

Early Results of Bouquet Technique in Treatment of Metacarpal Fractures

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ABSTRACT

Introduction: Metacarpal fractures are frequent, and many of them can be managed non-surgically with the proper reduction and immobilisation. As with any hand fracture, the major goals are to achieve anatomic and stable reduction, bone union, and early mobilisation. **Objective:** The aim of the present study was to evaluate the outcome of bouquet technique in management of unstable metacarpals fractures as isolated or multiple shaft metacarpal fractures, irreducible or unstable fracture, greater than 30 degree fracture angulation, greater than 10 degree rotational deformity, and extensive (more than 5 mm) metacarpal shortening.

Patients and methods: A prospective follow up study was carried out on 20 patients with metacarpal fractures, managed at El Queen Hospital, Dar Elhekmah Hospital and Abo Khalifa Emergency Hospital, A total of 17 males and 3 females with unstable 2nd to 5th metacarpal fractures fixed by intramedullary k-wires (Bouquet osteosynthesis) were recruited.

Results: The average Quick DASH score was 1.45 (SD 1.23), ranging from zero to four points, and the mean grip strength of the damaged hand was 96%, which was significantly lower than the non-injured side's range of 85% to 100%. The functional outcome was satisfactory. Up to 18 patients (90%) patients reported being extremely satisfied, while 2 (10%) patients reported being satisfied.

Conclusion: Bouquet pinning and transverse wiring techniques in metacarpal fractures showed good range of motion (total active motion >245), grip strength, early radiographic bone union and less post-operative infection.

Keywords: Metacarpal Fractures, Bouquet Technique, Fixation, Immobilization, Follow up study, Al-Azhar University.

INTRODUCTION

One of the most frequent orthopaedic injuries is a metacarpal fracture, which is regularly seen in emergency rooms and in patients seeking advice outside. To get the best results, Most of these metacarpal fractures can be treated well without surgery. Unintentional falls, polytrauma injuries received in motor vehicle accidents, direct hits to a hard object, or physical assaults account for the majority of fractures. The most frequent types of metacarpal fractures are fourth and fifth metacarpal shaft fractures. A common injury in the United States, metacarpal fractures account for 30% of all hand fractures and 18% of all fractures below the elbow ⁽¹⁾. 70% of them happen between the second and third decades of life ⁽²⁾.

Metacarpal fractures are common, and with the right reduction and immobilisation, many of them can be treated without surgery. The main objectives are to achieve anatomic and stable reduction, bone union, and early mobilisation, as with any hand fracture. Positive functional outcomes require effective therapy and, whenever possible, early range of motion. A less intrusive treatment option for metacarpal shaft fractures below the c-arm is percutaneous Enders type intramedullary k wire fixation. As a result, rewarding performance is advantageous.

In the current study, pre-contoured K wires were implanted intramedullary to fix metacarpal shaft fractures using percutaneous blooming (Bouquet Technique), with the aim of assessing the procedure and functional outcome.

The aim of the present study was to evaluate the outcome of bouquet technique in management of unstable metacarpals fractures as isolated or multiple shaft metacarpal fractures, irreducible or unstable

fracture, greater than 30 degree fracture angulation, greater than 10 degree rotational deformity, and extensive (more than 5 mm) metacarpal shortening.

PATIENTS AND METHODS

A prospective follow up study was carried out on 20 patients with metacarpal fractures, managed at El Queen Hospital, Dar Elhekmah Hospital and Abo Khalifa Emergency Hospital, A total of 17 males and 3 females with unstable 2nd to 5th metacarpal fractures fixed by intramedullary k-wires (Bouquet osteosynthesis) were recruited.

The minimum and maximum follow-up periods for each patient ranged from 8 to 16 weeks.

Inclusion criteria: Solitary or multiple shaft metacarpal fracture, greater than 30 degree fracture angulation, greater than 10 degree rotational deformity, and severe (>5mm) metacarpal shortening were all indications of an unstable or irreducible fracture.

Exclusion criteria: Patients with old fractures, non-united metacarpal fractures and intra-articular metacarpal fractures were excluded.

Methods of diagnosis

History taking: Name, age, sex, occupation, special habits of medical importance and hand dominance.

Mode of trauma: Punch trauma was the main mechanism, direct trauma as fall of a heavy object on the hand, road traffic accident and falling on the ground also caused the injuries

Physical Examination: A thorough evaluation of the damaged extremity was done before surgery, taking note of the dominant hand, the location of the pain, and any oedema. The patient was instructed to create a fist or the examiner should passively flex the fingers at the

metacarpophalangeal (MP) and interphalangeal (IP) joints in order to detect any rotational malalignment. All finger extensors and flexors were examined and compared with the contralateral side. If the fingers were not pointed in the direction of the scaphoid tubercle when in flexion, malrotation was seen.

Radiographic evaluation: Standard lateral, posteroanterior (PA), oblique X-rays.

Surgical technique

Intraoperative fluoroscopy: Intraoperative imaging (C-arm) was a prerequisite and was used for all cases throughout the procedure.

Operative steps: A 2-cm arciform incision is made proximal to the base of the metacarpal a hole is made through the ulnar cortex with the drill directed distally to open the canal, Closed reduction of the metacarpal fracture was done using the conventional methods of reductions by traction and fracture manipulation or Jahss maneuver for neck fractures, reduction clamp may be used percutaneously in some fractures as spiral fractures to reduce the fracture anatomically, the most important step is to correct the rotational deformity.

The first K-wire is bent at one end to control the direction of introduction, were gently curved lengthwise, and are driven in the medulla using the T handle before the second one is introduced.

After reduction is checked under an image intensifier, percutaneous fixation is performed using two round-tip K-wires (1.2 mm). The two wires are positioned in dissimilar directions so that they divided in the metacarpal head as a "flower bouquet" after being driven through the medullary canal consecutively".

Final fluoroscopic checks for the adequacy of fracture fixation and clinical check for rotational position of the finger in extended and semi flexed position were carried out then the K-wires were cut and buried under the skin.

A short arm splint was applied in an intrinsic plus position (80° metacarpophalangeal joint flexion and full interphalangeal joint extension) for 14 days in order to assist healing of the soft tissue.

Follow up program:

Early follow-up (6 weeks): The hand is immobilised for 14 days postoperatively in an intrinsic plus position splint (80° metacarpophalangeal joint flexion and complete interphalangeal joint extension) to prevent collateral ligament tightening and digital stiffness. After the operation, the patient was discharged from the hospital the following day. The first visit to the outpatient clinic was one week later for dressing, and the second visit took place two weeks later for imaging, dressing, and the beginning of active protected range of motion for the MCP and IP joints. Patients were assessed clinically on weeks 2, 4, and 6 following surgery with x-ray assessment using anteroposterior, lateral, and oblique views on 2, 4, and 6 weeks. K-wires

were removed 6-10 weeks after the surgery. Late follow-up (6 weeks to 3 months): On weeks 8, 10, and 12 following surgery, hand lateral, posteroanterior, and oblique X-rays were taken to evaluate the patients clinically and radiologically. Pain using a VAS and daily activity limitation using VAS were recorded as the two components of the subjective evaluation (Quick DASH score). The range of movement of MCP, PIP, and DIP joints were measured with a standard hand goniometer for both hands and the amount of loss was calculated in degrees.

Ethical Approval:

This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Al Azhar University. Written informed consent was obtained from all participants. This study was executed according to the code of ethics of the World Medical Association (Declaration of Helsinki) for studies on humans.

Statistical Analysis

For quantitative data, mean, standard deviation (SD), and range were used to summarise the data, and for qualitative data, frequency and percentage were used. The Fisher exact test was used to evaluate proportions between research groups in comparisons. Excel 14 and Minitab for Windows were used for all statistical analysis.

RESULTS

The average operation lasted 26.5 minutes (SD 7.8). The median follow-up duration, which ranged from 10 to 16 weeks, was 11.6 (SD 1.3) weeks. At an average of 7.4 (SD 0.75) weeks, with a range of 6 to 8 weeks, X-rays and a clinical examination showed indications of bone union.

All patients exhibited practically complete extension and 90° flexion of the metacarpophalangeal joints, as well as full flexion of the interphalangeal joints, at the time of the final follow-up, with a mean total active motion (TAM) of 260.6° (245°-270°). None of the individuals had any rotational deformities that could be seen clinically. The average Quick DASH score was 1.45 (SD 1.23), ranging from zero to four points, and the mean grip strength of the damaged hand was 96%, which is significantly lower than the non-injured side's range of 85% to 100%.

The functional outcome was satisfactory. Two (10%) patients and 18 (90%) patients were both very satisfied. The average pain visual analogue score was 0.85 (SD 0.8), with a range of 0 to 3. All patients were delighted with the cosmetic and functional outcomes of their operation and went back to their regular jobs. One patient who had stiffness when they first came in eventually got better with physiotherapy. One patient had a 5th metacarpal that was 10 degrees angled without any functional discomfort or extension lag. There were no other issues noted.

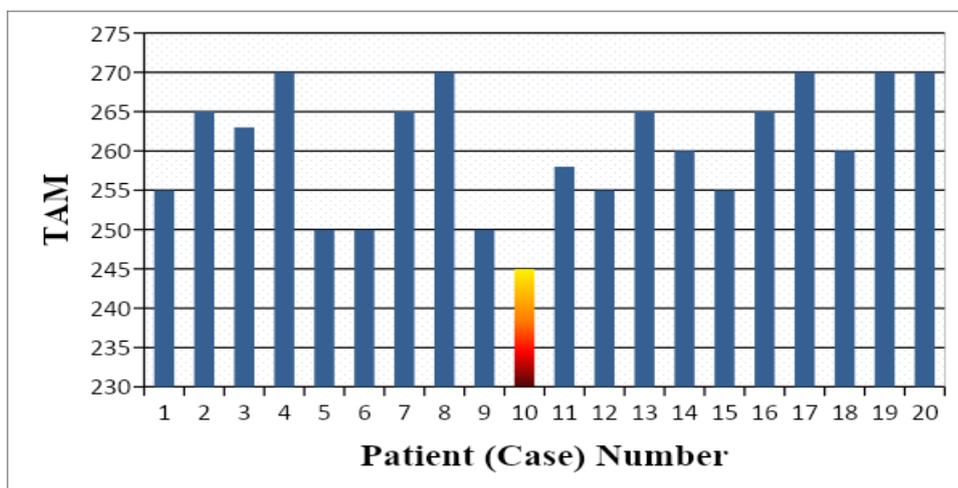


Figure (1): Total Active Motion among the patients after 3 months of follow up.

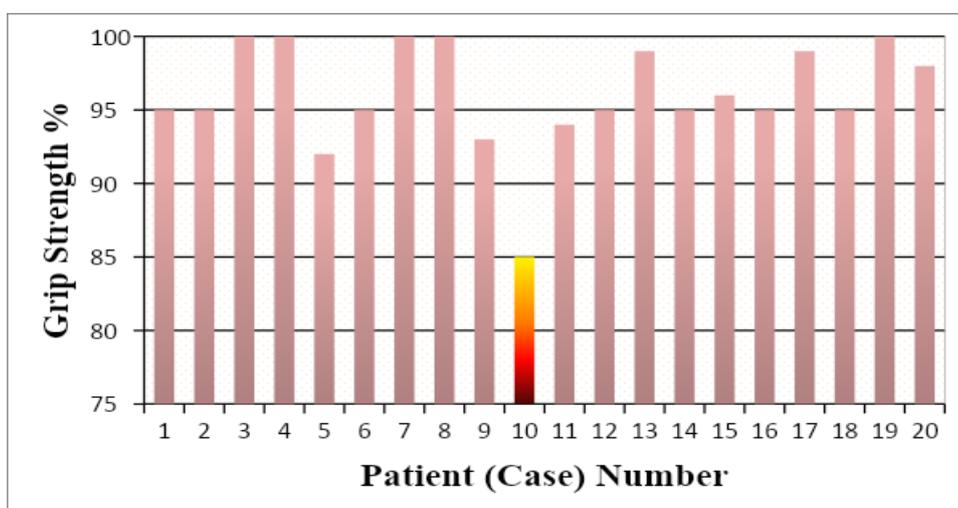


Figure (2): Grip strength among the patients after 3 months of follow up.

CASE PRESENTATION

Male Patient 29 year’s manual worker came to Emergency Room of Dar Elhekmah Hospital complaining of pain and swelling of the right dominant hand after falling on the ground. By examination localized tenderness over the 3th metacarpal bone and diffuse swelling on the dorsum of the hand was found, clinically slight rotational deformity of the 3th finger was noticed and patient was neurovascular intact. Plain x-ray showed transverse fracture of the 3th metacarpal shaft with 30 degree angulation and shortening. Surgical fixation of the 3th metacarpal fracture was done using Intramedullary K-wires “bouquet technique”. Prior to being included, a patient’s written agreement was acquired, and they were told about the surgical procedure.

Surgery was done under regional anesthesia, fracture reduction under image intensifier by traction and manipulation, 2 Intramedullary K-wires 1.2 mm was used. Below elbow extended splint was done in intrinsic plus position for two weeks. Protected active and active assisted range of motion (ROM) started after splint removal, plain x-ray at 2, 4 and 6 weeks has been obtained, and K-wires were removed at 9 weeks after

union confirmation clinically and radiologically. TAM of the 3th finger (at 6 weeks 90%, at 3 months 100%, of uninjured side), Quick DASH (2 very good at 6 weeks, 0 excellent at 9 weeks), grip strength (at 6 weeks 90% and at 9 weeks 100% of uninjured side).

DISCUSSION

A third of all hand fractures are metacarpal fractures, which are fairly common. Most of these fractures can be treated with protective splintage and early motion because they are closed, simple, transverse, or short oblique⁽³⁾.

Fusetti *et al.* studied 81 patients who had metacarpal fractures that were fixed with a plate and screw. Up to 28 out of 81 (35%) patients and 33 out of 104 (32%) fractures had one or more issues. Each of the 15 (11%) patients and 20 of 104 (20%) fractures that developed one or more significant sequelae. Up to 13 of 81 (16%) patients and 13 of 104 (13%) fractures assessed had one or more minor problems. Twelve (15%) patients experienced issues with fracture healing. There were 6 delayed unions and 6 nonunions in attendance. Further surgery was performed on all 6 nonunion patients and 1 patient with a symptomatic

delayed union. With TAM 180 degrees, 8 (10%) patients had functionally significant stiffness, and 5 of them needed a second procedure to increase their range of motion. Only 7 (8%) patients, who experienced plate loosening or rupture, required hardware removal, as did two symptomatic patients⁽⁴⁾.

A 36% complication rate was found in 66 metacarpal fractures treated with plates and screws, according to Page and Stern. The most often reported consequence was stiffness, with 76% of the patients in the study reporting total active mobility less than 220°. Minor extensor lag was present in 16% of complications, contractures in 7.9%, significant extensor lag in 6.3%, and minor extensor lag in 16.6% of problems. Serious problems are uncommon; nonunion, infection, and tendon rupture account for 1.6% of all reported events, respectively⁽⁵⁾.

Hardware complications have been documented to cause revision surgery at rates of 4.6-32%⁽⁶⁾.

The results of 150 patients treated with antegrade intramedullary K-wires for fixing metacarpal fractures were published by **Rocchi et al.** in 2018. The average surgery time was 14 minutes (ranged from 4 to 33 minutes), the average Q-DASH score was 12.3 points (ranged from 0 to 37 points), and bone union was seen in each patient after a mean of 4.7 weeks (ranged from 4 to 7 weeks). A total of 12 individuals experienced a superficial pin site infection or inflammation, which cleared up in all of them after receiving oral antibiotics. Rotational deformity was seen in 8 of these patients⁽⁷⁾.

In 2013, **Potenza et al.** managed 35 cases of metacarpal fractures using the transverse wire approach. Nearly all patients have achieved union 8 weeks after surgery. Five cases involved a little local infection at the site of the K-wire introduction, which was successfully treated with antibiotic therapy. Two patients did not report any significant hand function impairment, despite having a slight restriction in the fifth MP joint's ROM less than 108. In the heads of the fifth metacarpals of three individuals, there was an average of 78 degrees of persistent palmar angulation (range 5-138)⁽⁸⁾. The findings of Choi and Song's study using transverse K-wires to treat metacarpal fractures in 34 patients were reported in 2007. Five cases experienced skin issues near the K-wire tips, and three cases had angulation of above 20 degrees. There was residual rotational deformity in 3 cases. The K-wires in one case were removed and treated with a plate and screws since the casing was not joined⁽⁹⁾.

Foucher was quick to portray the bouquet osteosynthesis (various intramedullary adaptable wires obsession for metacarpal cracks), which has had astounding results throughout recent years. Three pre-twisted Kirschner wires (K-wires) are brought into the diminished metacarpal head in unique directions involving an open method for antegrade intramedullary obsession. This outcome was steady with that of **Sletten et al.**⁽¹¹⁾ bouquet nailing

methodology to 41 patients with unsound metacarpal cracks. The grasp strength (kg) was 49 and the mean Hat was 260. The mean Speedy Scramble score (range 0-100, 0 best) was 0 while the general VAS fulfilment (0-100, 100 best) was 100 (range 0-41). Only 2 patients went through treatment for shallow pin lot diseases with oral anti-toxins, and there were 2 occurrences of pin movement. At the 1-year follow-up, 4 patients displayed a slight rotational distortion; however it didn't influence their practical result or require a medical procedure.

Amsallem and colleagues⁽¹²⁾ detailed their discoveries in which 30 fighter's break patients were dealt with utilizing the smoothed out bouquet procedure and a solitary thick K-wire. The typical working time was 14 minutes (range 7-28 minutes), and following a three-month follow-up, all cracks had recuperated with a mean Cap of 264 degrees. There was no indication of a contamination, 2ry relocation, K-wire movement, or harm to the tactile part of the ulnar nerve.

Mohammed et al. reported correction of one crack for fruitless obsession, three reports of shallow pin parcel contaminations, and slight extensor slack in two patients of around 15°, were better than these⁽¹³⁾.

In the ongoing review, the mean complete dynamic movement (Cap) was 260.6° (range 245°-270°).

None of the patient had any clinically discernible rotational deformation, which was in accordance with **Sletten et al.**⁽¹¹⁾ with Hat 262° In bouquet sticking gathering and 264° in cross over wiring gathering, and better than Hat in **Moon et al.**⁽¹⁴⁾ near study with the intramedullary sticking gathering that was 250° and 245° in the cross over wiring bunch. While **Amsallem et al.**⁽¹²⁾ utilized single thick intramedullary K-wire (adjusted bouquet) and detailed mean Cap 264° when contrasted and the sound side. While when they involved plate and screws for obsession, **Fusetti et al.**⁽⁴⁾ revealed lower Cap of 180°.

The typical Speedy Scramble score of the ongoing review was 1.45 (SD 1.23) going from zero to 4 focuses which again was in accordance with **Sletten et al.**⁽¹¹⁾ in the two gatherings which had Fast Scramble score of 0 point (range 0-41) and resembled the consequences of **Rocchi et al.**⁽⁷⁾ with antegrade Intramedullary wiring which showed a score of 12.3 places (range from 0 to 37 places).

In **Lee et al.** review showed the typical Scramble score of 8.7 with changed retrograde Percutaneous Intramedullary K-wire **Lee et al.**⁽¹⁵⁾ Whenever plate and screws were utilized **Westbrook et al.**⁽¹⁶⁾ and **Ozer et al.**⁽¹⁷⁾ revealed mean Scramble score 5 and 8.07 focuses separately.

CONCLUSION

Bouquet pinning and transverse wiring techniques in metacarpal fractures showed good range of motion (total active motion >245), grip strength, early

radiographic bone union and less post-operative infection.

Conflict of interest: The authors declare no conflict of interest.

Sources of funding: There was no specific grant for this research from public, private, or nonprofit funding organisations.

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