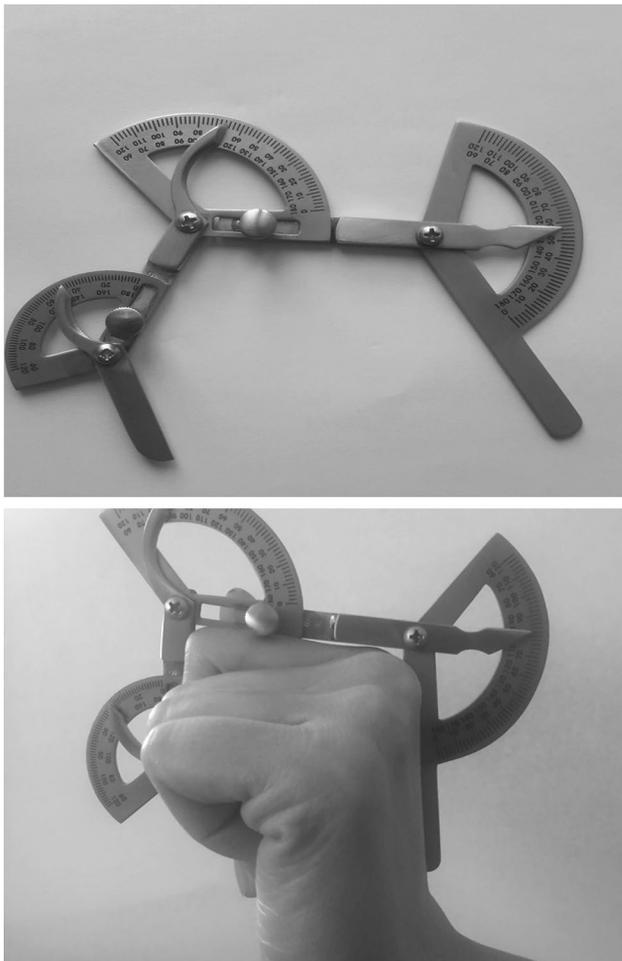


Fig. 3 Goniometer for ROM measurement

One of the disadvantages for pinning from the head of metacarpal is transfixation of the MCP joint and in opinion of some of the authors, this should be avoided anytime.

Table 1 Fingers joints range of motion in the two groups

	3 months follow up			6 months follow up		
	MCP	PIP	DIP	MCP	PIP	DIP
Group 1	79.13±9.99	87.96±16.81	71.58±10.67	81.96±7.27	87.96±16.81	73.20±10.08
Group 2	80.03±8.66	87.62±15.02	18.8 71.09±	82.40±7.23	15.10±2.67	72.84±8.19
<i>p</i> value	0.710	0.900	0.840	0.813	0.934	0.877

Table 2 Comparison of TAM in the two groups

	Number of patients in each group in 3 months follow-up				Number of patients in each group in 6 months follow-up			
	Poor	Fair	Good	Excellent	Poor	Fair	Good	Excellent
Group 1	2	4	4	19	2	2	2	22
Group 2	2	5	8	18	1	5	2	24
<i>P</i> value	0.875				0.890			

Therefore, even though the cross pinning seems to be more difficult and with the need of more fluoroscopy, it seems more appropriate. In fact, this was our rationale for performing the study and we expected that the results will confirm the superiority of the cross pin method! This method has the advantage of avoiding damage to metacarpophalangeal joint and allowing free movement in it after the operation (Fig. 4), but both in our experience and others' [14] this was not the case in practice and the range of motion was not different in the two groups. We cannot rationalize this finding, but perhaps rapid performance of the surgery (less than 1 week of the fracture) and also fixation of the MCP joint in 90 degrees of flexion, which is ideal for prevention of stiffness and also rapid initiation of motion may have been influential. It must be noted that crossing the MCP joint is the "author's preferred method" in one of the most authentic textbooks on fractures [5]. Anyway the authors still think that it may be a good practice to avoid crossing the MCP joint, whenever possible, especially in the younger patients.

Surgeon convenience in performing the surgeries has not been the center of much attention and we think the reason is the fact that the technique is related to expertise and experience and no single method may be advocated for all surgeons, but according to the surgeon performing surgeries on our patients, transmetacarpal pinning was much easier.

The possibility of conservative management of these fractures is an issue [22–24]. In fact, this may be the treatment of choice for minimally displaced phalangeal fractures that are stable or will be stable after reduction. These may be ideal candidates for treatment with splinting and the MP joint in flexion (Fig. 5). Despite these facts, we preferred to manage all of proximal phalangeal fractures in our center with CR-PCP, in part because of our unfavorable unpublished experience with conservative treatment. Even though, we admit that conservative treatment may have been a good choice in some of our



Fig. 4 Schematic presentation of a fractured proximal phalanx treated by cross pins from phalanx base, showing theoretical advantage of full joint extension

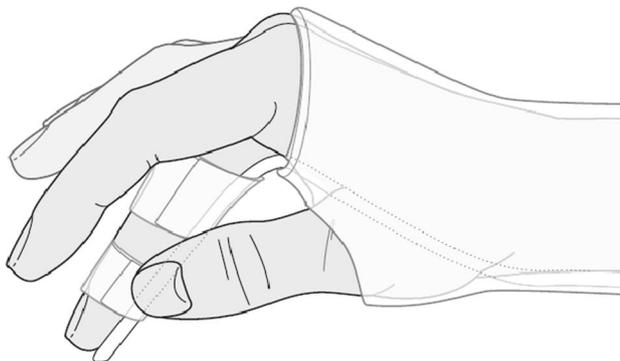


Fig. 5 Nonoperative treatment of proximal phalangeal fractures with immobilization in flexion and extension block taping. The diagram has been reproduced with permission from “AO Handbook—Nonoperative Fracture Treatment”, Copyright by AO Foundation, Switzerland

patients, in agreement with experience of others [25–28]. A good topic for future studies may be the comparison of conservative and operative management of these fractures.

An interesting finding of the present study was the statistically significant improvement in ROM of all of the joints of the involved finger in the 3–6 months follow-up interval. We could not find a limit in time after which ROM would not improve after proximal phalanx fracture treatment and this may be another good topic for further research. Again, the reverse correlation of age with final ROM was an expectable but interesting finding of the present study.

The present study has limitations: the strict inclusion criteria makes generalization of the findings difficult. On the other hand, including all parts of the phalanx and smokers and nonsmokers, despite their random allocation to each group may be a limitation. We did not measure the power grip and especially the fractured finger power and certainly this is a limitation and may be center of attention in future. Another limitation is the fact that conservative treatment was not considered in any fracture patterns.

Based upon the findings of the present study, it seems that both transarticular pin fixation and fixation from base of metacarpal in treatment of transverse and short oblique fractures of the proximal phalanx are associated with good results and are comparable to each other.

Compliance with ethical standards

Conflict of interest The Authors declare that they have no conflict of interest.

References

1. Belsky MR, Eaton RG, Lane LB. Closed reduction and internal fixation of proximal phalangeal fractures. *J Hand Surg Am.* 1984;9(5):725–9.
2. Elmaraghy MW1, Elmaraghy AW, Richards RS, Chinchalkar SJ, Turner R, Roth JH. Transmetacarpal intramedullary K-wire fixation of proximal phalangeal fractures. *Ann Plast Surg.* 1998;41(2):125–30.
3. Hornbeck EE1, Cohen MS. Closed reduction and percutaneous pinning of fractures of the proximal phalanx. *J Hand Surg Br.* 2001;26(1):45–9.
4. Henry MH. Fractures of the proximal phalanx and metacarpals in the hand: preferred methods of stabilization. *J Am Acad Orthop Surg.* 2008;16(10):586–95.
5. Henry MH. Hand fractures and dislocations. Rockwood and Green’s fractures in adults. Vol. 1. Bucholz RW, Heckman JD, Tornetta P, editors. Philadelphia: Lippincott Williams and Wilkins; 2015. pp. 915–89.
6. Al-Qattan MM. Displaced unstable transverse fractures of the shaft of the proximal phalanx of the fingers in industrial workers: reduction and K-wire fixation leaving the metacarpophalangeal and proximal interphalangeal joints free. *J Hand Surg Eur.* 2011;36(7):577–83.
7. Al-Qattan MM. Closed reduction and percutaneous K-wires versus open reduction and interosseous loop wires for displaced unstable transverse fractures of the shaft of the proximal phalanx of the fingers in industrial workers. *J Hand Surg Eur.* 2008;33(5):552–6.
8. Kumar K. Scenario of hand fractures in a tertiary hospital: a prospective study. *Musculoskelet Surg.* 2013;97(1):57–60.
9. Shah SS, Rochette LM, Smith GA. Epidemiology of pediatric hand injuries presenting to United States emergency departments, 1990 to 2009. *J Trauma Acute Care Surg.* 2012;72(6):1688–94.
10. Anakwe RE, Aitken SA, Cowie JG, Middleton SD, Court-Brown CM. The epidemiology of fractures of the hand and the influence of social deprivation. *J Hand Surg Eur.* 2011;36(1):62–5.
11. van Onselen EB, Karim RB, Hage JJ, Ritt MJ. Prevalence and distribution of hand fractures. *J Hand Surg Br.* 2003;28(5):491–5.
12. Stanton JS, Dias JJ, Burke FD. Fractures of the tubular bones of the hand. *J Hand Surg Eur.* 2007;32(6):626–36.

13. Ip WY, Ng KH, Chow SP. A prospective study of 924 digital fractures of the hand. *Injury*. 1996;27:279–85.
14. Faruqui S, Stern PJ, Kiefhaber TR. Percutaneous pinning of fractures in the proximal third of the proximal phalanx: complications and outcomes. *J Hand Surg Am*. 2012;37(7):1342–8.
15. Eberlin KR, Babushkina A, Neira JR, Mudgal CS. Outcomes of closed reduction and periarticular pinning of base and shaft fractures of the proximal phalanx. *J Hand Surg Am*. 2014;39(8):1524–8.
16. Green DP, Anderson JR. Closed reduction and percutaneous pin fixation of fractured phalanges. *J Bone Joint Surg Am*. 1973;55(8):1651–4.
17. Joshi BB. Percutaneous internal fixation of fractures of the proximal phalanges. *Hand*. 1976;8:85–92.
18. Coonrad RW, Pohlman MH. Impacted fractures in the proximal portion of the Proximal phalanx of the finger. *J Bone Joint Surg Am*. 1969;51(7):1291–6.
19. Horton TC, Hatton M, Davis TR. A prospective randomized controlled study of fixation of long oblique and spiral shaft fractures of the proximal phalanx: closed reduction and percutaneous Kirschner wiring versus open reduction and lag screw fixation. *J Hand Surg Br*. 2003;28(1):5–9.
20. Botte MJ, Davis JL, Rose BA, et al. Complications of smooth pin fixation of fractures and dislocations in the hand and wrist. *Clin Orthop Relat Res*. 1992;276:194–201.
21. Stahl S, Schwartz O. Complications of K-wire fixation of fractures and dislocations in the hand and wrist. *Arch Orthop Trauma Surg*. 2001;121(9):527–30.
22. Figl M, Weninger P, Hofbauer M, Pezzeri C, Schauer J, Leixnering M. Results of dynamic treatment of fractures of the proximal phalanx of the hand. *J Trauma*. 2011;57(4):852–6.
23. Franz T, von Wartburg U, Schibli-Beer S, Jung FJ, Jandali AR, Calcagni M, Hug U. Extra-articular fractures of the proximal phalanges of the fingers: a comparison of 2 methods of functional, conservative treatment. *J Hand Surg Am*. 2012;37(5):889–98.
24. Held M, Jordaan P, Laubscher M, Singer M, Solomons M. Patterns. *Hand Surg*. 2013;18(2):229–34.
25. Giddins GE. The non-operative management of hand fractures. *J Hand Surg Eur*. 2015;40(1):33–41.
26. Carpenter S, Rohde RS. Treatment of phalangeal fractures. *Hand Clin*. 2013;29(4):519–34.
27. Fok MW, Ip WY, Fung BK, Chan RK, Chow SP. Ten-year results using a dynamic treatment for proximal phalangeal fractures of the hands. *Orthopedics*. 2013;36(3):e348–52.
28. Held M, Jordaan P, Laubscher M, Singer M, Solomons M. Conservative treatment of fractures of the proximal phalanx: an option even for unstable fracture patterns. *Hand Surg*. 2013;18(2):229–34.