

Transfixing the Boxer's Fracture by K.wires to the Adjusent Healthy Metacarpal: Prospective Randomized Study

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Abstract

Background: The fractures of the 5th metacarpal neck are common and mainly occur in young men. The aim of this work was to evaluate the clinical and radiological outcomes after closed reduction and fixation of fifth metacarpal neck fractures (Boxer 's fracture) using transverse K-wires fixation. **Methods:** This prospective randomized study was conducted on 20 isolated fracture of 5th metacarpal neck patients were treated by percutaneous transfixing K-wires, aged equal or older than 15 years old, males only. All patients were subjected to: Routine preoperative investigations, history taking, clinical examination [general examination, local examination ,The rest of the hand skeleton, checking the initial deformity ,angulation, rotational malformation , skin condition, the intensity of the edema all over the hand],and radiographic evaluation [Standard anteroposterior, lateral and oblique X-rays were done]. **Results:** The Grip strength of studied patients ranged from 75-96 %. The Quick DASH disability Score of all studied patients was zero except one case had scores (20, 25). All patients were satisfied and resume their work and daily activity except one patient; despite fracture union, he was unsatisfied due to partial stiffness and residual pain at the hand with manual activities. The TAM score of studied patients ranged from 220 - 270 degrees. **Conclusions:** The utilization of transfixing Kwires for fixation may facilitate early hand mobilization, repair the deformity, and yield favorable clinical and radiographic results.

Keywords: Fractures; Transfixing the Boxer's Fracture; K.wires; Healthy Metacarpal

1. Introduction

Metacarpal bone fractures are prevalent skeletal injuries, with the neck of the fifth metacarpal bone collectively bearing responsibility for around 50% of such incidents. Active young males are prone to developing these fractures, which typically manifest in the dominant hand. These are typical aggression-related injuries, which are typically the result of striking a hard object with a closed fist (Boxer's fracture) ^[1].

These fractures occur when a flexed metacarpophalangeal joint (MCP) is subjected to a longitudinal compression force, such as when a clenched fist strikes a solid object. The fracture is typically unstable during volar angulation as a consequence of the interosseus muscles deforming and comminution the volar cortex ^[2].

These fractures were treated non-operatively until the beginning of the 20 century. Fractures that are stable and do not require operative intervention are those that are minimally or non-displaced. Such fractures can be reduced closed and secured with a cast or splint ^[3].

Mini plate and screws, lag screws, external fixators, cerclage wires,tension band wires, K-wires (whether transverse transfixing, intramedullary, or crisscross), intramedullary nancy nails, and mini plate and screws are all examples of fixation techniques ^[4].

The utilization of transverse K-wire fixation to stabilize metacarpal fractures was initially documented by **Berkman and Miles**, involving the transverse passage of multiple K-wires between the fifth and fourth metacarpal bones in order to stabilize the fracture. ^[5].

Kirschner wires for percutaneous pinning are an appealing alternative due to their ability to circumvent the need for extensive surgical dissection and devitalization of soft tissue at the fracture site. Additionally, it inhibits extensor irritation caused by a dorsal plate, thereby decreasing the likelihood of extensor tenosynovitis ^[6].

The success rate of percutaneous pinning is as high as 100% bony union. The technique of transverse wiring is forgiving. In the event that fracture reduction or pin placement is deemed unsatisfactory, reinsertion can be easily accomplished. Pins, on the other hand, lack rigidity, have the potential to divert attention away from a fracture, and may detach or become infected. The primary complications associated with transfixing transverse K-wires are tethering of soft tissues, particularly the sagittal bands of the extensor mechanism, which can result in partial stiffness and pin tract infections. Additionally, the dorsal digital branch of the ulnar nerve may sustain iatrogenic damage to the little finger. However, these complications are thankfully preventable. ^[7]. This study aimed to assess the clinical and radiological outcomes subsequent to transverse K-wire fixation for closed reduction and fixation of fifth metacarpal neck fractures (commonly referred to as Boxer's fracture).

2. Patients and Methods

This prospective randomized study was carried out on 20 isolated fracture of 5th metacarpal neck patients were treated by percutaneous transfixing K-wires, aged equal or older than 15 years old, males only.

The patient or their legal guardianship was consulted prior to providing informed written consent. Ethical Committee of Benha University Hospitals, Beaha, Egypt, approval was obtained prior to conducting the research.

Patients who are fifteen years of age or older and have an irreducible, unstable fracture, closed extra-articular or Malrotation deformity clinically manifested as a fracture neck of the fifth metacarpal bone and palmar angulation exceeding 30 degrees are included. Patients under the age of fifteen, those with open fractures, multiple injuries, neglected or old fracture cases, comminuted fractures, intra-articular fractures, refusal to undergo surgery, palmar angulation below 30 degrees, and pathological fractures were excluded from the study. All patients were undergone to: Clinical examination [general examination, local examination (checking the initial deformity (angulation, rotational malformation), the rest of the hand skeleton, skin condition, and the intensity of the edema all over the hand), and history taking [patient's name, age, gender, hand dominance, medical diseases, and special habits of medical significance such as smoking and drug abuse]; routine preoperative investigations; and radiographic evaluation. .

I. Intra operative management:

Surgical procedures were performed on all patients while they were supine, with the injured upper limb supported by a radiolucent table oriented perpendicular to the patient's body. Under general anesthesia, brachial plexus block anesthesia, or ulnar nerve block anesthesia at the wrist joint, every patient underwent the operation. Antibiotic prophylactic intravenously (Amoxicillin/sulbactam 150 mg/kg) was administered prior to the onset of anesthesia. Intra-operative imaging was utilized in all cases throughout the procedure as a prerequisite.

II. Operative details

Reduction was accomplished through the implementation of either the Jahss maneuver, which involved applying a dorsal force to the distal fragment while fully flexing the metacarpophalangeal and proximal interphalangeal joints, or axial traction under image intensification in the case of manual reduction. Three K-wires with sufficient diameter are employed. After reduction, the initial K-wire is inserted via the ulnar border of the hand and traversed from the little metacarpal shaft to the ring metacarpal shaft, which is approximately ten mm proximal to the fracture. By avoiding the articular surfaces, the second and third K-wires are inserted via the ulnar border of the hand and advanced from the little to the ring metacarpal heads. Parallel is the passing of these wires to the first. In order to verify the rotation, the extension and flexion positions of the finger are subsequently assessed. In order to prevent soft

tissue tethering and stiffness, the surgeon must position his index and middle fingers dorsally on the intermetacarpal space between both of the fourth and fifth metacarpal bones, while placing his thumb on the same space palmarly. This separation and maintenance of distance between the two metacarpal bones during insertion of the transfixing K-wires is essential. In order to facilitate removal, the K-wires were left protruding through the skin.

III. Post-operative measures:

In the intrinsic plus position, the reduced metacarpal bones were encased in a dorsal short arm splint (ulnar gutter) that was precisely molded and shaped. This splint maintained an approximate 30° extension of the wrist, a 70° flexion of the MCP, and full extension of the interphalangeal joints. After two weeks of recovery from surgery, the splint was removed, and patients were permitted to resume their daily activities as they felt comfortable. All patients underwent early physical therapy following the removal of the splint. Two months following their operation, every patient was instructed to refrain from engaging in strenuous activities. Gutter ulnar splint. In order to facilitate removal, the K-wires were left protruding through the skin. Following six weeks postoperatively, removal was performed under local anesthesia. After fixation, patients presented at the outpatient clinic at the following intervals: two weeks, four weeks, one and a half months, three months, and six months. Clinical evaluation of the extent of residual pain via visual analog scale, fracture stability, and range of motion (ROM) in comparison to the normal side constituted a follow-up protocol designed to detect and treat emerging complications as soon as possible.

Immediate postoperative plain radiographs were obtained at two weeks, four weeks, six weeks, three months, and six months after the procedure. These radiographs were analyzed for indications of wire loosening, the occurrence of deformities, residual angulation, callus formation integrity, and the progression of fracture union rate and time. Hand function was evaluated two months after the operation and once the patient completed physiotherapy using the Quick DASH score, Total Active Motion of the little finger (TAM) score, hand grip strength in comparison to the normal side, and ROM.

Using a manual dynamometer and comparison to the contralateral side, the hand's grip strength was assessed two, three, and six months subsequent to the operation. TAM is recommended by the American Society for Surgery of the Hand; it is the additive sum of flexioadopted procedures. The approach utilized was to calculate the extension deficit at the distal interphalangeal (normally 0°-280°), proximal interphalangeal (normally 0°-110°), and metacarpophalangeal

(normally 0°-90°) joints, which are all within the expected range of 250°-280°. This evaluation was conducted two to three months after the procedure.

A higher score on the Disabilities of the Arm, Shoulder, and Hand scale indicates a more severe disability, as it assesses both symptoms and the ability to perform specific activities. For the Quick DASH score, the following equation is used: The sum of the responses is -1. 25 times the quantity of completed responses The calculation of the Quick DASH score may be impeded in the presence of more than one absent item. DASH Disability Quick Score.

Statistical analysis:

SPSS v26 was utilized for the statistical analysis (IBM Inc., Armonk, NY, USA). Histograms and the Shapiro-Wilks test were utilized to assess the normality of the data distribution. The parameters of a quantitative nature were expressed as the mean and standard deviation (SD). As median and interquartile range

(IQR), quantitative non-parametric data were presented. In percentages and frequencies (%), qualitative variables were denoted.

3. Results

The age of studied patients older or equal to fifteen years old (P=0.25 t-test). All studied cases were males (100%). This fracture usually occurred in jobs that need manual work and in sports activity. The manual workers were the most affected entity due to their nature of the work (50% of cases). The second most affected entity was the students due to either athletic sports or aggression (25% of cases). Punch was the commonest cause of trauma, it was the cause of fracture in 15 patients (75% of cases), Direct trauma due to ground level falls was the cause in two patients (10%) and the remaining three patients (15%), fracture was due to motor vehicle accident (MVA). (P = 0.01). The Interval before operation of studied patients ranged from 1-7 days (P=0.43) (Table 1).

Table (1)Age distribution, Occupation, mode of trauma, and interval before operation of in studied cases

Age distribution	Number of patients	Results
16 – 27	12	Excellent
>27 – 37	5	Excellent
>37	3	Good
Total	20	---
Mean ± SD	27.2 ± 7.8	---
P-value	0.25	---
Occupation		
Student	5	25%
Driver	1	5%
Carpenter	2	10%
Electrician	1	5%
Plumber	1	5%
Manual worker	10	50%
Total	20	100%
Mode of trauma		
Punch	15	75%
Direct trauma	2	10%
RTA	3	15%
Interval before operation		
1-3 days	15	Excellent
4-5 days	3	Excellent
6-7 days	2	Excellent
Mean ± SD	3.3 ± 2	---
P-value	0.43	---

Data are presented as number (%) and mean ± SD.

The Grip strength of studied patients ranged from 75-96 %. We used manual dynamometer for measurement and percentage was measured compared to the normal hand, the grip strength measured at second and third months after fixation. The Quick DASH disability Score of all studied patients was zero except one case had

scores (20, 25). All patients were satisfied and resume their work and daily activity except one patient; despite fracture union, he was unsatisfied due to partial stiffness and residual pain at the hand with manual activities. The TAM score of studied patients ranged from 220 - 270 degrees (Table 2).

Table (2) Grip strength, quick DASH disability Score, and TAM score measured at third month after removal of implant.

	Number of patients	Results
Grip strength% to other hand		
91-100 %	17	Excellent
81-90 %	3	Good
70-80 %	0	Fair
<70 %	0	Poor
Mean ± SD	90.6 ± 4.7	---
P-value	0.026	---
Quick DASH		
0-10	38	Excellent
11-20	1	Good
21-30	1	Fair
>30	0	Poor
Range	0 – 25	---
Mean ± SD	3 ± 8 (median = 0)	---
P-value	0.7	---
TAM score		
270-280	15	Excellent
210-270	5	Good
140-210	0	Fair
<140	0	Poor
Mean ± SD	256 ± 12	---
P-value	0.001	---

Data are presented as number (%), mean ± SD or median.

Complications:

MCP joint partial stiffness and residual pain were reported by two patients (10%) out of a total of twenty cases. Patients who did not begin physiotherapy immediately did so for personal reasons; however, they improved and became satisfied within one to two months. A superficial

pin tract infection appeared in one patient (5% of the total) but was resolved after one week of treatment with oral antibiotics. Patient neglect of local cleansing of K wires and water usage was attributed to personal factors (Figure 1).



Fig. (1) Superficial pin tract infection

4. Case Presentation

Male Patient 55 years old carpenter came to E.R. of shebin elkom teaching hospital complaining of pain and swelling of the left non dominant hand after trauma while he lifting large heavy piece of wood. By examination localized tenderness over the 5th metacarpal bone and diffuse swelling on the dorsum of the hand was found, and patient was neurovascular intact. PXR showed short oblique fracture of the 5th metacarpal shaft with 50 degrees angulation. Surgical fixation

of the 5th metacarpal fracture was done using transverse wire technique. Surgery was done under general anesthesia, fracture reduction under image intensifier by traction and manipulation (Jahss method). A splint was placed for 2 weeks postoperative. PXR at 2, 4 and 6 weeks has been obtained, wires were removed at 6 weeks after union confirmation clinically and radiologically. TAM of the 5th finger was 255, Quick DASH was 1 very good, grip strength was 95% (Figure 2).

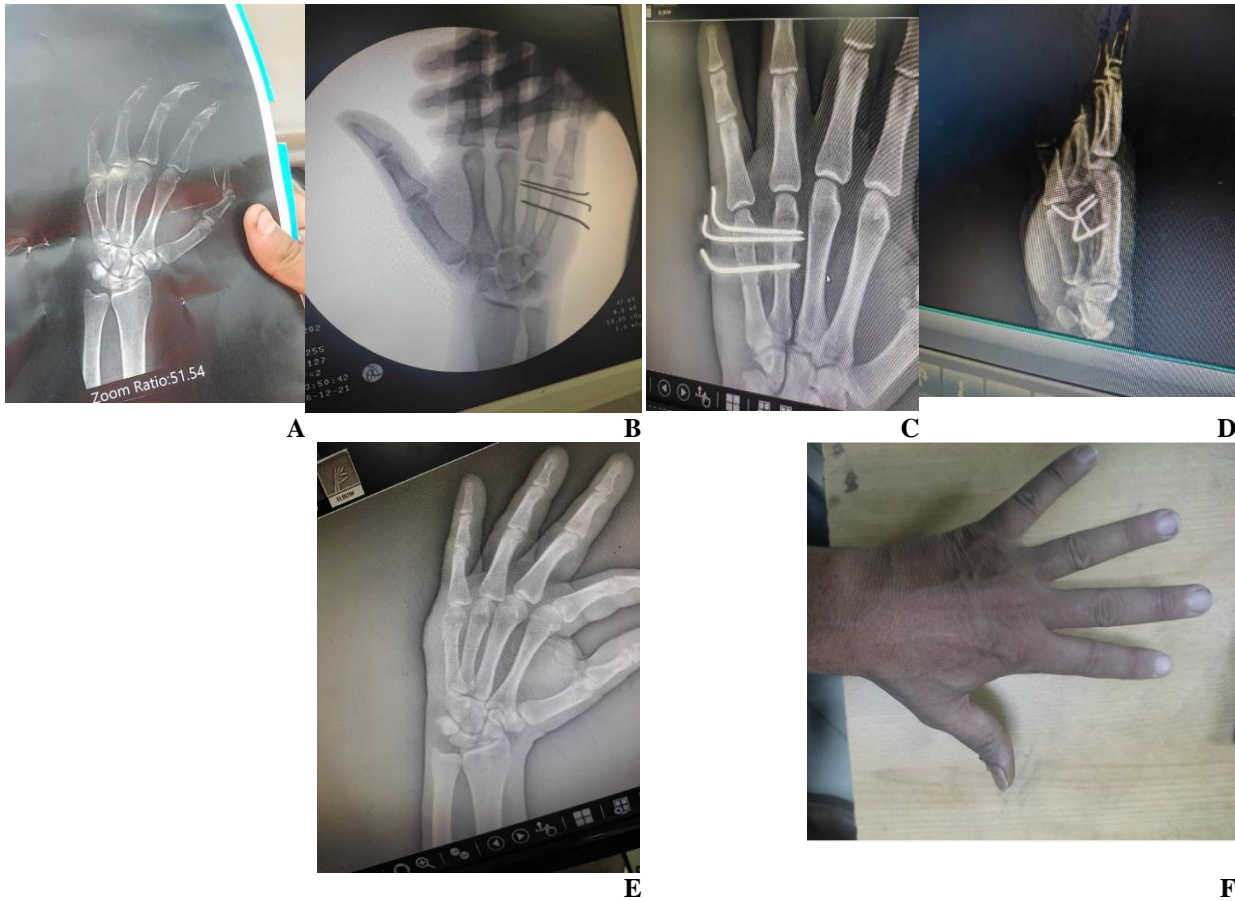


Fig. (2) (A) Initial X ray before treatment, (B) Intra-operative x-ray, (C) Follow up 2 weeks after fixation, (D) 4 weeks post-operative x-rays, (E) 6 weeks postoperative x-rays, (F) 8 weeks postoperative

Male Patient 15 years old student came to E.R. of shebin elkom teaching hospital complaining of pain and swelling of the right dominant hand after trauma after punching somebody while playing kickboxing. By examination localized tenderness over the 5th metacarpal bone and no diffuse swelling on the dorsum of the hand was found, and patient was neurovascular intact PXR showed transverse fracture of the 5th metacarpal shaft with 40 degrees angulation.

Surgical fixation of the 5th metacarpal fracture was done using transverse wire technique Surgery was done under general anesthesia, fracture reduction under image intensifier by traction and manipulation, two weeks of splinting postoperative PXR at 2, 4 and 6 weeks has been obtained, wires were removed at 6 weeks after union confirmation clinically and radiologically. TAM of the 5th finger was 260 degrees, Quick DASH was 0 excellent, grip strength was 95% (Figure 3).



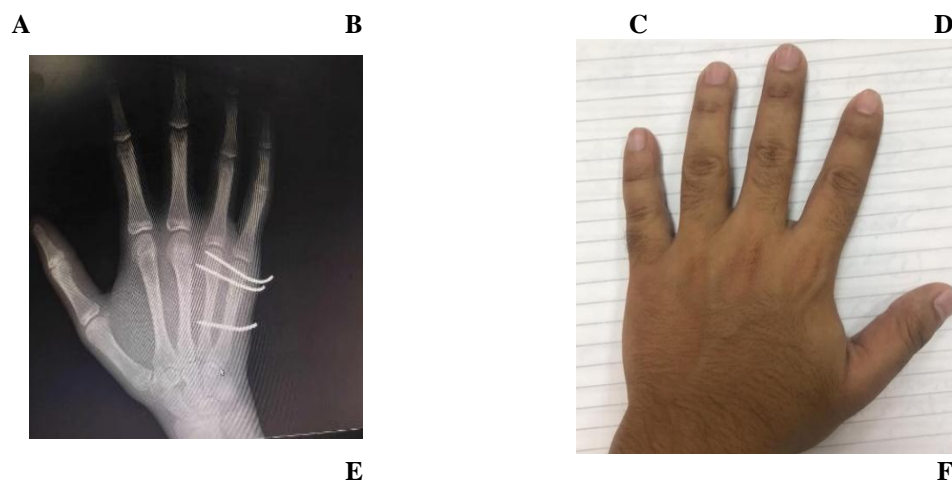


Fig. (3) (A) Initial X ray before treatment, (B) Intra-operative x-ray, (C) Follow up 2 weeks after fixation, (D) 4 weeks post-operative x-rays, (E) 6 weeks post-operative x-rays, and 8 weeks postoperative

5. Discussion

Metacarpal neck fractures of the little finger are prevalent and predominantly affect young males. The damage is frequently caused by acts of aggression, including fistfights and blows to the head with hard objects. It is generally accepted that conservative treatment is adequate for most small finger metacarpal neck fractures. However, there is no consensus regarding the acceptable degree of palmar displacement [8].

In their biomechanical investigation, [9] utilized cadaveric specimens to ascertain the impact of fracture angulation on the intrinsic muscles' capacity to initiate grip. Based on their findings, fracture angulations of no more than thirty degrees resulted in functional length reduction of the muscle group, which was comparable to nearly normal mechanics.

[10] administered an ulnar gutter plaster cast for three weeks, followed by mobilization, or a pressure bandage for one week, with immediate mobilization, to forty (n=40) patients who exhibited angulation of less than thirty degrees in a prospective study. Patient satisfaction was observed to be a direct result of prompt mobilization. The two treatment methods for boxer's fractures did not differ statistically in terms of ROM, patient satisfaction, or pain perception.

A number of prospective randomized trials have been conducted to compare various conservative treatment modalities for metacarpal neck fractures of the small finger.

In a randomized study, [11] applied buddy taping or a metacarpal brace to seventy-three (n=73) patients who presented with boxer's fracture and dorsal angulation of less than 40°. The metacarpal brace group exhibited reduced pain and a marginally improved ROM at the three-week mark.

A similar conclusion was reached by [12] regarding the adequacy of a one-week pressure

bandage followed by immediate mobilization as a treatment for metacarpal neck fractures of the little finger.

Wire technique drawbacks include inadequate absolute stability, wire migration, pin site contamination, infection susceptibility, and the requirement for implant removal [13].

The study cohort comprised 18 little metacarpal fractures and two ring metacarpal fractures; overall, the participants reported favorable hand function with minimal complications [13].

The study by [14] confirms that the functional and radiological outcomes produced by transverse K wires were statistically comparable to those of other techniques and were excellent. This approach is supported by our organization due to its relative ease of execution and speed (an average of 28 minutes) in repairing metacarpal shaft fractures, the absence of soft tissue dissection, and its biological benefits (preventive damage to the periosteal blood supply and predictable bony union). When applied to metacarpal neck fractures, wire placement away from the MP joint produced very good results.

In our study, twenty (n=20) patients who were treated with percutaneous transfixing K wires for fractures of the fifth metacarpal neck were described.

Patients must be at least 15 years old; the cohort's mean age was 32.5 years, with a standard deviation of 7.8. Most of the patients were under the age of 45. The findings presented here are consistent with those of [15] and [16]. Additionally, this explains why these fractures are more prevalent among young, active individuals. Outstanding results were achieved with these young people.

In terms of gender, every patient included in this study was male. This is consistent with the research, as males engage in more athletic activity

and masculine manual labor than females. In all patients, the injured hand was the dominant hand. These fractures commonly manifest in the dominant hand and are frequently attributed to punch injuries, according to the findings of [13] who observed that with the exception of one patient, all patients experienced hand involvement.

Using a goniometer and oblique X-rays, the palmar angulation of the metacarpal head was determined to range from 30 to 60 degrees, with a mean of 45 degrees and a standard deviation of 8.7 degrees. [9] found that fracture angulation of no more than 30 degrees resulted in the muscle group's functionality remaining nearly unchanged; further angulation reduced the muscle group's length of function; therefore, surgical intervention is recommended for optimal outcomes.

Under general anesthesia, brachial plexus block, or ulnar nerve block at the wrist joint, the procedures were carried out. The range of the operation was 15 to 35 minutes, with an average of 23 minutes. The mean operative time was 25 minutes in the study by [15] and 19.5 minutes in the study by [16].

Surgical intervention occurred an average of 3.3 days after the date of injury (range: 1–7 days, SD: 2).

Without rotational or severe angulation deformities, all fractures resolved to radiological bony union. The initial average volar angulation upon radiographic evaluation was 40 degrees (30–60°, SD = 8.7°). It had decreased to 1.46° (0–15°, SD = 3°) after reduction. In this study, union is observed in every patient. The findings presented in this research were in close concurrence with those of [13] and [16].

The mean TAM at the final follow-up was 256° (SD = 12; range: 220°–270°). Each individual patient attained complete extension of the digit. Comparatively, the average grip strength of the injured hand was 90.6% (range: 75%–96%, SD: 4.7) lower than that of the healthy, uninjured hand. The quick DASH score for every patient was zero. The findings were comparatively consistent with those documented by Hassan **Boussakri et al** [15].

The outcomes of surgical procedures were deemed satisfactory by 95% of patients in terms of both functionality and cosmetically.

We recommend that technique in all indicated 5th metacarpal neck fractures (boxer's fractures) as regard surgeon preference and condition of the patient, especially when severe swelling of the hand is present and with angulation more than thirty degrees to get good functional results and low morbidity.

6. Conclusions

Transfixing K-wires fixation is minimally invasive percutaneous technique straightforward, simple, easy and with no affection on articular

surface and joint capsule, which promotes the recovery of joint function without affecting the extensor tendon. Early hand mobilization, correction of the deformity, and favorable clinical and radiographic outcomes are all possible with this method.

References

- [1] Moore A, Varacallo M. Metacarpal Hand Fracture. StatPearls. Treasure Island (FL) ineligible companies. Disclosure: Matthew Varacallo declares no relevant financial relationships with ineligible companies.: StatPearls Publishing Copyright © 2023, StatPearls Publishing LLC.; 2023.
- [2] Wolfe SW, Pederson WC, Kozin SH, Cohen MS. Green's operative hand surgery e-book: Elsevier Health Sciences; 2021.
- [3] Nixon AJ. General considerations for Fracture repair. *Equine Fracture Repair*. 2019;35-43.
- [4] Kawamura K, Chung KC. Fixation choices for closed simple unstable oblique phalangeal and metacarpal fractures. *Hand Clin*. 2006;22:287-95.
- [5] Moharrami A, Mirghaderi SP, Hoseini Zare N, Tabatabaei Irani SP, Moazen-Jamshidi MM, Kalantar SH. Transverse pinning of concomitant first and second metatarsal fractures using 1.5mm K-wires; case report and technical note. *Ann Med Surg (Lond)*. 2022;79:103906.
- [6] Vilcioiu D, Cristescu I, Mirea L, Milea C, Mates I, Mohan AG. Functional Outcomes after Surgical Treatment of Hand Fractures - ORIF vs. CRIF Analysis. *Key Engineering Materials*. 2017;745:124-33.
- [7] Ewais WM, Romaih MA-E. Minimally invasive antegrade intramedullary fixation for unstable subcapital fracture of the fifth metacarpal by single elastic nail. *The Egyptian Orthopaedic Journal*. 2021;56:13-7.
- [8] Shultz, S. J., Houglum, P. A., Perrin, D. H. *Examination of Musculoskeletal Injuries*. Chicago: Human Kinetics; 2010.
- [9] Ali A, Hamman J, Mass DP. The biomechanical effects of angulated boxer's fractures. *J Hand Surg Am*. 1999;24:835-44.
- [10] Poolman RW, Goslings JC, Lee JB, Stadius Muller M, Steller EP, Struijs PA. Conservative treatment for closed fifth (small finger) metacarpal neck fractures. *Cochrane Database Syst Rev*. 2005;2005:Cd003210.
- [11] Harding IJ, Parry D, Barrington RL. The use of a moulded metacarpal brace versus neighbour strapping for fractures of the little finger metacarpal neck. *J Hand Surg Br*. 2001;26:261-3.
- [12] Stadius Muller MG, Poolman RW, van Hoogstraten MJ, Steller EP. Immediate mobilization gives good results in boxer's

- fractures with volar angulation up to 70 degrees: a prospective randomized trial comparing immediate mobilization with cast immobilization. *Arch Orthop Trauma Surg.* 2003;123:534-7.
- [13] Mohammed R, Farook MZ, Newman K. Percutaneous elastic intramedullary nailing of metacarpal fractures: surgical technique and clinical results study. *J Orthop Surg Res.* 2011;6:37.
- [14] Elaxir H, Adawy AH, Essawy OM, Shoulah SAE-R. Bouquet technique in management of unstable metacarpal fractures. *Benha Medical Journal.* 2022;39:680-95.
- [15] Boussakri H, Elidrissi M, Azarkane M, Bensaad S, Bachiri M, Shimi M, et al. Fractures of the neck of the fifth metacarpal bone, treated by percutaneous intramedullary nailing: surgical technique, radiological and clinical results study (28 cases). *Pan Afr Med J.* 2014;18:187.
- [16] She Y, Xu Y. Treatment of fifth metacarpal neck fractures with antegrade single elastic intramedullary nailing. *BMC Musculoskelet Disord.* 2017;18:238.