

Percutaneous flowering technique of intramedullary k- wire fixation for metacarpal shaft fractures- Bouquet/ Foucher Technique

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Abstract

Introduction: Metacarpal fractures are one of the most common orthopedic injuries seen in orthopaedic practice. The aim was to study the technique and functional outcome of metacarpal shaft fracture treated with percutaneous flowering (Bouquet Technique/Foucher's technique) intramedullary fixation of precontoured K wires.

Materials and Methods: A nonrandomized, uncontrolled prospective study was performed on 38 patients with 47 metacarpal fractures. They were treated by percutaneous enders type flowering technique (Bouquet) with intramedullary precontoured thin K wires. All patient were screened using inclusion and exclusion criteria and followed up prospectively and assessed the Hand radiologically, clinical and functional outcome, Total active movement, Grip strength, VAS score.

Results: Male patients had a significantly higher frequency (68.1%) in comparison to female patients (31.9%) Most common ray affected was 4th and 5th ray followed by 2nd ray and then third ray. 38.3% of fractures were oblique type and 53.2% fractures were transverse, spiral and comminuted being 8.5%. Shaft of metacarpal fracture was maximum affected (74.5%) followed by base (14.9%) and neck (10.6%). 50% patients underwent implant removal in a period of 6 weeks.

Conclusion: This method is simple, needs minimal instruments like plier, T handle, k wire cutter bender and is cost effective, and well tolerated and with added advantage of early bone healing with good functional outcome. Being percutaneous technique there is no operative incision scar or need of anaesthesia required for removal of k wires after the treatment period.

Keywords: Bouquet technique of Precontoured, Intramedullary K wire flowering fixation, Metacarpal fracture.

Introduction

Metacarpal fractures are one of the most common orthopedic injuries, and are frequently encountered in casualty departments and as out door patients for consultations. Most of these metacarpal fractures can be successfully managed without operative intervention, to achieve optimal outcomes.

Most of fractures are due to either accidental falls or as a part of polytrauma injuries caused in RTA. Or direct blows to hard object or in assault injury. Fourth and fifth metacarpal shaft fractures are the most common metacarpal fractures.

Metacarpal fractures are among the most prevalent injuries, comprising approximately 30% of all hand fractures and 18% of all below-elbow fractures in the United States.¹⁻³ The majority (70%) occur within the second and third decades of life.⁴

Metacarpal fractures are common, and many can be managed non-operatively with appropriate reduction and immobilization. As with any hand fracture, the primary goals are to achieve anatomic and stable reduction, bony union, and early mobilization to minimize disability.

Functional outcomes depend on appropriate treatment and early range of motion whenever possible.

Percutaneous enders type intramedullary k wire fixation of metacarpal shaft fractures is a minimally invasive technique of fixation under c-arm. The advantage being functional outcome is rewarding. The present study made attempt to assess the technique and functional outcome of metacarpal shaft fracture treated with percutaneous

flowering (Bouquet Technique /Foucher's technique) intramedullary fixation of precontoured K wires.

Materials and Methods

The present study was conducted on 47 metacarpal closed fractures shafts at different levels proximal midshaft or distal shaft with the aim to study the efficacy of this type of percutaneous fixation during November 2015 to December 2018. Majority were victims of RTA, followed by assault and quarrel injuries trying to defend, direct axial blow of fist on hard object and lastly fall on hands Few presented late after 3-5 days of fracture in OPD department for complaint of pain swelling of affected hand. All affected patients were x-rayed of affected hand with AP and Oblique view. Fractures geometry was recorded like transverse, oblique, and level of fracture proximal, midshaft or distal shaft of metacarpal was noted. Elderly patients were investigated medically and from anesthetic point of view. Patients were followed up at regular intervals to check clinical, radiological and functional outcome of the hand upto 6 months

Operative Technique

Most of the metacarpal fractures is managed under regional anaesthesia like brachial plexus block or wrist block or IVRA (Biers block) Tourniquet is applied at proximal arm with adequate soft padding. The limb is exsanguinated with esmarch bandage and the tourniquet is inflated and maintained at a pressure of 250 mm. The whole limb is scrubbed, prepped and draped with limb over side table with radioluscent top for intraoperative c arm screening.

Tourniquet was not applied in patients who were operated under wrist block.

Before making an entry hole the extensor tendons are palpated by passive flexion and extension and rolling of extensor tendons of fractured digit /finger and care is taken not to pierce it. Skin marking for entry point is done at the base of fractured metacarpal by screening under c-arm.

Entry point

Dorsoradial of base of 2nd and 3rd Metacarpal and dorsoulnar of base of 4th and 5th metacarpals are ideal points of entry according to AO principles. (Fig. 1). Here we took additional entry points from dorsoradial aspect of 4th and 5th and dorsoulnar of base of 2nd and 3rd metacarpals by milking away the extensor tendons from the proposed entry site over the skin to pass second k wire.

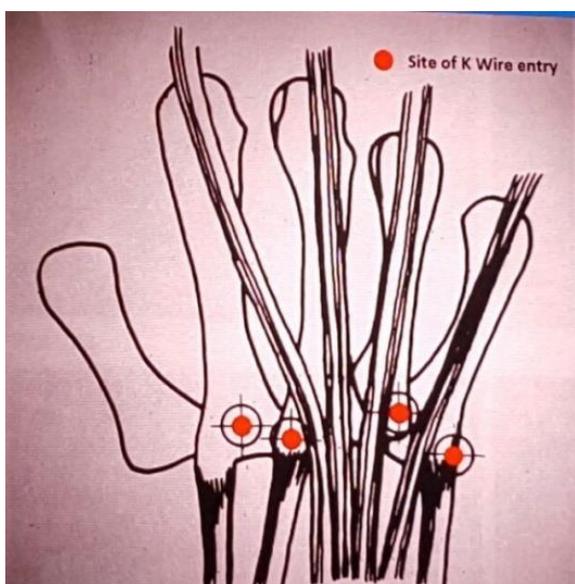


Fig. 1

An oblique entry hole is made percutaneously through the skin directly at the base of fractured metacarpal with 2.5 mm k wire. (Fig. 3) Then a 1.5 mm thin contoured k wire is selected and grasped in T handle. Its sharp tip is cut off and the tip of cut end is bent for negotiation into the entry hole and then gradually slid into medullary canal upto fracture site. (Fig. 2). A gentle traction and manipulation of distal segment is done to align and get the reduction. Then the T handle with the k wire is pushed into distal segment screening under c arm.

Equipments required are drill machine, T handle for grasping thin contoured k wire with bent tip and k wire cutter. (Fig. 2)



Fig. 2: Instruments, Drill, 'T' handle with precontoured bent tip K wire for manual gentle pushing the K wire in to canal

Schematic line diagram for making an entry and antegrade passing k wire (Fig. 3)

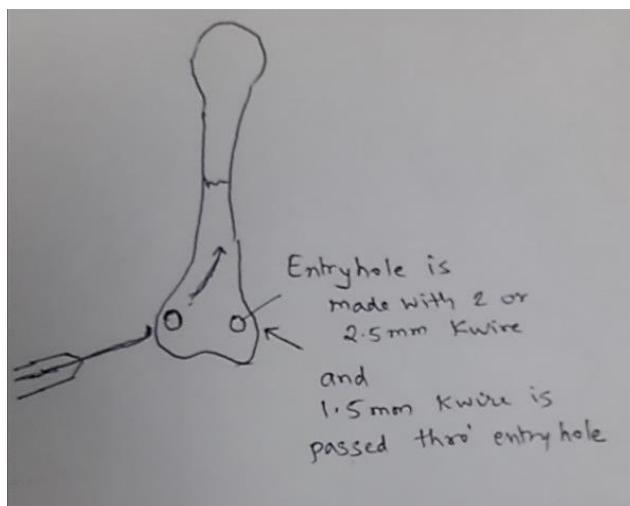
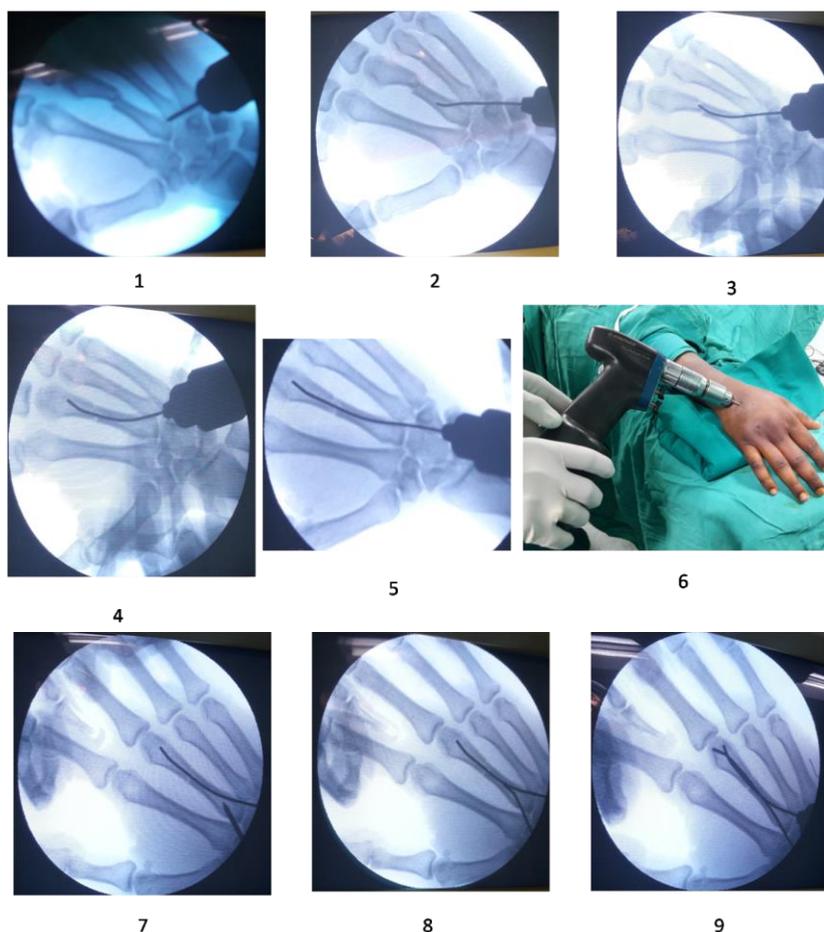


Fig. 3

Intra operative steps c arm pictures (Fig. 4)**Fig. 4:**

1. Drilling entry hole on dorsoulnar side of 3rd metacarpal
2. Passing bent tip k wire through entry hole
3. Negotiating at fracture site
4. K wire passed into distal segment
5. Final placement of k wire with its tip directed in opposite side
6. Clinical photo of Percutaneous fixation
7. Making a hole with thick K wire
8. Passing thin K wire through hole into canal
9. Final placement of K wire in flowering fashion in head of metacarpal.

Similarly another entry hole is made on opposite side of previous entry (Fig. 4 step 7,8) hole of same metacarpal at its base and another 1.5 mm k wire with its tip bent at its end is passed and negotiated into medullary canal and then into distal segment. The curved bent tip of two k wires is directed on opposite sides. (Fig. 4 step 9) The medullary canal determines the accommodation of k wires. Normally two k wires of appropriate thickness (1.5 mm) was sufficient. The thickness of k wire can be 1mm, 1.5 mm or 2mm depending on diameter of medullary canal of fractured metacarpal. In some cases we could pass only one thick 2mm k wire instead of two 1.5mm k wires where the canal was narrow.

In cases of proximal shaft fracture of metacarpal we faced some difficulty to make entry and negotiate k wire in the canal because of short proximal segment. In such cases we passed the k wires in retrograde manner by making entry hole at head neck junction on either side and passed bent tip k wire through the entry hole in retrograde manner and negotiated into proximal segment to reach its tip in the base of metacarpal. and the tips of k wire was directed in opposite direction in the base of metacarpal. (Fig. 5)

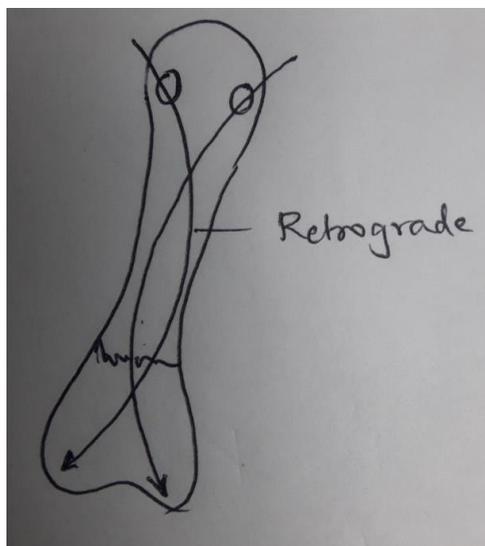


Fig. 5

In short proximal segment k wire was passed in retrograde manner.

Once both k wires are in the medullary canal it is confirmed in AP and Oblique views to doubly confirm that they are in the canal in proximal and distal segment. The extra k wire remaining out side is bent to 90* and cut off outside skin. (Fig. 6)

Foucher recommends leaving sufficient length of the wire to allow easy secondary removal.

The same procedure is repeated for fixing adjacent fractured metacarpal bones. The bent cut off k wire tip is padded with small cotton guage. Pressure bandage is applied with bulky soft padding. The hand and wrist is supported with a short cock up plaster slab with hand in functional position. Tourniquet is released. Patient is shifted to recovery and later to their respective ward/room. Patients were administered two doses of simple antibiotic like Ampicillin and cloxacillin combination parenteral injectable preoperatively and 6 hours postoperatively as prophylaxis against infection with oral NSAIDs for controlling post operative pain.

Patients were discharged on same day evening or second day once they were stable and regional anaesthesia is weared off totally. They were advised to keep their hands elevated to prevent oedema of hand and active movements at Metacarpophalangeal joint. They were asked to follow up every 3 weeks and 6 weeks. A follow up x-ray of hand AP Oblique was taken to assess the fixation done and compared with immediate post op xray to see and realize any loosening of k wires or back out and to see callus at fracture site suggestive of healing. The cock up slab was removed at 4 weeks if patient was comfortable and advised active wrist and MCP joint movements to prevent stiffness. The k wires were removed at 8 weeks and at 10 weeks in severely comminuted and displaced fractures. The patient was advised active exercises at metacarpophalangeal joint, interphalangeal and wrist joint. Reluctant patients required aggressive physiotherapy to regain normal grip and movements of interphalangeal joints. Improvement of range of movements at wrist and interphalangeal joints were noted at every fifteen days and were encouraging. They were followed up upto five to six months for clinical radiological and functional assessment. Functional assessment was assessed by ability to pinch and grip and ability to make a fist of hand and flex and extend at wrist joint painlessly.



Fig. 6

Clinical cases

Case 1





Clinical picture of percutaneous fixation and post op x-ray

Case 2



4th and 5th MC shaft fracture



Immed post op At 6 weeks follow up



Clinically good function of extension and flexion of MCP and IP joints



Clinically good painless hand grip

Case 3



3rd Metacarpal shaft fracture



Immed post op



Clinical photograph

Case 4



4th and 5th metacarpal shaft fracture Intra op pictures



Intra op pictures Clinical picture of fixation



Immed post op xray

Case 5



3rd and 4th Metacarpal shaft fracture



Immed post op x-ray after percut k wire fixation



Clinical photograph

Results

Table 1: Age distribution

Age (years)	Number	Percentage
21 – 30	19	40
31 – 40	13	30
41 – 50	8	16
> 50	7	14
Total	47	100

Most common age group involved in fracture was 21-30 years (40%) followed by 31-40 years (30%), 41-50 years (16%) and more than 50 years (14%).

Table 2: Gender distribution

Gender	Number	Percentage
Male	32	68.1
Female	15	31.9
Total	47	100

Male patients had a significantly dominant (68.1%) in comparison to female patients (31.9%).

Table 3: Distribution of causes

Cause	Number	Percentage
RTA	30	63.8
Fall from bikes	11	23.4
Assault direct hit on hard object in quarrels	3	6.4
Fall on hand fall of heavy object on hand	3	6.4
Total	47	100

In the present, most of the injury reported had a history of RTA (63.8%) followed by fall from bikes (23.4%).

Table 4: Side of fracture

Side	Number	Percentage
Right	33	70.2
Left	14	29.8
Total	47	100

In the present, most of the fracture reported had a right side (70.2%) followed by left side (29.8%).

Table 5: Type of fracture

Type of fracture	Number	Percentage
Transverse	25	53.2
Oblique	18	38.3
Comminuted	4	8.5
Total	47	100

Most common type of fracture was Transverse (53.2%) followed by oblique (38.3%).

Table 6: Level of fracture

Level of fracture	Number	Percentage
Proximal third shaft	7	14.9
Midshaft	35	74.5
Distal shaft	5	10.6
Total	47	100

In the present study, midshaft was dominant level of fracture (74.5%) observed.

Complications

Although most patients with metacarpal fractures do well, complications associated with these injuries are also prevalent, and can arise from either surgical or nonsurgical management of the initial injury. Surgical management can result in hardware-related issues such as adhesions, infection, and tendon rupture, while a more conservative approach can result in malunion or stiffness arising from immobilization. The incidence of complications is highly correlated with the severity of the initial injury, with open fractures and crush injuries decreasing the potential for uneventful union.

Malunion is the most common complication encountered in the management of metacarpal fractures, particularly after non-operative management of unstable fracture patterns.

We encountered k wire loosening in 3 cases by 4th week follow up but the fracture was stable and adherent with soft callus so we removed the loose k wire as it was not serving any purpose and continued with cock up plaster slab for 3-4 weeks more. Superficial skin infection was seen in 2 cases because of sequel of loosening of k wire and irritating surrounding skin tissue. They were managed with cleansing of k wire insertion site and oral antibiotics. They resolved subsequently in due course of time.

Some reluctant patients experienced stiffness at metacarpophalangeal joint and interphalangeal joints, they were managed by assurance, and motivating for aggressive physiotherapy by performing active and passive exercises.

Discussion

No absolute contraindications exist for treatment of metacarpal injuries. Almost all injuries are amenable to either immobilization or closed or open reduction, with or without fixation.¹

The primary goals of treatment of metacarpal fractures are to achieve acceptable alignment, stable reduction, strong bony union, and unrestricted motion and a excellent functional outcome in a minimally invasive method.²

Although some fracture patterns are ideally suited to specific techniques, the choice for fixation is largely directed by fracture pattern and surgeon preference. Selection of optimum treatment depends on many factors like cost factor of hospital expenses, implant cost (mini plate and screws) patient compliance and affordability. Surgical fixation of metacarpals shaft fractures must be judiciously done for getting better functional outcome than conservative treatment management.

Though metacarpal shaft fractures can be managed conservatively, there are certain indications to fix and stabilize the fracture. There are different methods of fixing the shaft fractures of metacarpals like passing straight k wires in the medullary canal, mini plates, compression screws, external fixator spanning the segments depending on the type of fracture whether it is closed, or open, comminuted, etc. Each method has its own advantages.

Open reduction and mini plate fixation were associated with hardware failure infection and poor healing of fracture with complication rate upto 35% in some series.^{5,6} Intramedullary fixation can be used to stabilize without tissue dissection and lesser complications.⁷

The technique of using multiple K wires for metacarpal fractures was introduced by Foucher ("bouquet" osteosynthesis)^{3,4,8-10} and is based on principle of Ender's flexible intramedullary pinning. (As we do Enders nailing or TENS nailing in paediatric femur shaft fractures). This technique of fixation has three point fixation at entry point, in the canal, and in the head. When two elastic k wires are passed and flowered up (distal bent tips are directed in opposite directions) distally the reduction is stable and maintained nicely without bowing or angulation maintaining the length of metacarpal. Fouchers technique is well documented and practiced in European countries from last twenty years,¹¹ but performed very less frequently.

Metacarpal shaft fractures tend to angulate apex dorsal with the head displaced palmarly due to the deforming pull of the interossei muscles. Only small amounts of angulation ($\leq 10^\circ$) are acceptable in the second and third metacarpals. The fourth and fifth finger metacarpals are much more mobile, and angulation of 20° and 30° , respectively, can be accepted. The more proximal the fracture, the more pronounced the deformity and the less angulation that can

be accepted. Any malrotation is an indication for surgical intervention. Shortening from 3-4 mm is well tolerated.¹

The operative technique described by us is percutaneous fixation without any incision and post operative incisional scar and is different compared to Gonzalez et al and Foucher's technique. The k wires are inserted through a small incision and buried in subcutaneous tissue and skin is sutured in the technique of Gonzalez and Foucher's technique^{3,4} In our technique the k wire is passed percutaneously and bent wires are left outside the skin which is removed by just pulling them out later at the end of union period of 6-8 weeks on out-patient basis. There is no need to explore the buried k wire in subcutaneous tissue¹².

Foucher has described antegrade nailing but we have tried retrograde pinning in cases of short proximal segment which is not described anywhere. This retrograde Foucher technic is very delicate surgery which needs precision and skill to pass k wires through entry holes made in head neck junction of metacarpal and negotiate prevent thin k wires into canal and into short proximal segment.

There are number of methods to evaluate outcomes of hand fractures in the literature¹³. But here is no gold standard universally accepted method used to measure outcome for hand fractures. Most of the importance is given to radiological findings at every follow up considering k wire placement any loosening or back out of k wire, status of union, malalignment loss of reduction etc., good clinical function, and no pain and disability and a good response to the surgery.

Most patients who have undergone open reduction and internal fixation perform well with more than 75% having 220* TAM score². This method which we modified Bouquet technique is a closed and percutaneous method of intramedullary fixation of metacarpal fractures, it is far much superior to ORIF method with least possibility of infection.

We assessed the patients clinically with their grip strength, ability to make a fist of hand, pinch grip, VAS and Range of motion at metacarpophalangeal joint and wrist joint.

The TAM (Total Active Motion) score TAM = Total flexion at MCP joint + PIP joint + DIP - Extension deficit of all three joints.

Considering 90* at MCP joint 90* at PIP joint and 70* at distal Interphalangeal joint Total TAM will be 250*. TAM score was above 230* in 45 patients the remaining two patients were very apprehensive and were having TAM score of 200 to 210*. The final functional outcome was rewarding and satisfactory.

Conclusion

Percutaneous Enders type flowering intramedullary K wire fixation of metacarpal shaft fractures is a minimally invasive method for fixing and stabilizing unstable and stable metacarpal shaft fractures. This type of fixation has three point fixation namely, at entry point, in the canal of shaft and in the head neck because of curved shape and bent tips of K wires having good bony purchase with stable

fixation. This technique is very similar like doing closed Enders nailing in paediatric femur shaft fractures. There is no operative incision scar as seen in open reduction and mini plating or screw fixation. This method of fixation is stable and being percutaneous technique there is no skin and soft tissue adherence and can be rehabilitated early without any stiffness. This method is simple, needs minimal instruments like plier, T handle, k wire cutter bender and is cost effective, and well tolerated and with added advantage of early bone healing with good functional outcome. Being percutaneous technique there is no operative incision scar or need of anaesthesia required for removal of k wires after the treatment period.

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None.

Conflict of interest

None.

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