Benha Journal of Applied Sciences (BJAS) **print: ISSN 2356–9751**
Vol. (7) Issue (2) (2022), (83- 88) **online: ISSN 2356–976x**
http://bjas.journals.ekb.eg

Bouquet technique in management of metatarsal fractures

E.M.Mohamady, H.E.Farag and M.M.Mahmoud
Orthopedic Surgery, Dept., Faculty of Medicine, Benha Univ., Benha, Egypt
E-mail:Muhammad.mansour21@fmed.bu.edu.eg

Abstract

Background: Metatarsal fractures are a prevalent cause of persistent foot discomfort in both adults and children alike. Depending on where the damage occurs anatomically and how it occurs, many types of metatarsal fractures may occur. The purpose of this study is evaluation of the bouquet technique in treating unstable metatarsal fractures. Methods: Closed intramedullary pinning was performed on 20 metatarsal fracture patients at Benha University Hospital's department of Orthopedics and Traumatology over a 6- to 12-week follow-up period. Results: The current study confirms that functional and radiological results using intramedullary K-wires pinning "Bouquet osteosynthesis" technique were good and statistically comparable with the other techniques. With minimal soft-tissue incision and avoiding periosteal blood supply, we feel this procedure is more biological and allows for predicted bone union in metacarpal shaft fractures. Placement of the wires away from the MCP joint gives excellent outcomes in terms of ROM in metatarsal neck fractures, making it preferable to the traditional retrograde wiring procedure with plate and screws. It was shown that the Bouquet procedure resulted in a 100% bone union in the metatarsal fractures of 20 patients with an average age of 30 who had been injured in a fall. The average length of immobilisation was four weeks. Within three months, the ankle, MTP, and IP joints should be able to restore to their pre-injury range of motion, enabling the patient to return to their usual job routine. There were no serious issues in terms of both clinical and radiological outcomes. As a result, the rigidity of ORIF is offset by a higher risk of infection and ROM complications. It was shown that retrograde pinning was stiffer than antegrade pinning. Treatment of misplaced metatarsal fractures using a prebent Kirschner wire and closed antegrade intramedullary nailing in Bouquet technique is successful. The recovery period is shortened, the clinical union occurs sooner, and patients are able to resume their usual daily activities as a consequence of receiving early surgical therapy. Metatarsal fractures can be fixed more effectively, with fewer problems, and with early weight-bearing via our research.

Key words: Bouquet technique, metatarsal fractures

1. Introduction

Metatarsal There are 3.2 to 6.8 percent of all injuries, with an annual incidence rate of 6.7 occurrences per 100,000 people. 35 percent of all foot injuries are caused by this kind of injury, and it is roughly 10 times more common than the Lis franc fracture-dislocations. After the fifth metatarsal fracture, the most frequent foot fracture is a central metatarsal fracture (from the second to the fourth), whereas the least common foot fracture is a first metatarsal fracture. Pre- or post-closed reduction may be used to treat most foot fractures since they are stable. If there are several fractures, substantial shortening, rotational abnormalities, or major angular deformities, surgical treatment may be necessary. The kind of fracture, the preference of the surgeon, and any accompanying injuries all play a role in determining the best technique of fixing. There are many authorised surgical methods for treating metatarsal fractures, including open reduction, plate and screw fixation, and k-wire fixation. Intermedullary fixation utilising k-wires is another surgical treatment that may be performed. Different approaches, such as mini-open and percutaneous procedures, may be used to carry out this surgical treatment. In the treatment of metacarpal fractures, the Bouquet approach (intramedullary fixation of fractures using several flexible wires) was first described by Foucher, and it has had great outcomes for the last two decades. Following the closed reduction of the fracture, anterograde intramedullary fixation utilising pre-bent K-wires (K-wires) is used to stabilise the reduced metacarpal head. Because they prevent major surgical dissection and soft tissue degeneration at the fracture site, minimally invasive treatments utilising Kirschner wires are a promising alternative. Extensor tenosynovitis due to extensor irritation is less likely with a dorsal plate, however Kirschner wire fixation n has been associated with extensor tenosynovitis. Aim 5: To determine if the bouquet approach is effective in the treatment of unstable metatarsal fractures. Multiple or single fractures of the shafts or the neck of the metatarsal. A metatarsal fracture that cannot be reduced or stabilised. A fracture of the first metatarsal. More than a 10-degree sagittal plane deformity in the central metatarsals. More than 4mm in diameter central metatarsals are uncommon. translation.

2. Patients and Methods

Patients

A There were 20 patients, 16 males and four females, who had unstable metatarsal fractures repaired by intramedullary k-wires at Benha University Hospital (Bouquet osteosynthesis).

The surgical technique was explained to the patients in writing, and they gave their permission. A minimum of 12 weeks and a maximum of 24 weeks of follow-up were required for all patients.

The American Orthopedic Foot and Ankle Society (AOFAS) forefoot score was used to evaluate these individuals after surgery. Radiologically, the fracture was shown to have healed.

Individual or numerous shaft or neck fractures of the proximal or distal metatarsal bones are eligible for inclusion in the study, as long as the fracture is either unreducible or unstable. Inclusion criteria include:

Isolated or multiple shaft or neck fractures Irreducible or unstable fracture

Old, neglected fractures are a definite no-no in this case.

Internal fractures of the articular cartilage.

Fractures that have not yet reunited.

Patients who are unable to have surgery due to medical reasons.

Methods

Detection and treatment of disease

preserving the past

1. My own life narrative

Name, gender, date of birth, place of employment, address, phone number, and any unusual behaviours that could be relevant to your health.

Trauma in two forms:

After direct damage and falling down, foot twist was the most prevalent cause of injury (30 percent) (25 percent for each). It was the least common mode of transportation (20 percent)

Examination of the body

With attention to any potential life-threatening conditions and care according to Advanced Trauma Life Support (ATLS), other systems damage, and related fractures.

Further Tenderness, range of motion, swelling, skin condition, neurovascular examination, and testing for concomitant injuries were all part of the standard foot examination.

Examining the foot in comparison to the opposite foot.

X-ray examination

Anteroposterior, Lateral, and Oblique X-rays of foot were performed on all patients as part of the evaluation process. Ankle in A-P and lateral view shown in Fig. 1.

Laboratory:

Preoperative laboratory testing includes a comprehensive blood picture, kidney profile, liver profile, random blood sugar, and coagulation profile.

All patients gave their permission in the same way.

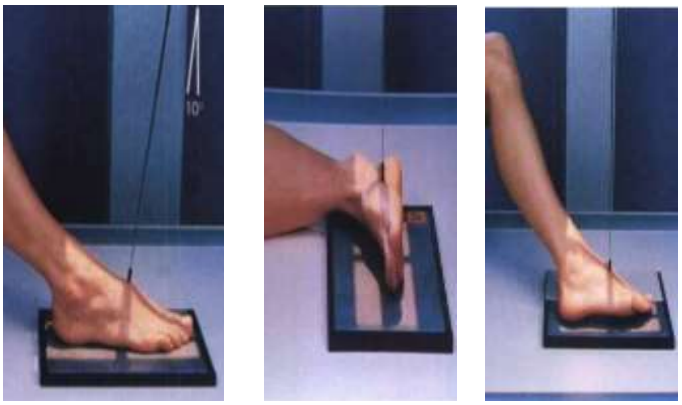

Fig. (1) Positions of the foot on cassette during plain X-ray. **A:** true A.P. view, **B:** lateral view and **C:** oblique view.

Surgical technique

- **Anesthesia:** Spinal anesthesia was used in all patients.
- **Position:** Supine position with tourniquet application then, Patients were operated on a standard radiolucent orthopedic table under image intensifier guidance fig. (2).

Fig. (2): Patient positioning: patient supine with foot on c-arm.

Intraoperative fluoroscopy:

Using a C-arm (intraoperative imaging) was a necessity and was employed in all instances.

Operational strategy:

Palpating the metatarsal base reveals the location of the incision, which is a 2-cm longitudinal incision made towards the proximal end. Shown in Figure 1. [3]. The periosteum is approached and a hole is drilled in the metatarsal bone using a 2.0 mm drill bit or 2.0 mm Kirschner wire after the tissues have been dissected layer by layer with care not to harm neurovascular systems and extensor tendons. To get to the metatarsal medullary area, a hole is drilled through the anterior cortical bone only at an angle of around 45°.

Three millimetre and twelve millimetre long Kirschner wires with rounded tips are gently curled longitudinally and bent five degrees at two different locations to regulate insertion direction. The size of the fractured metatarsal medullary cavity dictates the diameter of the Kirschner wires to be employed.

The c-arm guides the insertion of a k-wire. Once the fracture location is located, continue imaging.

A reduction clamp may be utilised percutaneously in specific fractures, such as spiral fractures, to decrease the fracture anatomically during a closed reduction of the metatarsal fracture. In order to protect the capsular ligament complex and prevent compromising local nutrition, no direct incisions are made to reach the fracture centre. In order to provide enough stability, the first wire is inserted through the same hole after reduction has been verified using an image intensifier. The second wire is then inserted through the same hole.

The T handle is used to move the Kirschner wire through the intramedullary canal until it reaches the fracture site. After that, the long axis of the Kirschner wire is turned such that the bent distal end points toward the displaced distal end. While being careful not to perforate the joint, the proximal end of the Kirschner wire is gently tapped into the subchondral bone of the metatarsal head. It is subsequently rotated to decrease the displacement of the fracture, and the second wire is put via the same hole.

Three fixation points may be established in any direction by severing the two wires that have been pushed through the medullary canal and putting them in different directions.

After establishing clinical and radiological alignment, the wire is bent at the entry site based on the quality of the reduction noticed by c-arm. To avoid cutting through skin, maintain the nail's proximal cut end as near to the bone as possible. Plaster casting and dressing are then applied to the wound.

When there are numerous metatarsal fractures, the one with the highest displacement is treated first by reducing and fixing it. Fixing a less severe fracture first allows us to lessen the more severe one, making it simpler to reduce the more displaced one. An incision was created across the interosseous area so that one incision could be used for the two metatarsal bones that were next to each other Fig. (3).

Fig. (3) skin incision for multiple metatarsal fractures

3. Results

The mean age of the studied patients was 30 ±10 years. There was a male predominance (80.0%), while females were 20% **(Table 1).**

Table (1) Demographic characteristics of the studied patients.

Demographics		
Age (years)	Mean ±SD	30 ±10
Gender	Males n (%)	16 (80.0)
	Females n (%)	4 (20.0)

About two-thirds (65.0%) had left side affection. Three-quarters of the patients had multiple fractures (75%). The most frequent fracture pattern was the spiral pattern (35.0%), while the least frequent was the comminuted pattern (15.0%). The most frequent fracture location was the neck (45.0%), while the least frequent was the sub-capital (15.0%) **(Table 2).**

Table (2) Fracture characteristics of the studied patients.

		n (%)
Side affected	Left	7 (35.0)
	Right	13 (65.0)
Number of fractures	Single	15 (75.0)
	Multiple	5 (25.0)
Fracture pattern	Comminuted	3 (15.0)
	Oblique	5 (25.0)
	Spiral	7 (35.0)
	Transverse	5 (25.0)
Fracture location	Neck	9 (45.0)
	Shaft	8 (40.0)
	Sub-capital	3 (15.0)

The most common mechanism of injury was foot twist (30%), followed by direct trauma and falling down (25% for each). RTA was the least frequent mechanism (20%) **(Table 3).**

Table (3) Mechanism of injury of the studied patients.

		n (%)
Mechanism of injury	Direct	5 (25.0)
	Falling down	5 (25.0)
	Foot twist	6 (30.0)
	RTA	4 (20.0)

The median time of surgery was 30 minutes and ranged from 15 to 120 minutes. The mean time to radiological union, wire removal, ROM start, and weight-bearing were 8 weeks, 11 weeks, 3 weeks, and 5 weeks, respectively. Only two patients had skin complications, and four patients had stiffness. About two-thirds of the patients (60.0%) reported a mild verbal rating scale **(Table 4).**

Table (4) Surgical outcome in the studied patients.

Surgical outcomes		
Time of surgery (min)	Median (range)	30 (15 - 120)
Time to union (wks)	Mean ±SD	8 ±1
Time to wire removal (wks)	Mean ±SD	11 ±1
Time to ROM start (wks)	Mean ±SD	3 ±1
Time to weight-bearing (wks)	Mean ±SD	5 ±1
Skin complications	n (%)	2 (10.0)
Stiffness	n (%)	4 (20.0)
Verbal rating scale	No n (%)	8 (40.0)
	Mild n (%)	12 (60.0)

The median pain score was significantly higher at 6 months (40) than 3 months (30) (P = 0.008). Also, the median total AOFAS score was significantly higher at 6 months (100) than at 3 months (90) (P = 0.003). No significant differences were reported regarding activity limitation support (P = 0.083), maximum walking distance (P = 0.083), foot wear requirements (P = 0.083), walking surface (P = 0.083), gait anomaly (P = 0.157), and alignment (P = 1.0) **(Table5).**

Table (5) AOFAS score at 3 and 6 months in the studied patients

	AOFAS score		
	3 months	**6 months**	**P-value**
Pain	30 (30 - 40)	40 (30 - 40)	0.008*
Activity limitation support	10 (7 - 10)	10 (10 - 10)	0.083
Maximum walking distance	10 (7 - 10)	10 (10 - 10)	0.083
Foot wear requirements	5 (3 - 5)	5 (5 - 5)	0.083
Walking surfaces	10 (5 - 10)	10 (10 - 10)	0.083
Gait anomaly	10 (5 - 10)	10 (10 - 10)	0.157
Alignment	15 (15 - 15)	15 (15 - 15)	1.0
Total score	90 (80 - 100)	100 (90 - 100)	0.003*

Wilcoxon signed ranks test was used ***Significant**

4. Discussion

Among the 20 patients, foot twisting accounted for 30% of the injuries, followed by direct trauma and falling (25 percent for each). It was the least common mode of transportation (20 percent) The proximal and distal joints of the metatarsal bones were examined during clinical evaluations for metatarsal injuries. In order to properly diagnose a metatarsal fracture, radiologists often use anteroposterior, lateral, and a 45-degree oblique view of the foot as standard imaging.

In our investigation, closed antegrade intramedullary nailing for the reduction and fixing of metatarsal fractures was shown to be effective. The elastic characteristics of the rod are used to provide stability in this approach. Allows early joint mobility by avoiding opening of the fracture site, which damages the articular surface and capsule-ligamentous structures. Full weight bearing began on average six weeks after the commencement of the procedure, and union was achieved on average six weeks after the start of the procedure. Motion in the joint was immediately available and there was no pain or discomfort thereafter. The fractures healed completely in the clinical setting. It was 40 out of 40 potential points on the pain scale. The average score on the function subscale was 40 out of a possible 45. Our patients' mean alignment subscale score was the highest possible. The radiologic consolidation period was between 8 and 9 weeks on average. In all of the instances, there were no complaints of refracture. The advantages of enabling early range of motion recovery and the enhancement of blood supply and osteoblast activity by the action of the load on the lower leg in the postoperative phase and prompt rehabilitation did not exhibit detrimental consequences. Among the K wire fixation-related complications were two cases of pin tract infection (15 percent). Cephalosporins were used to treat a pin tract infection. Another problem was RSD in the foot, which was treated with painkillers over the course of a month.

In 30 patients with 46 metatarsal head, neck, or shaft fractures, Kim et al. [6] used closed intramedullary pinning for reduction and stabilisation of metatarsal fractures. Fractures of the metatarsal head, neck, or shaft with a displacement more than 3 to 4 millimetres or an angulation greater than 10 in the sagittal plane matched the inclusion criteria. In the six weeks after surgery, and again at the final follow-up, the patient's time to union, mobility limits at the afflicted metatarsophalangeal joints, and residual discomfort were all assessed. An average of 7.1 (range 6 to 10) weeks later, the fracture healed. Patients with mild metatarsophalangeal joint restriction at six weeks but recovered to full range at final follow-up had an average American Orthopedic Foot and Ankle Society score of 96.7 (range 83 to 100) points at final follow-up (excellent result in all patients). According to (6), (7), Hettchen and colleagues Twenty-six out of the 19 patients studied had an average follow-up of two and a half years (range: three to 72 months). As of this writing, the AOFAS score ranged from 62 to 100 points. It took 10 shortenings to get rid of one incidence of skin irritant. There were no signs of pseudoarthrosis, subsequent fracture dislocation, or nail breaking. No refracture occurred when the TEN was removed 13.412.9 (range: 5–52) weeks after implantation.

An intramedullary pinning method called closed intramedullary pinning was used to treat seven patients. All seven metatarsal bones showed proper alignment with no angular deviations or metatarsal shortening on radiographs collected at a mean period of 12 weeks (range, 8–15). After treatment, all distal growth plates closed (the 20- year-old patient already had all growth plates closed before the trauma).

After a minimum of two years of follow-up, no complications were found in patients, including pseudo arthrosis and infection in the bone or soft tissues. From the time the Kirschner wires were removed, all of the patients had no discomfort and resumed their regular stride. In all instances, photographs were taken 12 months following the fracture and revealed a perfectly normal posture.

In this research, there weren't enough people, thus the findings aren't statistically significant. significance.

5. Conclusion

ORIF provides a more rigid stability, but it comes with a greater risk of infection and reduced range of motion after surgery. It was shown that retrograde pinning was stiffer than antegrade pinning. Treatment of misplaced metatarsal fractures using a prebent Kirschner wire and closed antegrade intramedullary nailing in Bouquet technique is successful. The recovery period is shortened, the clinical union occurs sooner, and patients are able to resume their usual daily activities as a consequence of receiving early surgical therapy. For metatarsal fractures, our research found that our approach of fixation was more effective, less invasive, and allowed patients to return to full weight bearing sooner than previous procedures.

References

[1] BA. Petrisor, I .Ekrol, C. Court-Brown. The Epidemiology of Metatarsal Fractures. Foot Ankle Int. Mar.vol.27(3),pp.172–4.2006 .

[2] V .Chammas, ID. Asaumi, AA .Netto, R da R. Macedo, DL .Turco, LMR. Rodrigues. Minimally invasive intramedullary fixation with flexible nails in the treatment of metatarsal neck fractures. Sci J Foot Ankle. Vol.30;13(2):97,pp.103.2019 .

[3] E .Peled, D .Norman, E .Melamed. Metatarsal Fracture Reduction and Fixation by Kirschner Wires: Technical Tip. Surg Sci.vol.03(06):344,pp.6.2012 .

[4] G. Foucher. “Bouquet” osteosynthesis in metacarpal neck fractures: a series of 66 patients. J Hand Surg. May.vol.20(3 Pt 2),pp.S86-90.1995 .

[5] M. Ahmad, M. Mohammad Plate and Screw Versus Intramedullary K Wire for Fixation of Unstable Metacarpal and Phalangeal Fractures.

Egypt J Plast Reconstr Surg.vol.1;42(2),pp.213–9.2018 .

[6] H-N .Kim, Y-J .Park, G-L. Kim, Y-W .Park. Closed Antegrade Intramedullary Pinning for Reduction and Fixation of Metatarsal Fractures. J Foot Ankle Surg. Vol.51(4),pp.445–9.2012 .

[7] M. Hettchen, AC .Strauss, PH. Pennekamp, C. Burger, O .Weber, MC .Müller. [Elastic Stable Intramedullary Nailing (ESIN) of Metatarsal Fractures]. Z Orthopadie Unfallchirurgie..vol.154(2),pp.148–56. 2016 .

[8] HJ .Aguado, PG .Herranz, JM. Rapariz. Metaizeau's technique for displaced metatarsal neck fractures. J Pediatr Orthop Part B.vol,1;12(5),pp.350–3.2003.