



Case Series

Intra-medullary, at fracture site introduction of K-wires for metacarpal fracture fixation (in-site technique). A new fixation technique and a case series

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ABSTRACT

PURPOSE: Metacarpal bone fractures represent one-fifth of upper extremity fractures. The most commonly affected bone was the fifth metacarpal also known as boxer's fracture with a range 9.7–50%. Different techniques have been described for fracture fixation with K-wires being the most described technique. In this paper, we present a new technique utilizing k-wires to reduce and fix metacarpal fractures in an easy less traumatic way aiming to optimize the clinical outcomes in regards of range of motion and stiffness.

METHODOLOGY: Retrospective chart review including all the patients that were managed with the new technique.

RESULTS: 24 fractures were fixed with the new technique without violating the MCP joint with different fingers involvement and different presenting deformity. At the end of the splinting time, 80% of the cases had full ROM at the time of splint removal. The remaining 20% had some stiffness that improved with further physiotherapy.

CONCLUSION: This approach is easy to teach, fast with good clinical outcomes. However, a larger sample size study comparing this technique to the existing treatment options is needed.

TYPE OF STUDY: Case Series and literature review, Level IV.

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1. Background

Metacarpal bone fractures represent one-fifth of upper extremity fractures, with an annual incidence reported as 264,000 cases in the United States. These fractures were mostly caused by accidental falls (47%) which predominantly occurred at home (30%). The majority occurred in individuals between the ages of 15–55 years, with a male predominance ratio of 3:1 [1]. Furthermore, the most commonly affected bone was the fifth metacarpal also known as boxer's fracture with an incidence reported in the literature ranging from 9.7 to 50% [2–6].

Management options of metacarpal fractures vary from non-operative to operative treatment, depending on multiple factors like fracture location, the degree of angulation, shortening, mal-rotation and presence of multiple fractures. Different modalities of

operative fixation have been described as the use of Kirschner wires (K-wire) either transversely or by intramedullary pinning, the use of plates and screws, cerclage wiring, tension banding, and external fixator [7–9].

K wires were first introduced by Lord in 1957 for displaced metacarpal fracture. The described technique led to the ability to return to work with no infection or refracture rates reported [10]. This technique has evolved throughout the years and multiple modifications has been introduced including number of wires, entry points, and the location of the wires. However, the most commonly used method of introducing K-wires involves advancing the wire through the metacarpal head in a retrograde fashion into the medullary canal. This process sometimes requires multiple passes into the metacarpal head till the operator gets the K-wire into the medullary canal which might cause significant damage to the articular cartilage. Also passing the wire in this fashion sometimes fixes the extensor mechanism (proper extensor tendon or sagittal bands) which prevents early range of motion at the metacarpophalangeal joint (MCP joint) and may predispose to adhesions [11].

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Fig. 1. A chart showing the different presentation of the metacarpal fractures and their deformities.

As a result, several studies suggested modifications to the existing method or introduced numerous techniques for fifth metacarpal bone fracture fixation to achieve a stable fixation with less complication and a faster recovery rate; like the use of a single k-wire approach and antegrade fixation of 5th metacarpal fractures [12–16].

In this study, we describe our technique of retrograde percutaneous K-wire fixation for all metacarpal fractures in a series of patients.

2. Aims

- To describe a new technique, its indications, application, and limitations and apply it in all metacarpal fracture fixation.
- Emphasizing the differences between the new technique and the standard techniques.
- Explaining the importance of the way of fixation when it's compared to other modalities.
- Presenting the outcome of using this technique in our patient population.

3. Methodology

We conducted a case series study including all the cases done with this technique by a single senior hand surgery consultant in a single governmental hospital over a period of five years focusing on certain factors like the type of metacarpal fractures, pre-operative and postoperative function, follow up, patient satisfaction and complications. Literature review was done as Pubmed database was searched using the keywords: Metacarpal Bones, Fractures, K-Wire, Kirschner Wire, plates and screws, conservative, closed reduction, open reduction in different combination. A list of 35 related articles were reviewed and a literature review was written based on it. The next step was reviewing the files of the patients who underwent this method of fixation and the outcomes after 12 weeks of follow up with documentation of the complications and level of satisfaction. All the patients who had trauma resulted in metacarpal fractures and underwent this technique of fixation were included. Those with pathological fracture or fractures fixed with different techniques were excluded.

This study was granted an IRB approval from local ethical committee in our institute. The research was registered with research registry with UIN: researchregistry5754 [17]. The work has been reported in line with the PROCESS 2018 criteria [18].

Table 1

Fracture site in relation to Right hand involvement.

Fracture site	Number of cases	Right hand involvement
Isolated little finger MC	11	8
Isolated ring finger MC	4	2
Isolated index finger	1	1
Combined middle and ring fingers	3	1
Combined ring and little fingers	1	1

Table 2

Number of fractured bones for each fracture pattern.

Fracture pattern	Number of Fractured bones
Transverse	10
Oblique	10
Spiral	4
Total	24

4. Results

The study included 20 healthy patients with 24 fractured metacarpals, with an average age of 29.85 (ranging from 12 to 54). Table 1 shows the fracture sites with isolated little finger metacarpal fractures being the commonest and mostly occurring in the right hand. Table 2 summarizes the fracture pattern in which spiral fracture was the least commonly encountered in 2 cases only.

At the time of presentation all patients had displaced fractures with 8 out of 20 patients had bone shortening, 5 patients had scissoring, and 2 patients had extension lag (Fig. 1).

Regarding operative fixation, 16 fracture sites were reduced with 2 k-wires and a single k-wire was used in 8 fractures. The length of fixation was between 3–4 weeks. Fig. 1 shows the intra-operative steps in k-wire fixation.

4.1. Surgical technique

At the time the patients were seen in ER, they were put on a volar splint and evaluate their overall condition and general status to be optimized for the surgery. The Procedures were done under general anesthesia or brachial plexus block. After that, the procedure will commence in the following steps. First, the fracture site is identified under fluoroscopy (Fig. 2). A K-wire is inserted through the fracture site manually (Figs. 3 and 4) then advanced to the proximal fragment with a drill until it reaches the wrist joint and pierces the skin (Figs. 5 and 6). Another K-wire is inserted following the same technique (Fig. 7). Then the fracture is reduced (Fig. 8) and both k-wires



Fig. 2. PA X-ray showing a displaced fracture at the shaft of the 5th metacarpal.



Fig. 4. PA X-ray showing manual insertion of the K-Wire under fluoroscopy through the fracture site.



Fig. 3. A picture of the manual insertion of the K-Wire under fluoroscopy through the fracture site.



Fig. 5. A picture of K-wire retrieved through the wrist with the drill after being advanced through the fracture site.



Fig. 6. PA X-ray showing a K-wire at the fracture site after being retrieved through the wrist.

are advanced distally without violating the metacarpophalangeal joint (Fig. 9).

Postoperatively, patients were kept on a volar slab for one week. After that, the slab is shortened to the level of metacarpophalangeal joint and patients are allowed to start range of motion exercises for the phalanges. After another 3 weeks, K-wires and slab were removed.

Follow ups were available for 15 cases only for a total of 12 weeks. From the remaining cases 12 patients (80%) demonstrated a full range of motion of metacarpophalangeal joint after removing the splint in 4 weeks. While 4 patients (20%) had varying degrees



Fig. 7. PA X-ray showing the insertion of the 2nd K-wire in the same maneuver.



Fig. 8. PA X-ray showing both K-wires at the proximal fracture site before reducing the fracture.

of MCP stiffness requiring further Physiotherapy that improved at the end of the follow up period. We didn't encounter any malalignments, nonunion, nor malunion. All patients went back to their regular daily activities after the end of the follow ups.

5. Discussion

Metacarpal fractures are one of the most regularly encountered injuries in the upper extremity. Devastating deformities can occur if some types are left untreated. Management options vary from non-operative immobilization to surgical treatment with different techniques and methods used depending on the fracture site, the degree of angulation, and many other factors [6,19]. Therefore, establishing an easy and fast approach with the least complication is of importance.

By reviewing the literature, there were different techniques with different varieties of methods of insertion of the K-wires.



Fig. 9. PA X-ray showing the reduced fracture with the one K-wire at its final destination in the metacarpal head while advancing the other K-wire through the fracture site.

Each of which shows different advantages and disadvantages in regards of the surgical techniques and possible outcomes. Some of the methods used for operative fixation include reduction and K-wires to fix the shaft and the head of the fifth metacarpal to fourth metacarpal which was first described by Bosworth in 1937 [20]. Then in 1976, Foucher started the “bouquet” method for metacarpal neck fracture using multiple k-wires [21]. Smith and Peimer introduced another technique using a retrograde crossed k-wires for fixation in 1977 [22].

A retrograde intramedullary nailing was introduced for fifth metacarpal fractures. This technique had an advantage of establishing early ROM compared to antegrade approach which was thought to result from adhesions of the extensor hood. Moreover, it demonstrated superiority in terms of pain improvement and less shortening of 5th metacarpal [16]. A review was done by Beredjiklian on little finger metacarpal fractures in which he encourages operative stabilization depending on patient age, job, and handedness with the only exception to elderly patients who have limited hand function, in which conservative management remains the mainstay of treatment [23].

No similar studies were found using this technique to fix the metacarpal bone fractures. By applying the new technique, we achieved minimum soft tissue injury, early ROM and faster recovery rate compared to the classic retrograde method. Some limitations to our study were observed such as the small sample size, fractures in pediatric age groups with narrow intramedullary space, base fractures with a small proximal segment and in comminuted fractures.

6. Conclusion

In conclusion, this approach is easy to teach, with easy learning curve. It can be done in short time, in a fast way with good clinical outcomes avoiding complications related to stiffness and decreased ROM. However, a larger sample size study comparing this technique to the existing treatment options is needed.

Conflicts of interest

No Conflicts.

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Ethical approval

Approved by our local ethical committee. File No. 3488/2015.

Consent

All involved patients were consented to publish this paper

Author contribution

- Abdulaziz K. Alhujayri: Conceptualization, methodology, writing original draft.
- Nawaf S. Alohaideb: Writing original draft, Reviewing and editing the draft
- Seham F. Alarfaj: Data Curation, Reviewing and editing the draft
- Nasser Alhodaib: Visualization and supervision

Registration of research studies

1. Name of the registry: Research Registry
2. Unique identifying number or registration ID: researchregistry5754
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): <https://www.researchregistry.com/browse-the-registry#home/registrationdetails/5ef5d03346391600176522ab>

Guarantor

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