Treatment of unstable metacarpal fractures using transverse Kirschner-wire fixation technique

Osama M. Essawy, Mohamed S. Sultan

Department of Orthopaedics, Faculty of Medicine, Benha University, Benha, Egypt

Correspondence to Osama M. Essawy, MD, Department of Orthopedics, Benha University, Banha, Egypt Tel: +20 100 516 7067; e-mail: esawyosama@gmail.com

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Background
Several methods of fixing unstable metacarpal shaft fractures have been described. The aim of the study was to assess the clinical and radiological results of transverse Kirschner (K)-wire fixation technique for the treatment of unstable ulnar four metacarpal fractures.

Patients and methods
A prospective study was held between 2014 and 2016 at Benha University Hospital on 25 patients (22 males and three females) who had unstable metacarpal fractures affecting second to fifth metacarpals treated with transverse wiring technique. The patients' mean age was 30.9 years. The dominant hand was affected in 21 patients, whereas in four patients, the nondominant hand was affected. Under fluoroscopy, closed reduction and percutaneous fixation with three K-wires, one proximal and two distal to the fracture site, was done. The mean operative time was 28.8 min. The inclusion criteria included patients with acute metacarpal shaft fracture with unaccepted shortening, angulation, and rotation.

Results
The mean follow-up period was 12.1 months. Bony union was achieved at an average of 6.8 weeks. At the final follow-up, all patients had almost full range of motion, with a mean total active range of motion of 260° (245–270°). None of the patients had any clinically detectable rotational deformity, and the functional outcome was satisfactory, with mean grip strength of the injured hand of 97% in comparison with the noninjured side. The average Quick Dash score was 1.5±1.6, ranging from 0 to 4.5 points. The mean visual analog score for pain was 0.92±1.1. All patients returned to their ordinary jobs and were cosmetically and functionally satisfied with the results of their surgery. Two patients presented with superficial pin-tract infection and one patient united with 15° radiological angulation of the fifth metacarpal without any functional affection. No other complications occurred.

Conclusion
Transverse K-wire technique is an effective, easy, and safe method for treating unstable metacarpal fractures, without significant complications.

Keywords:
displaced metacarpal fractures, metacarpal fractures, transverse wiring, mini-invasive, unstable metacarpal

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Introduction

Metacarpal fractures are common injuries, representing 30–50% of all hand fractures. Good functional outcomes have been reported with conservative management, and that is why, not all metacarpal fractures require surgical intervention. A vast majority of metacarpal fractures are usually stable and do not require operative treatment. Unstable metacarpal fractures constitute 8% of all metacarpal injuries [1].

Shortening and malunion of the metacarpal fractures can cause significant limitation of the hand range of motion (ROM). Every 2 mm of shortening up to 10 mm creates a 7° extensor lag. Grip strength is also affected by the amount of shortening; at the full flexion of the digit, shortening of more than 5 mm results in a significant decrease in flexion force [2].

Although less than 10° of rotation could be accepted, angulation of the metacarpal shaft fracture has significant deliberation, and the indication for surgical intervention is highly variable, with some of the authors accepting up to 70° of angulation. Owing to the compensatory movement of the fourth and fifth carpometacarpal (CMC) joints, the acceptable degree of angulation increases for the more ulnar digits. Fewer angulations of the second and third metacarpals can be tolerated, as their CMC joints are much less mobile [3].

Several methods for fixing unstable metacarpal fractures have been described. Fixation techniques involve the use of K-wires, intramedullary or transverse techniques, cerclage wires, plate and screws, lag screws, tension band wires, or external fixators [4]. Percutaneous transverse pinning with Kirschner wires (K-wires) is an attractive easy option which achieves high union rates and limits the potential complication of extensor irritation by a dorsal plating and extensive surgical soft tissue dissection [5].

The aim of this prospective study was to assess the functional outcome after percutaneous transverse fixation with K-wires for the treatment of unstable ulnar four metacarpal fractures.

Patients and methods

A prospective study was held between 2014 and 2016 at Benha University Hospital that included 25 patients, comprising 22 males and three females, with unstable second to fifth metacarpal fractures fixed by percutaneous transverse K-wire technique. The patients' mean age was 30.9±10.1 years, ranging from 15 to 51 years. The inclusion criteria included acute metacarpal fracture with unaccepted shortening, angulation, and rotation. Exclusion criteria were open fractures, old neglected fractures, or nonunited fractures.

The study was approved by Ethical Committee of Benha University and was conducted in accordance with the ethical standards of the Institutional and National Research Committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All patients signed an informed consent after clear explanation of the surgical procedure.

The mechanism of injury was punch trauma in 12 patients, fall on the ground in nine patients, and direct trauma in four patients (Table 1). The dominant hand was affected in 21 patients, whereas in four patients, the nondominant hand was affected.

All patients were evaluated preoperative clinically and radiologically. At least three views of the hand (anteroposterior, oblique, and lateral views) were obtained. The fracture pattern was transverse in eight patients, spiral in seven patients, oblique in seven patients, and comminuted in three patients (Table 2). The commonest finger affected was the fifth followed by the fourth metacarpals (Table 3).

Table 1 Mechanism of injury

Injury mechanism	*N*
Punch trauma	12
Fall on the ground	9
Direct trauma	4

Surgical technique

All patients were operated under general anesthesia. All patients received 1 g of intravenous ceftriaxone antibiotic prophylactically during induction of anesthesia. Under fluoroscopy, according to fracture pattern, closed reduction of metacarpal fracture was done using the conventional methods of reduction; in some fractures, mainly the spiral fractures, bone reduction clamp may be used percutaneously to reduce the fracture anatomically, where the most important step is to correct the rotational deformity (Fig. 1c).

After reduction is checked by image intensifier, percutaneous fixation using three K-wires was performed, the first wire proximal to the fracture followed by two K-wires distal to the fracture site (Fig. 1d–f). Final fluoroscopic checks for the adequacy of fracture fixation (Fig. 1g–i) and clinical check for rotational position of the finger in extended and semiflexed position were carried out, and then the K-wires were cut and bent over the skin. An extended below-elbow splint was applied (Fig. 1j–m).

Postoperative care

The splint is applied for 2 weeks to assist healing of the soft tissues. Patients were discharged on the same day from the hospital. The wound was reexamined after 1 week, and the splint was changed after two weeks to short below-elbow splint down to the MCP joint. The patients were encouraged to start active finger flexion and extension while in short splint for 2 weeks (Fig. 2). Then, the splint was removed, and the patients

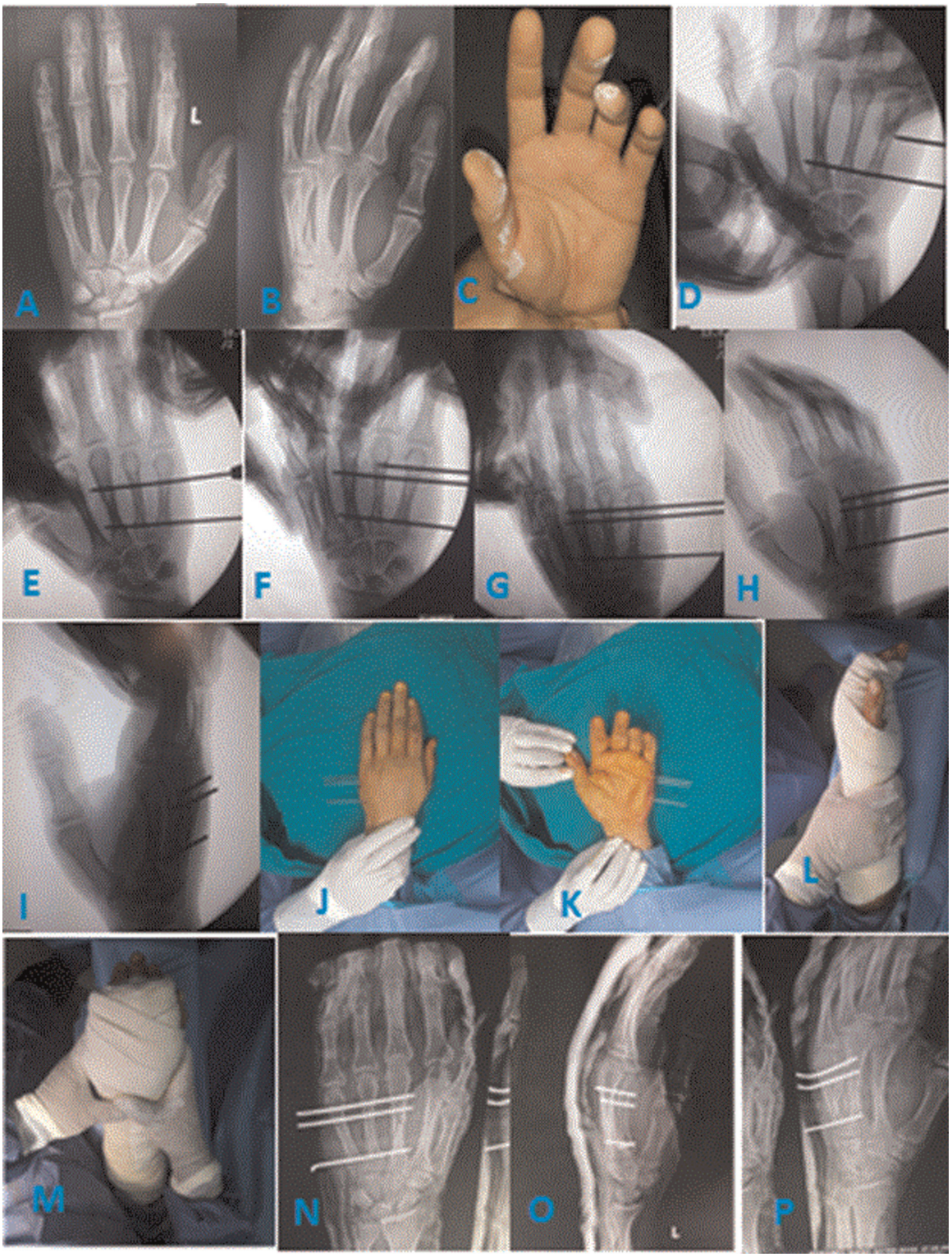
Table 2 Fracture pattern

Fracture pattern	*N*
Transverse	8
Spiral	7
Oblique	7
Comminuted	3

Table 3 Distribution of metacarpal fractures

Fractured MCP	*N*
Fifth	17
Fourth	6
Third	1
Second	1

Figure 1



Surgical technique. (a,b) Preoperative radiography showing fracture of the third and fourth metacarpals. (c) Clinical photograph showing the malrotation of fourth finger. (d,e,f) Steps of wire insertion. (g,h,i) Final intraoperative fluoroscopic image. (j,k) Clinical photograph showing corrected rotational deformity. (l,m) Postoperative splint. (n,o,p) Postoperative radiography.

continued active ROM with wires in place till union achieved (Fig. 3).

All patients were evaluated radiologically every 2 weeks till union, and then the wires were removed (usually from 6 to 8 weeks postoperatively), and full motion and functional activities were allowed. At final follow-up, patients were evaluated by assessing the degree of pain using visual analog score (VAS), limitation of daily activities using Quick Dash Score, range of motion

Figure 2

Range of motion in short splint after 2 weeks with corrected rotational deformity of the fourth finger.

Figure 3

After 4 weeks. The splint was removed, and active range of motion was encouraged with wires in place till union achieved.

using total active motion (TAM equals the sum of active motion of MP, PIP, and DIP joint), and grip strength examination using bedside sphygmomanometer method (the patient applies maximal grip force to the partially inflated sphygmomanometer cuff with comparison to the healthy side).

Results

The mean operative time was 28.8±5.2 min. The mean follow-up period was 12.1±1.7 months, ranging from 10 to 16 months. Radiographies and clinical examination revealed evidence of bony union at an average of 6.8±1.1 weeks, ranging from 6 to 10 weeks. At the final follow-up, all patients had almost full extension and 90° flexion of the metacarpophalangeal joint and full flexion of the interphalangeal joints with mean TAM of 260° (245°–270°). None of the patients had any clinically detectable rotational deformity; functional outcome was satisfactory with mean grip strength of the injured hand of 97% (90–100%) in relation to the noninjured side strength; and average Quick Dash score was 1.5±1.6, ranging from 0 to 4.5 points. A total of 21 patients were very satisfied (84%) and four patients were dissatisfied (16%).

The mean VAS for pain was 0.92±1.1, ranging from 0 to 3. All patients returned to their ordinary jobs and were cosmetically and functionally satisfied with the results of their surgery. Two patients presented with superficial infection at the site of K-wire insertion and improved with oral antibiotic for 1 week and serial daily dressings; one patient was united with 15° angulation of the fifth metacarpal without any functional affection or extension lag. No other complications were reported (Figs 4–7).

Figure 4

Unstable fourth metacarpal fracture in a 25-year-old female patient. (a,b) Preoperative and (c,d) intraoperative radiographs. (e) Clinical image fixed by transverse K-wires. (f) Postoperative radiography. (g) Eight weeks postoperative after removal of K-wires showing fracture union.

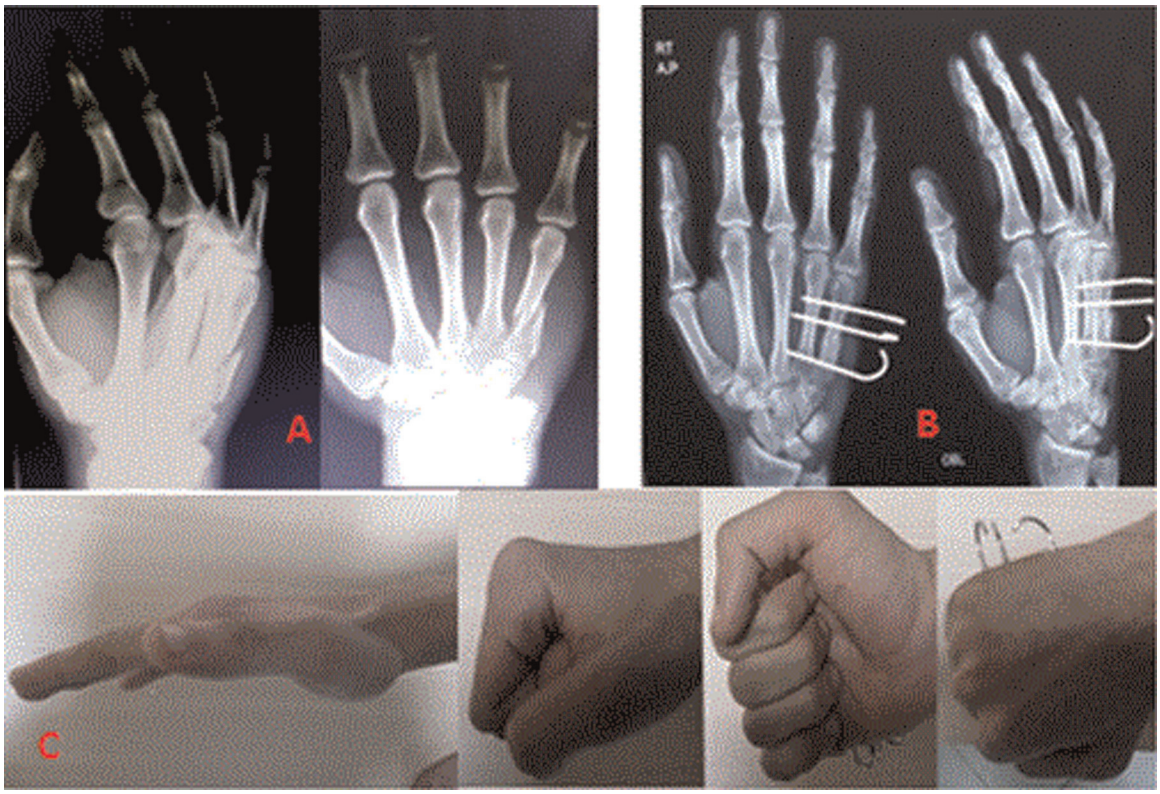
Discussion

Selection of the optimum treatment option for metacarpal fractures depends on a number of factors, including fracture location (intra-articular or extra-articular), fracture geometry (transverse, spiral, oblique, or comminuted), deformity (angular, rotational, or shortening), fracture stability, and associated osseous and soft tissue injuries. Regardless of the preferred mode of treatment, its goal should be full and rapid restoration of function [6].

Many metacarpal shaft fractures can be treated nonoperatively with closed reduction and immobilization, though unstable fractures require surgery. However, indications for conservative versus surgical treatment of metacarpal fractures are not well defined in the literature. Creating stability in an unstable fracture is the primary indication of surgery, although no clear definition of unstable metacarpal fractures exists. Most of the literature agreed that any degree of rotational deformity, angulation exceeding 30°, and shortening of greater than 5 mm are indications for surgical treatment [7].

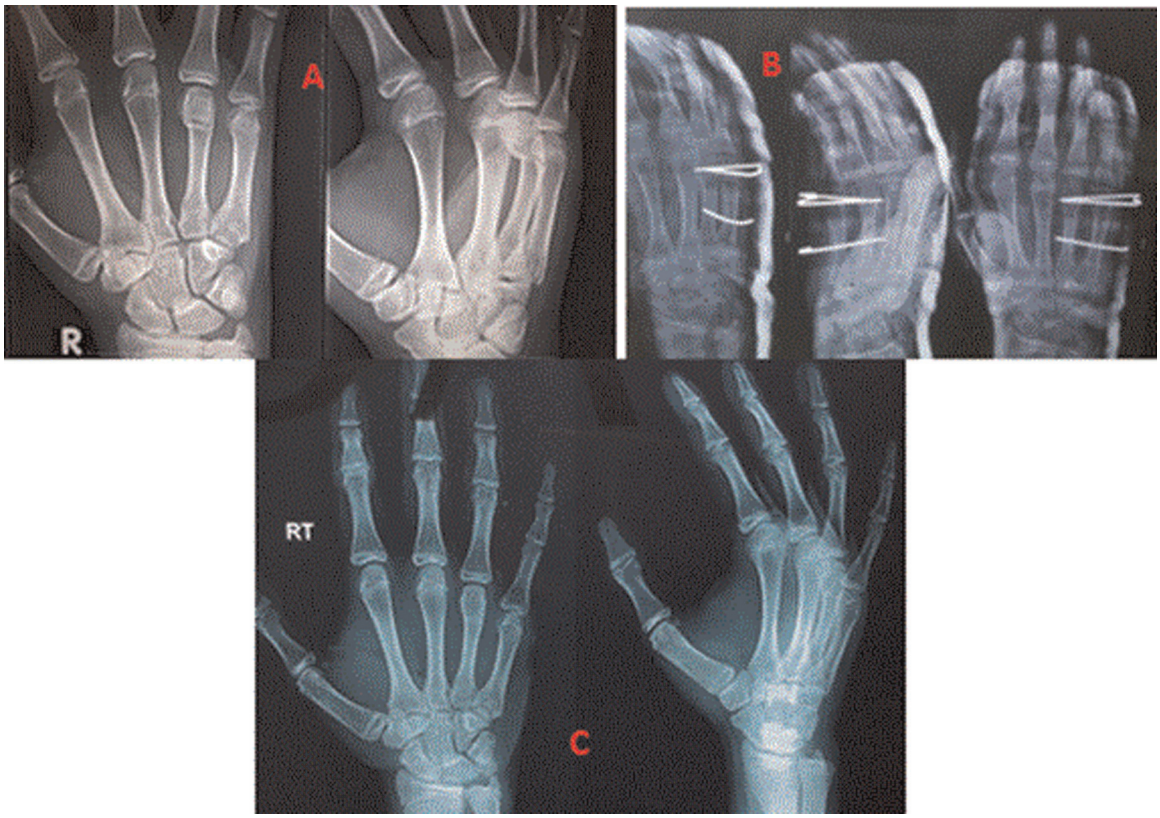
Multiple surgical procedures have been described, including the use of K-wires, circulage wires, tension band wires, lag screws, plate and screws, and external fixators. Of these, K-wire fixation is a popular choice owing to the simplicity of the procedure and the

Figure 5



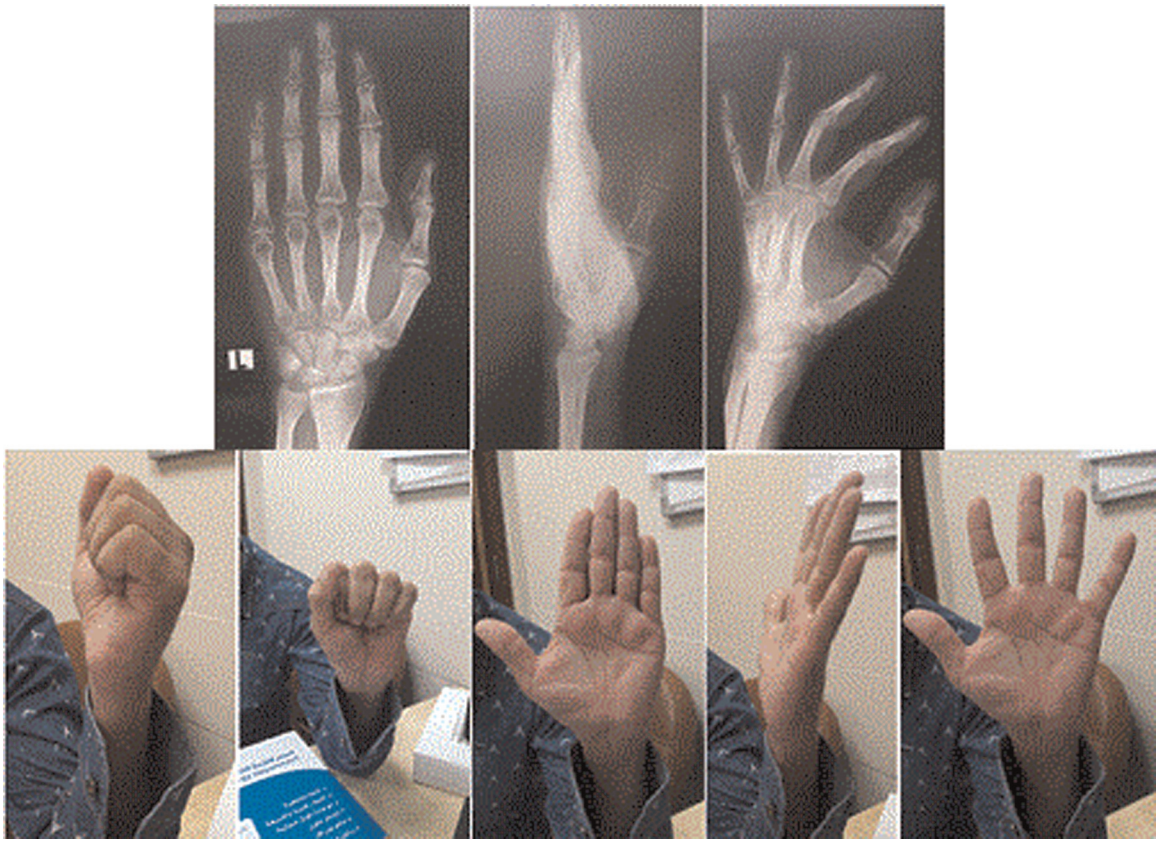
Spiral displaced fractured fifth metacarpal in a 32-year-old male patient. (a) Preoperatively and (b) 6 weeks postoperatively showing bone union. (c) Range of motion with wires in place.

Figure 6



A 15-year-old boy with fracture of the fourth metacarpal: (a) preoperative radiography. (b) Postoperative radiography. (c) After complete union.

Figure 7



Final follow-up of the patient presented in the surgical technique showing bony union and final range of motion.

minimal soft tissue interference. Therefore, multiple fixation techniques using K-wires were established including crossing wires, antegrade or retrograde intramedullary wires insertion, transverse wiring, and Bouquet osteosynthesis [7].

Plate fixation of metacarpal fractures has high complications rate. Page and Stern [8] reviewed 66 metacarpal fractures treated with plates and screws and revealed a 36% complication rate. Stiffness was the most commonly reported complication with 76% of patients reported to have TAM less than 220°. Sixteen percent of complications reported involved a minor extensor lag, whereas 7.9% had soft tissue contractures, followed by major extensor lag in 6.3% of recorded complications. More serious complications are rare, with infection, nonunion, and tendon rupture each comprising 1.6% of the complications reported [8]. Fusetti *et al.* [9] reviewed 105 nonthumb metacarpal fractures treated with plates and screws and found a 32% complication rate. The most common complication was poor healing with 15% nonunion and malunion. Overall, 10% of the complications were related to stiffness, whereas 8% of patients experienced hardware failure. Only 1% of those studied had a deep infection [9]. The reported rates of revision surgery owing to hardware complication are 4.6–32% [10].

Bouquet osteosynthesis (multiple intramedullary flexible wires fixation for metacarpal shaft and neck fracture) was first described by Foucher [11] in 1995 and had very good results over the past 2 decades. Mohammed and colleagues in 2011 performed a modification of 'bouquet' technique by using single percutaneous elastic intramedullary wiring for nailing of metacarpal fractures. The wire was extracted at a mean period of 4.4 weeks (range 3 to 6 weeks). Two cases had early (at 3 weeks) removal of wire for pin-site infection. One wire had buried into the wound, and in five patients, the wire was removed in the operating theater. Three superficial infections with surrounding cellulitis and one fracture required revision surgery for failed fixation. All their study patients regained full flexion, but two patients had a mild extensor lag of about 15°. The main limitation of their study was the short follow-up period, with an average of only 8 weeks [12].

In 2015, Aski and Bhatnagar managed 14 patients with retrograde percutaneous K-wire fixation for metacarpal

fractures, and all fractures united by 8 weeks. The mean follow-up was 6 months. Two cases had 15° malalignment at the fracture site during fixation; however, remodeling occurred at 6 months. Two cases developed pin-tract infection. All patients had almost full range of movement with good hand grip [13].

In 2017, Javali and Reddy published their results on 15 patients with the use of antegrade intramedullary K-wire for fixation of metacarpal shaft fracture. The mean duration of surgery was 44 min (range: 33–50 min), and the mean follow-up duration was 8 (6–12) months. The wire was extracted in all patients in a period ranging from 4 to 7 weeks. They reported two superficial wound (pin site) infections and two patients had a mild extensor lag of about 10° and the mean DASH score was 4.3 points [14].

Transverse K-wire fixation for metacarpal fracture stabilization can be used for all fracture locations and configurations. It was first described by Berkman and Miles [15]. Transverse K-wire fixation for metacarpal fracture fixation is a forgiving technique, which can be used for all metacarpal fractures. If fracture reduction or pin placement is unacceptable, it is a simple matter to be reinserted again [6].

Fusetti *et al*. [9] in 2002 suggested that the main advantage of percutaneous transverse K-wire fixation in treating metacarpal fractures is the avoidance of the complications occurring after open reduction and internal fixation, including difficulties with fracture healing, infection, stiffness due to extensive soft tissue dissection, later fibrosis and extensor tendon adhesion, plate loosening or breakage, and complex regional pain syndrome.

In unstable metacarpal fractures, Lamb *et al.* [16] suggested the use of two K-wires, one proximal and one distal to the fracture site. Using this technique, Paul *et al.* [17] performed a comparative study of two groups of patients treated by transverse wiring: one group with one distal wire and the other group with two distal wires. The final mean angular deformity was 18° with 1 distal pin and 6° with two distal pins. They concluded that to fully control rotation and stability of metacarpal fracture, it is essential to obtain a two-point fixation in both shaft fragments. This is achieved proximally through the intact CMC joint plus one K-wire, and distally by the use of two K-wires [17]. This concept was our surgical principle in this study.

In 2003, Galanakis and colleagues performed their study on 25 patients with closed unstable metacarpal fractures treated by percutaneous transverse fixation with K-wires for 3-month follow-up. There was evidence of callus formation in all fractures at 6 weeks. At the final follow-up, all patients had regained full flexion and extension ROM. Functional outcome at 3 months was satisfactory. None of the patients had any rotational deformity. All patients were satisfied with the results of their surgery. Four patients presented with skin irritation at the site of K-wire insertion [6]. This was superior to the study results of Choi and Song, who used transverse K-wires for fixation of metacarpal fractures in 34 patients. Three cases united with an angulation of more than 20°. Five cases had skin problems around the tip of the K-wire. Three cases had minimal rotational deformities, but they did not complain of discomfort. There was one case of nonunion, and the K-wires had been removed and treated by plate fixation and a bone graft [18].

Sletten *et al*. [19] in 2014 conducted a retrospective study on 67 patients comparing between transverse wiring (45 patients) and bouquet (intramedullary) pinning (45 patients) for management of isolated extra-articular fractures of the fourth and fifth metacarpals. Follow-up time was 28 (13–39) months for all patients and was significantly longer in the transverse pinning group than in the bouquet pinning group. The outcome was very good in both the pinning groups regarding Quick Dash score, VAS pain score, and VAS satisfaction, and no differences in clinical outcome could be found. ROM and grip strength were almost equal to the contralateral uninjured hand for both groups, whereas pin-tract infection was more in transverse wiring group. This was in line with the result of Wong and Yueng [20] in 2006, who followed prospectively 30 patients treated with intramedullary pinning and 29 patients treated with transverse pinning. No significant differences between the two groups were demonstrated at 6 weeks, 3 months, or 12 months of follow-up regarding TAM, pain, or grip strength.

Winter *et al.* [21] in 2007 performing a prospective randomized controlled trial study demonstrated that 18 patients operated with antegrade bouquet pinning had a slightly better TAM of the fifth finger and a better ROM in the fifth MP joint than 18 patients treated with transverse pinning at the final short-term follow-up of 3 months. The differences were only 18 and 12°, respectively, and no attempt was made to assess whether this difference was permanent, or if it had clinical functional implications. This was in line with the result of the retrospective study done by

Schadel-Hopfner and co-workers in 2007, which demonstrated a significantly better outcome at 18 months of follow-up after antegrade intramedullary pinning (15 patients) compared with retrograde crossed pinning (15 patients) regarding pain, Steel score, and ROM in the MP joint. No significant differences in grip strength or DASH score could be demonstrated [22].

Greeven and colleagues in 2015 published a systemic review as a comparative study between articles using percutaneous transverse K-wire fixation versus open reduction and internal fixation by plate and screws for fixation of closed, single second to fifth metacarpal shaft fractures. Of, 27 articles, 22 articles were excluded as these articles did not have sufficient data. The remaining five articles were included in the systematic review. There was no level I evidence to suggest one fixation technique over the other. The reported complications however for open reduction internal fixation (ORIF) and K-wire fixation in the treatment of single, closed metacarpal shaft fractures were unmistakably different for the two types of fixation. ORIF was associated with a considerable number of functional restricting complications like stiffness, adhesions, and consequent reoperations with lower TAM than transverse K-wires group, whereas K-wire fixation resulted frequently in superficial infection treated conservatively. The significance of these reported findings suggests that ORIF might be a less preferable surgical technique in comparison with transverse K-wires fixation in the treatment of metacarpal shaft fractures [23].

In this study, the mean TAM was 260° (245–270°). None of the patients had any clinically detectable rotational deformity. These results were in line with Sletten *et al.* [19], with mean TAM of 264° in the transverse wiring group and 262° in the Bouquet pinning group, but better than those of Moon *et al.* [4], who in a comparative study showed the transverse wiring group had a mean TAM of 245 and the intramedullary nailing group had a mean TAM of 250°. However, Han *et al.* [24] used intramedullary wires and reported the TAM was 92.0% when compared with the healthy side. While using plates and screws fixation, Ozer *et al.* [25] reported lower TAM of 225° (150–270°). Similarly, Page and Stern [8] reported that 76% of the patients had a mean TAM of less than 220° (Table 4).

The average Quick Dash score of the current study was 1.5±1.6, ranging from 0 to 4.5 points. This was in line with Sletten *et al.* [19], where both groups had a Quick Dash Score of 1 point (0–39), and was better than the results of Javali and Reddy (score 4.3) with the use of antegrade intramedullary K-wire [14]. However, some other studies used the full DASH score, where the average DASH score was 8.7 and 2.8 points in Lee *et al.* [27] and Han *et al.* [24], respectively, with modified retrograde percutaneous intramedullary multiple K-wire. When plate and screws were used for fixation, Ozer *et al.* [25] and Westbrook *et al.* [26] reported mean DASH score of 8.07 and 5 points, respectively (Table 4).

The complication rate was low in the 25 patients of the current study when compared with other studies (Table 5), with two patients having superficial pin-tract infection and one patient united with 15° radiological angulation of the fifth metacarpal without any functional affection or extension lag. In other studies using transverse wiring, Moon *et al.* [4] found 3 of 22 patients with pin-tract infection, Sletten *et al.* [19] found 8 of 45 patients with pin-tract infection, Galanakis and colleagues *et al.* reported 4 of 25 cases had skin irritation at the site of K-wire insertion [8], and the study by Paul *et al.* reported 8

Table 4 Functional outcome of different studies with different surgical techniques

	Surgical technique	TAM	Quick DASH
This study	Ts. Wiring	260°	1.5
Sletten *et al.* [19]	Ts. Wiring group	264°	1
	Bouquet pinning group	262°	1
Moon *et al.* [4]	Ts. Wiring group	245°	NA*
	Intramedullary nailing group	250°	NA*
Javali and Reddy [14]	Antegrade K-wire	NA*	4.3
Han *et al.* [24]	Intramedullary wires	92.0%	2.8 DASH
Lee *et al.* [10]	Retrograde multiple K-wire		8.7 DASH
Ozer *et al.* [25]	Plate and screws	225°	8.07 DASH
Page and Stern [8]	Plate and screws	<220° in 76%	NA*
Westbrook *et al.* [26]	Plate and screws	NA*	5 DASH

TAM, total active motion. *NA: not available in the study.

Table 5 Complications of this study compared with other studies

	Surgical technique	Cases no.	Complications
This study	Ts. Wiring	25	No major complications 2 PTF 1 15° angulation
Paul *et al.* [17]	Ts. Wiring	22	8 PTF
Galanakis *et al.* [8]	Ts. Wiring	25	4 PTF
Choi and Song [18]	Ts. Wiring	34	35% (12 cases)
Moon *et al.* [4]	Ts. Wiring group	22	3 PTF
Sletten *et al.* [19]	Ts. Wiring group	45	8 PTF
	Bouquet group	22	–
Kelsch and Ulrich [28]	Bouquet pinning	34	1 extension and rotatory deficit of 15° and a 10°
Mohammed *et al.* [12]	Modified Bouquet pinning	20	3 PTF 2 mild extensor lag of 15° 1 revised for failed fixation
Javali and Reddy [14]	Antegrade K-wire	15	2 PTF 2 extensor lag
Lee *et al.* [27]	Retrograde multiple K-wire	56	3 PTF 6 temporary stiffness 1 palsy of the sensory branch of the ulnar nerve
Aski and Bhatnagar [13]	Retrograde Kirschner-wire	14	2 PTF
Ozer *et al.* [25]	Plate and screws	14	5 stiffness and adhesions
Fusetti *et al.* [9]	Plate and screws	105	32% of cases
Page and Stern [8]	Plate and screws	66	36% of cases
Westbrook *et al.* [26]	Plate and screws	22	5 stiffness and adhesions

PTF, pin-tract infection.

cases of pin-tract infections in 22 patients [17]. However, Choi and Song [18] reported more inferior results, with three cases united with angulation of more than 20°, and five cases had pin-tract infection. Three cases had minimal rotational deformities, and one case had nonunion. In other studies using different techniques, Aski and Bhatnagar [13] reported two pin-tract infection from 14 patients treated with retrograde percutaneous K-wire, whereas Javali and Reddy with the use of antegrade intramedullary K-wire on 15 patients reported two superficial wound (pin site) infections, and two patients had a mild extensor lag of about 10° [14].

Using Bouquet technique, Kelsch and Ulrich [28] reported that among 34 patients, one patient had an extension deficit of 15° and a rotatory deficit of 10°. However, Mohammed *et al*. [12] revised one fracture for failed fixation and reported three superficial wound infections with surrounding cellulitis and two patients had a mild extensor lag of about 15°. Lee *et al*. [27] reported three cases of pin-tract infection and six cases of temporary stiffness that improved with physical therapy, and one patient showed numbness owing to palsy of the dorsal sensory branch of the ulnar nerve. Wong and Yueng [20] reported one patient in the transverse wiring group that had stiffness of the injured finger with a TAM of only 150°, whereas one patient in the Bouquet technique group had K-wire migration, which required early removal and bracing. However, Ozer *et al.* [25] and Westbrook *et al.* [26] reported five cases with stiffness and adhesions requiring reoperation for tenolysis when using plate and screws fixation. The same was stated in the studies by Page and Stern [8] and Fusetti *et al*. [9], which reported 36 and 32% complication rate, respectively, with plate and screws fixation.

This study confirms that functional and radiological results using transverse K-wires technique was excellent and statistically comparable to other techniques. We believe in this because it is relatively simple and rapid to perform (28 min average), with no soft tissue dissection, and with more biological avoiding damage to the periosteal blood supply, which allows predictable bony union in metacarpal shaft fracture. However, in metacarpal neck fractures, placement of the wire away from the MP joint had very good results regarding ROM comparable to antegrade Bouquet technique and superior to both the classic retrograde wiring techniques (from the metacarpal head to the shaft) and plate and screws.

In our study, among 25 patients, most of them were men, with an average age of 30 years old, and had trauma mostly to their dominant hand, resulting in unstable metacarpal fracture. They were treated by transverse K-wires technique, resulting in 100% bony union within 6.8 weeks average, with maximum of 2-week duration of immobilization. We encouraged patients to start early active ROM in IP joints, which resulted in almost normal ROM within 3 months, and almost normal grip strength, allowing early return to work for

manual workers or return to school for students. Clinical and radiologic results were excellent without any major complications. The limitations of this study were the relatively small number of cases, the short period of follow-up, and the lack of direct comparison with another fixation method.

Conclusion

Despite availability of many options for fixation, percutaneous fixation using transverse K-wires is a good method for treatment of acute displaced unstable metacarpal fractures. We recommend this technique, which is more biological, technically easy, safe, cheap, and rapid to perform with good functional outcome.

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Conflicts of interest
There are no conflicts of interest.

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