

# Clinical and Radiological Outcomes of Kirschner Wire Fixation in Treatment of Extra Articular Fractures of The Proximal Phalanx

Ahmet Köse, Muhammed Çağatay Engin, Murat Topal\*, Mehmet Köse, Ayşe Şencan

DOI: 10.17944/mkutfd.468120

Ahmet Köse: Attending Surgeon, Sağlık Bilimleri University Erzurum Regional Research and Training Hospital Department of Orthopedics and Traumatology, Erzurum  
Email: kose.ahmet.46@hotmail.com  
ORCID id: <https://orcid.org/0000-0002-7744-1029>

Muhammed Çağatay Engin: Attending Surgeon, Bingöl State Hospital Department of Orthopedics and Traumatology, Bingöl  
Email: mcagatayengin@gmail.com  
ORCID id: <https://orcid.org/0000-0002-9302-9587>

Murat Topal: Asst. Prof. Dr., Kastamonu University Medical Faculty Department of Orthopaedics and Traumatology, Kastamonu  
Email: topal.md@gmail.com  
ORCID id: <https://orcid.org/0000-0002-5114-4691>

Mehmet Köse: Asst. Prof. Dr., Atatürk University Medical Faculty Department of Orthopedics and Traumatology, Erzurum  
Email: drkosem@hotmail.com  
ORCID id: <https://orcid.org/0000-0001-9948-3855>

Ayşe Şencan: Assoc. Prof. Dr., Sağlık Bilimleri University Baltalimani Research and Training Hospital Department of Department of Hand Surgery, İstanbul  
Email: aysencan35@gmail.com  
ORCID id: <https://orcid.org/0000-0001-7587-0674>

## Bildirimler/Acknowledgement

Yazarlar bu makale ile ilgili herhangi bir çıkar çatışması bildirmemişlerdir. The authors declare that they have no conflict of interests regarding content of this article. Yazarlar bu makale ile ilgili herhangi bir finansal destek bildirmemişlerdir. The Authors report no financial support regarding content of this article.

Received: 08.10.2018

Accepted: 27.03.2019

e-ISSN: 2149-3103

Web: <http://dergipark.gov.tr/mkutfd>

## Öz

*Ekstraartiküler Proksimal Falanks Kırıklarında Kapalı Redüksiyon ve Kirschner Teli Tespitin Klinik ve Radyolojik Sonuçları*

**Amaç:** Bu çalışmada eklem uzanım göstermeyen proksimal falanks kırıklarında uyguladığımız kirschner teli fiksasyonun radyolojik ve klinik sonuçlarını sunmayı amaçladık.

**Gereç ve Yöntem:** Kapalı, instabil, ekstraartiküler proksimal falanks kırığı nedeniyle kapalı redüksiyon ve Kirschner teli ile fiksasyon uyguladığımız 16 hastanın klinik ve radyolojik verileri retrospektif olarak incelendi. Tüm hastalarda ameliyat sonrası 6.ay değerlendirme parametreleri esas alınarak değerlendirme ve istatistiksel analiz yapıldı. Aktif ve pasif metakarpofalangial eklem ve interfalangial eklem hareket açıklıkları, Total eklem hareket açıklığı, kırık ve sağlam eller için kavrama gücü ölçümü, subjektif ağrı değerlendirmesi için görsel analog skor değerlendirmesi, fonksiyonel değerlendirme için Disabilities of the arm, shoulder and hand skoru, opere edilen parmakta pulpa ve palmar curve arası mesafe ölçümü, Belsky skoru, reoperasyon ve komplikasyonlar değerlendirildi.

**Bulgular:** Ortalama 4.8 (4-8) haftada radyolojik kaynama elde edildi. Hastaların fonksiyonel sonuçları değerlendirildiğinde; aktif metakarpofalangial eklem fleksiyonu ortalama 87.8 (60-90) derece, proksimal interfalangeal eklem fleksiyonu ortalama 77.5 (55-100) derece, distal interfalangial eklem fleksiyonu ortalama 73.4 (60-90) derece, ortalama total eklem hareket açıklığı 230 (170-270) derece olarak değerlendirildi. Kırığın olduğu elde kavrama gücü 36 (23-50) kgw, sağlam elde yapılan karşılaştırma 39.5 (30-50) kgw olarak ölçüldü. İstatistiksel açıdan kavrama gücü açısından anlamlı fark saptanmadı ( $p<0.05$ ). Görsel analog skor ortalaması 1.25 (0-5), Disabilities of the arm, shoulder and hand skoru ortalaması 10.5 (2-34), parmak pulpası ve parmak curve arası mesafe ortalama 6.25 (0-23) mm olarak değerlendirildi.

**Sonuçlar:** Proksimal falanks; kapalı, ekstraartiküler, instabil kırıklarında kapalı redüksiyon ve Kirschner teli ile fiksasyon uygulaması kabul edilen ve ucuz bir tedavi metodudur. Uygun endikasyonda seçilen hastalarda özellikle komünike, transvers ve kısa oblik kırıklarda başarılı radyolojik ve fonksiyonel sağlayan bir yöntemdir.

**Anahtar Kelimeler:** falanks, ekstraartiküler, kırık

## Abstract

*Kirschner Wire Fixation for Fractures of The Proximal Phalanx*

**Aim:** In this study, we aim to discuss the radiological and clinical results of closed reduction and Kirschner wire fixation we performed on 16 cases with extra-articular unstable proximal phalangeal fractures

**Materials and Methods:** Clinical and radiological data of 16 patients with closed, unstable (transverse or short oblique), extra-articular proximal phalangeal fractures to whom we performed closed reduction and fixation with Kirschner wire in Erzurum Regional Training and Research Hospital Orthopedics and Traumatology Clinic and Hand Surgery Clinic between 2014-2017 were retrospectively reviewed

**Results:** Functional results of the patients are evaluated; mean active MP joint flexion was 78.75 (60-90) degrees, proximal IP joint flexion was 77.5 (65-100) degrees, distal IP joint flexion was 73.4 (60-80) degrees and mean TAM was 230 (170-270) degrees. Mean passive MP joint flexion was evaluated as 81.25 (60-90) degrees, mean proximal IP joint flexion as 83 (60-100) degrees and mean distal IP joint flexion as 74 (65-90) degrees. The grip strength was measured as 36 (23-50) kgW in the fractured hand and the healthy hand comparison was 40 (30-50) kgW. Statistically, there was no significant difference between the two groups in terms of grip strength ( $p<0.05$ ). VAS mean was 1.25 (0-5), DASH mean was 10.5 (2-34), the mean distance between finger pulp and finger curve was 6.25 (0-23) mm. Belsky score was excellent in 4 patients, good in 9 patients and poor in 3 patients (Table 2). Two patients underwent tenolysis due to PIP joint contracture. Sudeck atrophy was observed in 1 patient for an average of 8 weeks. We achieved improvement with physical therapy, contrast bathing and medical treatment. There were no complications such as non-union, late union, superficial and deep infection, tenosynovitis. Our patients did not develop material extraction due to soft tissue and skin irritation. Radiologic evaluation of the follow up direct X-ray graphies revealed no displacement, angulation, and rotational deformities.

**Conclusion:** The proximal phalanx is 'small in size' for the body and 'functioning big' for the upper limb. Fractures of the proximal phalanges can be fixed with Kirshner wires after failed stabilization with closed reduction and brace fixation. It is a practical method which has satisfactory outcomes and has a relatively low cost.

**Keywords:** proximal phalanx, fracture, K wire

## 1. INTRODUCTION

Proximal phalangeal fractures are frequently frequent fracture s of the hand (1). Fracture type, fracture stability and maintaining stability of the fracture are main determinants in treatment (2). In proximal phalangeal fractures, the fracture is under the deforming effect of interosseous muscles, flexor and extensor muscles. Stable (transverse) and unstable (spiral, oblique and compound) fractures form by the deforming forces on the fracture line (3). Stable fractures are generally treated with conservative methods. Whereas in unstable fractures, obtaining anatomic reduction and maintaining stability is aimed (3, 4). Sooner frac-

ture union with early mobilization and by stable fixation provides better functional outcomes (5). In surgical treatment; closed reduction and Kirschner wire fixation, screw fixation, intramedullary screw fixation, external fixation, open reduction and plate-screw fixation are defined and frequently used methods (6-10).

The optimal surgical treatment of extra-articular proximal phalangeal fractures is controversial (10-13). Each method has advantages and disadvantages beside its suggested indications. In this study, we aim to discuss the radiological and clinical results of closed reduction and Kirschner wire fixation we performed on 16 cases with extra-articular unstable proximal phalangeal fractures.

Table 1. Demographic Data of Patients (R: Right, L: Left, M: Male, F: Female)

Patient	Age	Side	Fracture Phalanx	Gender	Trauma Etiology	Occupation	Fracture Type	Fracture Pattern	Time to Operation	Implant removal	Smoking
1	66	L	2	E	Fall	Worker	Shaft	Transverse	72	Yes	Yes
2	52	R	5	K	Blunt trauma	Teacher	Proximal	Oblique	48	Yes	Yes
3	42	R	4	K	Blunt trauma	Worker	Shaft	Transverse	96	Yes	Yes
4	52	L	5	E	Fall	Student	Proximal	Parçalı	168	Yes	No
5	38	L	5	E	Blunt trauma	Student	Shaft	Transverse	24	Yes	No
6	55	L	5	E	Fall	Farmer	Proximal	Transverse	120	Yes	Yes
7	35	R	2	K	Blunt trauma	Teacher	Shaft	Oblique	24	Yes	Yes
8	28	R	4	K	Fall	Soldier	Proximal	Transverse	36	Yes	Yes
9	37	R	5	K	Fall	Worker	Distal	Oblique	72	Yes	No
10	19	R	2	K	Blunt trauma	Farmer	Proximal	Transverse	24	Yes	No
11	38	R	5	E	Fall	Worker	Distal	Oblique	96	Yes	No
12	37	L	5	E	Fall	Worker	Proximal	Transverse	24	Yes	No
13	20	R	2	K	Blunt trauma	Farmer	Shaft	Oblique	48	Yes	No
14	24	L	3	E	Blunt trauma	Student	Proximal	Transverse	96	Yes	Yes
15	47	R	4	E	Fall	Farmer	Shaft	Trasnvers	120	Yes	Yes
16	39	R	5	K	Fall	Student	Proximal	Oblique	72	Yes	No

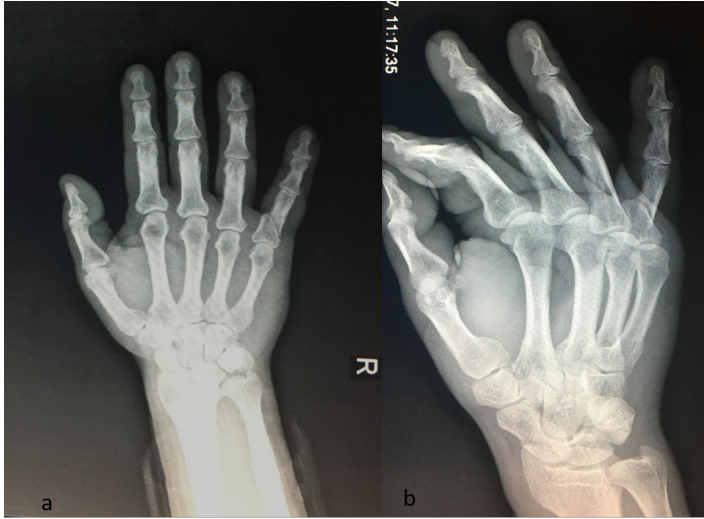
## 2. MATERIALS AND METHODS

Clinical and radiological data of 16 patients with closed, unstable (transverse or short oblique), extra-articular proximal phalangeal fractures to whom we performed closed reduction and fixation with Kirschner wire in Erzurum Regional Training and Research Hospital Orthopedics and Traumatology Clinic and Hand Surgery Clinic between 2014-2017 were retrospectively reviewed. Informed consent was obtained in all patients preoperatively. Approval was granted by the Institutional Review Board. Patients with closed, unstable (communicable, transverse or short oblique) that we could not obtain acceptable reduction and stability with closed reduction and that could have

been followed up for at least 6 months were included in the study.

Patients with ipsilateral fractures, open fractures, intra-articular fractures, pathological fractures, thumb fractures and open physes were excluded. Fracture types were classified according to AO (12) fracture classification. Relevant data have been obtained and statistically analyzed according to 6th month follow up clinical examination. Active and passive metacarpophalangeal (MP), joint-interphalangeal (IP), joint range of motions (ROM), total active motion (TAM), grip strength (kgw) measurement (SAEHAN Hydraulic Hand Dynamometer (SH5001), Gyeongnam, South Korea) for fractured and healthy hands, visual analog scale for subjective pain evaluation (VAS), Disabilities of the arm, shoulder and hand score (DASH) for functional

evaluation (14), Belsky score (15), distance measurement (mm) between pulp and palmar curve in the operated finger, reoperation and complications were evaluated. Union, displacement of fracture and loss of length of the phalanx were evaluated according to antero-posterior lateral and 30 to 45° pronation and/or supination oblique graphs taken in the first, second, third and sixth months after surgery.



**Picture 1.** 37-year-old female 5th proximal phalanx fracture of the right hand; Preoperative AP (a) and lateral (b) X ray views



**Picture 2.** Post-operative first day AP (a) and lateral (b) X ray views

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Erzurum Bölge Eğitim ve Araştırma Hastanesi (19.02.18/37732058-514.10).

## 2.1. Surgical Technique and Postoperative Follow up

All the patients were operated on by a single surgeon.

All patients were operated on under infraclavicular block anesthesia in supine position and with the use of pneumatic tourniquet.



**Picture 3.** 6th month followup direct graphics.



**Picture 4.** Functions of the injured hand at the 6th month followup visit

Traction and counter-traction was done in order to obtain anatomic reduction with the help of fluoroscopy. After achieving acceptable alignment of the phalanx K-wires have been introduced. A short arm brace up to the IP joint was used until the post-operative pain and inflammation subsided. Passive exercises in the brace were begun after the first week. After the second week, the brace was only used at night to provide early motion for the MP joint. Nocturnal bracing was terminated after the fourth week and active movements were allowed. Strenuous daily activities were allowed after the sixth week. Kirschner wire was removed at the 6th-8th week.

## 2.2. Statistical Analysis

The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) 20.0 version (IBM Corp, Armonk, NY, USA). The data are given in terms of number, percent, mean and standard deviation. The data for the variables included in the analysis were analyzed by the Kolmogorov Smirnov Test for whether the data corre-

sponded to the normal distribution. Spearman's correlation analysis was used for the correlation between the parameters used. The relationship between grip strengths of the treated and healthy hands was assessed by Mann-Whitney

U Test. The correlation between grip strength in the treated hand, MP joint flexion, and IP joint flexion was assessed by Spearman's correlation analysis. Significance level was taken as  $p < 0.05$ .

Table 2: Functional and Radiologic outcomes of the patients (MP: Metacarpophalangeal, IP: Interphalangeal, VAS: Visual analog scale, DASH: Disabilities of the arm, shoulder and hand score)

PATIENT	MP JOINT ACTIVE/ PASSIVE FLEXION (DEGREES)	PROXIMAL IP JOINT ACTIVE/PASSIVE FLEXION (DEGREES)	DISTAL IP JOINT ACTIVE/PASSIVE FLEXION (DEGREES)	TOTAL ACTIVE MOTION (DEGREES)	GRIP STRENGTH FRACTURED HAND (kgw)	GRIP STRENGTH HEALTHY HAND (kgw)	VAS	DASH	DISTANCE BETWEEN PALMAR CURVE AND PULP	BELSKY SCORE	FOLLOW UP PERIOD (MONTHS)	TIME TO UNION (WEEKS)	REOPERATION
1	70/75	75/80	65/65	210	28	36	0	9,09	10	GOOD	6	4	NO
2	70/70	85/85	70/65	225	40	43	2	6,81	6	GOOD	9	4	NO
3	85/85	85/85	75/70	245	45	45	1	4,54	1	GOOD	12	4	NO
4	60/75	45/60	65/70	170	25	34	5	29,54	23	POOR	12	4	YES
5	90/90	95/95	90/90	275	34	37	0	2,27	0	PERFECT	24	5	NO
6	80/85	75/90	75/75	230	31	35	1	9,09	3	GOOD	16	6	NO
7	90/90	95/95	75/75	260	50	50	0	2,27	0	PERFECT	14	5	NO
8	85/85	80/80	80/80	245	48	46	1	4,54	2	GOOD	20	4	NO
9	75/80	65/80	70/70	210	38	46	2	13,63	8	GOOD	12	5	NO
10	90/90	100/100	80/80	270	48	48	0	2,27	0	PERFECT	12	6	NO
11	60/60	55/60	65/70	180	24	30	4	34,09	20	POOR	12	6	NO
12	85/85	80/90	75/80	240	28	33	0	4,54	3	GOOD	22	4	NO
13	90/90	95/95	75/75	260	43	44	0	2,27	0	PERFECT	30	5	NO
14	85/85	80/90	80/80	245	29	32	0	8	2	GOOD	14	6	NO
15	65/70	55/65	60/65	180	23	30	3	27,27	18	POOR	16	5	YES
16	80/85	75/75	75/75	230	42	44	1	6,81	4	GOOD	12	4	NO

### 3. RESULTS

8 of the patients were male, 8 were female. Average age was 39 (19-66). In 10 patients, the fracture was in the right hand, and in 6 patients it was on the left hand. The dominant extremity was right in 13 patients, left in 2 patients and 1 patient was ambidextrous. 2nd phalanx in 4 patients, 3rd phalanx in 1 patient, 4th phalanx in 3 patients, 5th phalanx in 8 patients was fractured.

Etiology of the fractures was; falling in 10 patients, blunt trauma in 6 patients. 6 patients had diaphyseal (shaft) fractures, 8 had proximal metaphyseal fractures, and 2 had distal metaphyseal fractures. The fracture pattern was unstable transverse fracture in 9 patients, comminuted fracture in 1 patient and short oblique fracture in 6 patients. The mean time from the admission of the patients to the hospital to surgery was evaluated as 71 (24-168) hours. 8 of the

patients had cigarette use and 8 of them did not. Patients with additional traumas other than the phalangeal fracture were excluded from the study. 2 patients had type 2 diabetes mellitus, 2 had hypertension.

We performed an average of 3 weeks (3-4) brace immobilization after surgery. All demographic data of the patients are presented in table 1.

All patients were followed up for an average of 19 (6-36) months. A mean period of 4.8 (4-6) weeks for the radiological union was observed (Pictures 1-4). When the functional results of the patients are evaluated; mean active MP joint flexion was 78.75 (60-90) degrees, proximal IP joint flexion was 77.5 (65-100) degrees, distal IP joint flexion was 73.4 (60-80) degrees and mean TAM was 230 (170-270) degrees. Mean passive MP joint flexion was evaluated as 81.25 (60-90) degrees, mean proximal IP joint flexion as 83 (60-100) degrees and mean distal IP joint flexion as 74 (65-90) degrees. The grip strength was measured as 36 (23-50) kgW in



the fractured hand and the healthy hand comparison was 40 (30-50) kgW. Statistically, there was no significant difference between the two groups in terms of grip strength ( $p<0.05$ ). VAS mean was 1.25 (0-5), DASH mean was 10.5 (2-34), the mean distance between finger pulp and finger curve was 6.25 (0-23) mm. Belsky score was excellent in 4 patients, good in 9 patients and poor in 3 patients (Table 2).

Two patients underwent tenolysis due to PIP joint contracture. Sudeck atrophy was observed in 1 patient for an average of 8 weeks. We achieved improvement with physical therapy, contrast bathing and medical treatment. There were no complications such as non-union, late union, superficial and deep infection, tenosynovitis. Our patients did not develop material extraction due to soft tissue and skin irritation. Radiologic evaluation of the follow up direct X-ray graphics revealed no displacement, angulation, and rotational deformities.

#### 4. DISCUSSION

Proximal phalangeal fractures are frequently encountered orthopedic injuries (12,16). The first step in deciding the proper treatment is evaluation of the stability of the fracture (17). Successful results can be achieved with conservative treatment methods (short arm brace application, buddy taping) in stable fractures (4, 7, 18). Stiffness is more likely to develop in a fractured finger which had been treated conservatively with a longer immobilization period other than a less immobilized operated finger. That's why one of the most important aims in management must be early motion. In addition, conservative methods applied in unstable fractures can result insignificant functional loss (11). Surgical treatment should be planned according to the location and type of fracture at this stage. The main aim is to obtain an anatomic reduction and a stable fixation in comminuted, long spiral-oblique fractures which can cause shortness of the phalanges with rotational deformities (19). Rigid fixation is mandatory for early rehabilitation of the hand (2, 5, 6).

Best surgical treatment of proximal phalangeal fractures is still controversial. Appropriate treatments for the localization and type of the fracture in the bone have been proposed. Fixation with Kirschner wire's possible use in; intra-articular base fractures, extra-articular transverse base fractures, transverse or short oblique shaft fractures, spiral or long oblique fractures, partial diaphyseal fractures, and condylar fractures with double and multiple K wire fixation has been reported. The studies of different treatment methods in proximal phalangeal fractures are limited. Different fixation methods have advantages and disadvantages. K wire fixation indicated less soft tissue damage than screw or plate fixation, less contractility and stability, but

no superior functional outcome. Kirschner wire is cheaper than a screw or plate. Early rehabilitation is possible with screws, plates and K wire in respective order. There are no absolute contraindications of K wire fixation. Relative contraindications are intra-articular comminuted fractures, lack of soft tissue coverage and increased functional expectations of the patients (2, 11, 20, 21).

In this study, extra-articular proximal phalangeal fractures that were not stabilized by closed reduction and brace fixation were operated with Kirshner wire based on AO principles (12). Adequate stability was obtained in all of the patients. Early passive rehabilitation started. 3 weeks of immobilization was enough for progression from passive exercises to active exercises and bony union. Active movement started in patients whose subjective pain complaints subsided. All patients returned to pre-operative occupations. Displacement, angulation, and rotational deformity did not develop in any patient. Tenolysis was performed on 2 patients who developed PIP joint contracture at the 10<sup>th</sup> and 11<sup>th</sup> weeks respectively.

Fixation with Kirschner wires may cause soft tissue and tendon irritation. It has been reported that it could cause joint contracture. Leaving the ends of the wires on the skin may lead to cosmetic problems. Depending on the surgical treatment and period of immobilization; extensor tendon adhesions or poor functional outcomes can develop (11, 21-23). Closed reduction and K wire fixation can cause rehabilitation to be delayed because of skin irritation. We performed tenolysis due to the contracture developed in 2 patients.

Although malunion is the most common bony complication in the treatment of proximal phalangeal fractures, arthritis, cold intolerance, reflex sympathetic dystrophy and infections can also be seen (11, 24). It is reported in current studies that union is achieved in 4-8 weeks on average (11, 25). Radiological union was obtained in 4.8 (4-6) weeks in this study. We had 3 cases with joint stiffness and 1 of these patients had reflex sympathetic dystrophy (sudeck atrophy). There was no statistically significant difference between the grip strengths ( $p<0.05$ ). The functional evaluation parameters (VAS 0.8 (0-2), DASH 7 (2-27), finger pulp and finger curve distance 3 (0-8) mm) were similar to the comparative studies in the literature (11, 21). We achieved excellent results in 4 patients, good in 9 patients, and poor results in 3 patients in Belsky scores. There were no patients who had nonunion, late union and infection.

The study had limiting factors such as; being retrospective, heterogeneous fracture types and relatively low number of patients. In this context, studies which are prospective, randomized controlled, with greater number of patients with similar type of extra-articular proximal phalangeal fractures comparing different types of fixation are

required in determining the best method, but still we believe that this study will be a significant contribution to the literature

The proximal phalanx (16) is 'small in size' for the body and 'functioning big' for the upper limb. Fractures of the proximal phalanges can be fixed with Kirshner wires after failed stabilization with closed reduction and brace fixation. It is a practical method which has satisfactory outcomes and has a relatively low cost.

## REFERENCES

- Drenth DJ, Klasen HJ. External fixation for phalangeal and metacarpal fractures. *J Bone Joint Surg Br.* 1998;80(2):227-30.
- Le Nen D. Extra-articular fractures of the digital metacarpals and phalanges of the long fingers. *Chir Main.* 2014;33(1):1-12.
- Kurzen P, Fusetti C, Bonaccio M, Nagy L. Complications after plate fixation of phalangeal fractures. *J Trauma.* 2006;60(4):841-3.
- Lins RE, Myers BS, Spinner RJ, Levin LS. A comparative mechanical analysis of plate fixation in a proximal phalangeal fracture model. *J Hand Surg Am.* 1996;21(6):1059-64.
- Robinson LP, Gaspar MP, Strohl AB, Teplitsky SL, Gandhi SD, Kane PM, et al. Dorsal versus lateral plate fixation of finger proximal phalangeal fractures: a retrospective study. *Arch Orthop Trauma Surg.* 2017;137(4):567-72.
- Kamath JB, Harshvardhan, Naik DM, Bansal A. Current concepts in managing fractures of metacarpal and phalanges. *Indian J Plast Surg.* 2011;44(2):203-11.
- Kozin SH, Thoder JJ, Lieberman G. Operative treatment of metacarpal and phalangeal shaft fractures. *J Am Acad Orthop Surg.* 2000;8(2):111-21.
- Franz T, von Wartburg U, Schibli-Beer S, Jung FJ, Jandali AR, Calcagni M, et al. 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.
- 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.
- Gaston RG, Chadderdon C. Phalangeal fractures: displaced/nondisplaced. *Hand Clin.* 2012;28(3):395-401, x.
- Desaldeleer-Le Sant AS, Le Sant A, Beauthier-Landauer V, Kerfant N, Le Nen D. Surgical management of closed, isolated proximal phalanx fractures in the long fingers: Functional outcomes and complications of 87 fractures. *Hand Surg Rehabil.* 2017;36(2):127-35.
- Lee SG, Jupiter JB. Phalangeal and metacarpal fractures of the hand. *Hand Clin.* 2000;16(3):323-32, vii.
- Ebinger T, Erhard N, Kinzl L, Mentzel M. Dynamic treatment of displaced proximal phalangeal fractures. *J Hand Surg Am.* 1999;24(6):1254-62.
- Hudak PL, Amadio PC, Bombardier C. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand) (corrected). The Upper Extremity Collaborative Group (UECG). *Am J Ind Med.* 1996;29(6):602-8.
- Belsky MR, Eaton RG, Lane LB. Closed reduction and internal fixation of proximal phalangeal fractures. *J Hand Surg Am.* 1984;9(5):725-9.
- Logters TT, Lee HH, Gehrman S, Windolf J, Kaufmann RA. Proximal Phalanx Fracture Management. *Hand (NY).* 2017;1558944717735947.
- Rajesh G, Ip WY, Chow SP, Fung BK. Dynamic treatment for proximal phalangeal fracture of the hand. *J Orthop Surg (Hong Kong).* 2007;15(2):211-5.
- 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.
- 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.
- Meals C, Meals R. Hand fractures: a review of current treatment strategies. *J Hand Surg Am.* 2013;38(5):1021-31; quiz 31.
- Li G, Liu S, Chen G, Li Z, Liu Y, Sun G, et al. Comparison of Clinical Outcomes of Phalangeal Fracture Treated with Dorsolateral Approach or Post-middle Approach Using AO Mini Titanium Plate. *Indian J Surg.* 2015;77(Suppl 2):657-61.
- Page SM, Stern PJ. Complications and range of motion following plate fixation of metacarpal and phalangeal fractures. *J Hand Surg Am.* 1998;23(5):827-32.
- Onishi T, Omokawa S, Shimizu T, Fujitani R, Shigematsu K, Tanaka Y. Predictors of Postoperative Finger Stiffness in Unstable Proximal Phalangeal Fractures. *Plast Reconstr Surg Glob Open.* 2015;3(6):e431.
- Basar H, Basar B, Basci O, Topkar OM, Erol B, Tetik C. Comparison of treatment of oblique and spiral metacarpal and phalangeal fractures with mini plate plus screw or screw only. *Arch Orthop Trauma Surg.* 2015;135(4):499-504.
- 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.