

Minimal invasive percutaneous plate osteosynthes of distal femoral fracture

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Abstract

There is nine centimeter-long distal femoral fractures, and treating them may be difficult because of the difficulty of accessing the distal end of the femur. The goal is to see how well the minimally invasive plate osteosynthes (MIPO) method treats distal femoral fractures in adults. A total of 20 adults with distal femur fractures of categories A and C were included in this study and treated surgically with the MIPO distal femoral plate before being followed up. In all patients, the mean follow-up period was 5.600.50 months and the study was conducted both clinically and radiologically according to the Modified Hospital for Special Surgery (HSS) score, the Schatzker and Lambert score and the functional evaluation scale developed by Sanders and colleagues in relation to the range of motion, deformation, pain, walking ability and return to work for distal femoral fractures It was outstanding in 13 instances (65%), acceptable in 5, and mediocre in 2 situations (the remaining 25%). (10 percent). A superficial infection was found, as were 10o-20o of knee flexion loss, incomplete union, and a loss of less than 0.5 inch in length compared to the sound limb in this research investigation. Distal femoral fixation with the Mipo technique of the distal femur is the best option for fixing distal femoral fractures in adults because of the following advantages: high union rates without the use of bone grafts, low infection rates, and the ability to keep the distal femoral fixation in place with a stable fixation.

Keywords: percutaneous, plate, osteosynthes, femoral, fracture.

1. Introduction

Fractures of the distal femur account for 6% of all femur fractures. While distal femur fractures are more frequent in younger individuals, distal femur fractures are more common in the elderly. High velocity trauma in young individuals causes these fractures, whereas low velocity trauma in elderly patients with osteoporosis causes them. Factors including osteoporosis, severe fracture comminution, and intra-articular extension exacerbate these fractures [1].

In order to allow for early recovery and mobility, surgical treatments are beneficial. Supracondylar nails and blade plates and dynamic condylar screws as well as distal femur locking plates are among the surgical treatment options. When these fractures are treated with open reduction and internal fixation, it necessitates a lengthy surgical operation with potential consequences such as nonunion, severe bleeding, and poor tissue healing [2].

Recently developed surgical methods, such as minimally invasive plate osteosynthesis, indirect reduction, and submuscular approach, have increased focus on biology and blood supply preservation while utilising the less invasive stabilisation system (LISS) and locking plates. It is safe to say that all of these techniques have resulted in positive treatment results such as high rates of implant union, low implant failure and low secondary bone transplant operation rates [3]

The MIPPO method fixes the fracture with a tiny incision and little tissue dissection, resulting in reduced blood loss and an infection risk that is lower than that of an open procedure. [4]

Plate fixation is a difficulty due to metaphyseal comminution. With the locking compression plate (LCP), the plate may be placed without touching the bone, protecting the periosteal blood flow underneath

the plate. LCPs have a fixed angle construction. Metaphyseal comminution may make advantage of it. Unless all neighbouring screws break, it's difficult to remove one locking screw since its pull-out strength is much greater than ordinary screws. Osteoporotic bones will benefit from this since it gives them a stronger grip. In the case of minimally invasive plate osteosynthesis, the LCP may serve as an internal fixator (MIPO) [5].

Transarticular joint reconstruction and indirect plate osteosynthesis, an acronym-based method, has also been used to fix intra-articular distal femur fractures (TARPO). The main difference between the TARPO method and the MIPO technique described for distal femur intra-articular fractures is how the distal articular block is exposed. Traditional MIPO distal femur exposures use a midline skin incision and lateral parapatellar arthrotomy to expose the joint, while TARPO uses a midline skin incision and lateral parapatellar arthrotomy. This exposure increases the surgeon's ability to minimise and repair complicated intra-articular fractures because it increases exposure of the articular surface. Following reconstruction of the articular block, the procedure is identical to that used in MIPO [6]. The objective of this study is to assess the outcomes of MIPO treatment of distal femoral fractures in adults.

2. Patients and methods

The cross-sectional study included 20 patients with displaced complex distal femoral fractures operated upon and been followed up between January 2018 and April 2021. All of our cases had been treated in Ahmed maher teaching and zifta general hospitals.

The study was approved by the Ethical Committee of Benha Faculty of Medicine, And a written consent were taken from every patient.

According to the pre-planned case sheet, patients' data included details of the pre-operative clinical and radiological findings, operative procedure, rehabilitation program, as well as complications and the final functional and radiological scoring according to the chosen scoring system.

Inclusion criteria:

- Extra-articular distal femoral fracture with intra-articular extension.
- Extra-articular distal femoral fracture.
- Age: fracture in skeletally mature patients.
- Open fractures grade I can be included.

Exclusion criteria:

- Intra-articular distal femoral fracture only.
- Pathological fracture other than osteoporotic fracture.
- Fracture in children (immature skeleton).
- Open fracture grades II&III.
- Periprosthetic fractures.

Initial management

All patients were subjected to a careful local and general clinical examination, patient thoroughly examined as regards shock, head, chest, and abdominal injuries. Plain X-Ray films were taken for the injured limb and any other suspected injuries. The standard antero-posterior and lateral views were usually taken. Skin conditions were assessed and neurovascular insufficiency was looked for. The distal femoral fractures were splinted in above knee posterior slab.

Definitive Management

Accident – operation interval:

The time interval between the trauma and the surgery varied according to patient fitness, preparation, and control of comorbidities. A delay of operation time was due to: 1- Gross swelling of the limb. 2- Admission to the intensive care unit for observation following critical general condition in PC and internal hemorrhage. A delay of more than 10 days in 4 patients (20%) was due to waiting for improvement of general condition in elderly and unsuitable investigations due to anemia.

Operative technique

All cases were anaesthetized by spinal anaesthesia

Prophylactic intravenous antibiotic were used in all patient (1g of Cefotaxime) was given before incision, and continued postoperatively.

Patient positioning;

Patients were positioned supine on a radiolucent table which allows complete imaging of the lower limb; the extremity was draped free and positioned over a large leg roll to flex the knee. Rotational alignment was achieved by aligning the ASIS, patella, and 2nd toe of the foot

Plate selection:

Intraoperative plate length was determined under fluoroscopic control; I used locking compression distal femur plates (LCP)

Surgical approach:

Minimal Invasive Percutaneous Plate Osteosynthesis (MIPPO) approach was used for plate

insertion and screws fixation. Distal incision was done according the requirements of fracture reduction. Intra-articular fractures (AO/OTA types C1/C2) that required open reduction; the anterolateral parapatellar approach was used through 7 cm skin incision and joint arthrotomy for anatomical reduction of the articular block Figure (21- A). Distal part of Lateral approach was used in extra-articular fractures AO/OTA type A fractures, and type C fractures which were non displaced or successfully reduced with reduction clamp. The proximal incision was done either as single 4 to 5 cm incision which is helpful in obese patients facilitating plate positioning and screws insertion reducing both operative time and Image intensifier exposure time or through multiple 1 cm stab incisions.

Reduction of the articular block;

Reduction of the articular surface was done through arthrotomy and open reduction under vision or without arthrotomy under image control. This was helped by large reduction clamp or joy stick manipulation with a schanz screw inserted from medial side. Fixation was then achieved by 6.5 mm partially threaded cancellous screws outside the planned position of the plate; further fixation was achieved by partially threaded screws through the plate distal holes if needed.

Plate insertion;

Threaded locking drill sleeve attached to one of the distal holes of the plate and serves as a joy stick which moves the plate into perfect position under fluoroscopic control.

Metaphyseal-Diaphyseal Reduction;

A variety of aids were utilized which facilitate the closed reduction technique:

- Early intervention.
- Muscle relaxants.
- Supracondylar towel bumps placed in the area posterior to the supracondylar region.
- Manual traction which was helpful to establish length and rotation, and facilitate varus/valgus correction. Traction was applied with gentle pull behind the gastrocnemius with the knee in 45-60o of flexion. Utilizing the towel bumps as a fulcrum, the manual traction also facilitated reduction of the hyperextension deformity of the distal femoral condyle.
- Manual pressure utilizing large mallet to push on the proximal or distal deformed fragment.
- Femoral distractor.
- Bone hook.
- Bone levers.

Screw insertion:

Order, type, distribution, and number of screws were planned for each case individually through fixed rules; At least 2 bicortical locked head screws were inserted in each fragment. All Lag screws must be inserted before any of locked screws; all distal screws must be anterior to the Blumensat's line; if not must be unicortical. LHS were inserted through stab

incisions after drilling bone through threaded locking drill sleeve which were screwed in the locking hole.

Wound closure:

Wound closed in layers over suction drain taking care to avoid tight closure of the lateral retinaculum to avoid anterior knee pain (patellofemoral pain)

Postoperative management

- Antibiotic (Cefotaxime 1gm/12hour) was given for 5days, then oral first or second generation cephalosporin for further 10-14 days..
- Anticoagulant (Enoxaparin 80mg subcutaneously once a day) was continued until they are fully mobilized.
- Anti-tissue edema agent (usually alpha chemotrypsine injection) for cases with moderate to severe edema till subsidence of edema (limb elevation is essential).
- Suction drain was removed 48 – 72 hours and sutures after two weeks.
- Weight bearing was not allowed until early callus formation was seen on radiographs. The patients were then started partial-weight bearing, and gradually progressed to full-weight bearing for another 6 to 8 weeks.
- Passive range of motion exercises of the knee, to allow the patient to regain optimum range of motion.

Static exercise for the quadriceps and hamstring muscles and passive flexion and extension of the knee were started as soon as the pain allows usually after one week. Then active flexion and extension of knee till reaching full painless ranges of motion. Strengthening exercises were not encouraged because excessive force is applied to the plate bone interface and the direction of force is not well controlled.

Modified Hospital for Special Surgery (HSS) score [7], Schatzker and Lambert score [8], and Sanders score [9] are used to assess the final outcome .

Statistical methods

Data management and statistical analysis were done using SPSS version 25. (IBM, Armonk, New York, United States). Numerical data were summarized as means and standard deviations. Categorical data were summarized as numbers and percentages. Quantitative scores were compared at three months and six months using paired t-test. Schatzker and Lambert score was compared at 3 and 6 months using the sign test. All statistical tests were two-sided. P values less than 0.05 were considered significant.

3. Results

This study was conducted on 20 patients with a history of trauma affecting the distal femur. All patients underwent minimal invasive percutaneous plate osteosynthesis of distal femoral fractures. The mean age of the studied patients was 54 years, with a standard deviation of 16 years. Regarding gender, about two-thirds were females (60.0%) The right side was affected in 8 patients (40%) and the left in 12 patients (60%). 8 patients were fractured due to direct fall on the affected limb (40.0%), 12 patients were injured due to road traffic accident(60.0%) .There were 8 cases with type A1 fracture, 3 cases with type A2 fractures, 1 cases with type A3 fractures, 3 cases with type C1 fracture& 5 case with type C2 fracture according to the OTA/AO classification. **Table (1&2)**

The modified hospital for Special Surgery score significantly increased after 6 months (61.0) compared to after 3 months (42.0); P-value was < 0.001 **fig. (1)**

Table (1) General characteristics of the studied patients.

Age (years)	Mean ±SD	54 ±16
Gender	Males n (%)	8 (40.0)
	Females n (%)	12 (60.0)

Table (2) Mode of trauma in the studied patients.

Mode of trauma	n (%)
Road traffic accident	12 (60.0)
Slide and fall	8 (40.0)

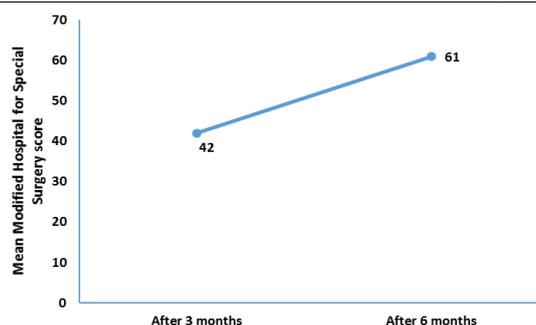


Fig. (1) Modified hospital for special surgery score at 3 and 6 months

Schatzker and Lambert score significantly changed after 6 months compared to after 3 months; P-value was < 0.001. No patient reported an excellent score after 3 months compared to 50% reported an excellent score after 6 months **fig. (2)**.

Regarding complications, three-quarters of the patients (75.0%) reported no complications. About one-quarter reported non-union (10.0%) or superficial infection (10.0%). Only 5% reported deep infection **Table (3)**.

Sanders score significantly increased after 6 months (33.0) compared to after 3 months (25.0); P-value was < 0.001 **fig. (3)**

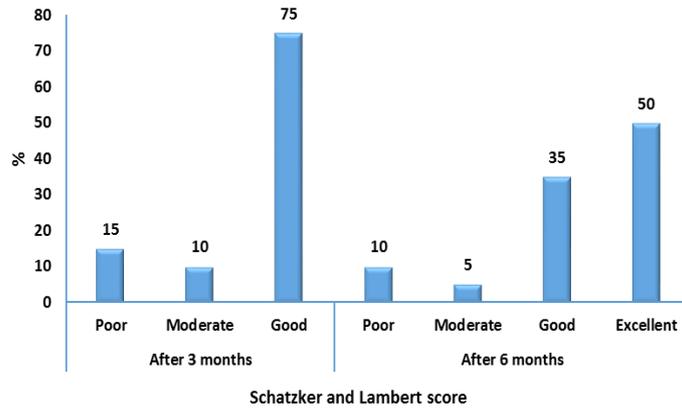


Fig. (2) Schatzker and Lambert score at 3 and 6 months

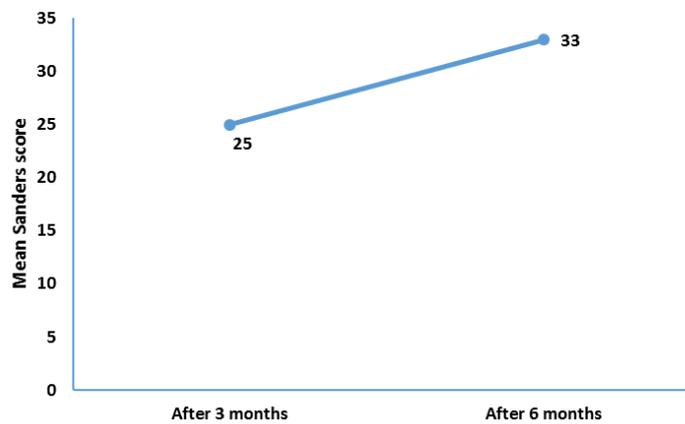


Fig. (3) Sanders score at 3 and 6 months

Table (3) Distribution of complications in the studied patients

		n (%)
Complications	Deep infection	1 (5.0)
	Non-union	2 (10.0)
	Superficial infection	2 (10.0)
	No	15 (75.0)

Case 1



Fig. (4a) Preoperative X.ray (anteroposterior and lateral view)

A.History: Male patient 60 years old. Mode of trauma: Severe (motor cycle accident).

B.Preoperative evaluation: Fig(4a)

- Fracture type: Type A3 distal femoral fracture.
- Side affected: The left side.
- Concomitant diseases: Cardiac & diabetic.
- No associated injuries.
- Time lapse before surgery: 4 days.

C.Reduction and fixation: Indirect reduction of the fracture was done intraoperative under C-arm guide in both AP and lateral views then a distal femoral locked plate was used for fixation of the fracture.



Fig. (4b) Immediate postoperative X.ray(anteroposterior&lateral views)



Fig. (4c) 3months follow up



Fig. (4d) 6 months follow up



Fig. (4e) Rom at 6 months follow up (from 0 extension to 135 flexion)

A. Postoperative evaluation: (Fig.4 b,c,d,e)

- Passive and active range of motion was encouraged from the 2nd day postoperatively.
- Normal knee joint alignment (about 7° valgus and no rotation).
- Physiotherapy was started after 1.5 month postoperatively.
- Partial weight bearing was started after 9 weeks.
- Complications: No complications had occurred.
- Radiological union started at about 16 weeks post operatively.
- ROM: normal (from 0° extension -135° full flexion).
- Walking was unrestricted and returned to normal activities after about 24 weeks.
- Follow up period was about 6 months.

Case 2

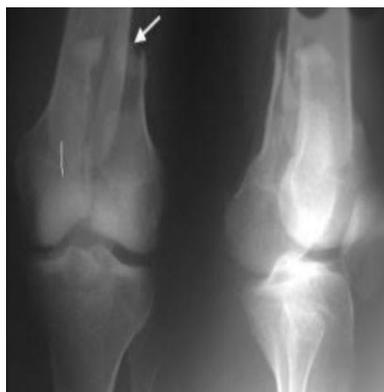


Fig. (5a)Preoperative x.ray (anteroposterior &lateral)

A.History: Female patient 32 years old, Mode of trauma: Severe (motor cycle accident).

B.Preoperative evaluation: Fig (5a)

- Fracture type: Type C1 distal femoral fracture.
- Side affected: The right side.
- Concomitant diseases: no comorbidities
- No associated injuries.
- Time lapse before surgery: 2 days.

C.Reduction and fixation: Indirect reduction of the fracture was done intraoperative under C-arm guide in both AP and lateral views then a distal femoral locked plate was used for fixation of the fracture with open transarticular reduction.

D.Postoperative evaluation: Fig (5b,c,d,e)

- Passive and active range of motion was encouraged from the 2nd day postoperatively.
- Normal knee joint alignment (about 7° valgus and no rotation).
- Physiotherapy was started after 1 month postoperatively.
- Partial weight bearing was started after 7 weeks.
- Complications: No complications had occurred.
- Radiological union started at about 12 weeks post operatively.
- ROM: normal (from 0° extension -135° full flexion).
- Walking was unrestricted and returned to normal activities after about 20 weeks.
- Follow up period was about 6 months.



Fig (5b) Immediate postoperative x.ray(anteroposterior &lateral)



Fig. (5c) 3months follow up



Fig. (5d) 6months follow up



Fig. (5e)Rom at 6 months follow up (from 0 extension to 135 flexion)

4. Discussion

Researchers discovered that osteoarthritis, osteoporosis, and rehabilitation problems all impact the older person's knee range of motion.

In addition to back discomfort, our older patients often complained of knee pain. The majority of patients had sporadic discomfort that worsened with exertion or exposure to cold temperatures.

Compared to a previous study [10], which reported three cases of superficial infections treated with antibiotics, we had two superficial infections and one deep infection in this series. Another group of researchers [11] also reported one case of superficial wound infection and one case of deep infections.

Of the 20 instances, 17 (85%) went straight to union, 2 (10%) had no union, and 1 (5%) had a delayed union. LISS findings from a prior research (10), which showed a fracture union rate of 70% after 6 months, were poorer than those reported in the literature (a rate of 85%). Other studies [12] found the greatest incidence of nonunion, however, which was just 7 instances (28 percent).

Fixed plates are increasingly utilised in osteoporotic bones for diaphyseal/metaphyseal reduction and for bridging severely comminuted fractures when using indirect reduction. Trauma treatment may benefit from a physiologically friendly approach by enhancing early and long-term results. Fracture reduction and stability have been maintained by locking plates with angular stable screws. Plates are inserted on the lateral side of distal femur with sufficient screws in locking mode and are intended to be anatomical locking plates. Relative stability allows for mobility at the fracture gap, which is the main objective of surgery using locking plates. Secondary callus development occurs as a result of the biomechanical concept of relative stability, which allows for a relatively dynamic deformation compared to initial callus formation in absolute stability [13].

Fixation stability (absolute vs. relative) influences fracture healing mechanobiology in a distinct way for each patient. There is less mobility at the fracture site with anatomical locking plates than with other fixation modalities (such as nails, conventional plates, and dynamic compression screws). Locking plates are a good option for senior osteoporosis sufferers because of this characteristic [13].

Despite this, loading is necessary to get the healing process started. Short locking plates have been found to fail in studies in Asia [14] as well. For a given weight and load, using lengthy plates enhances a plate's useful life by potentially increasing its working length.

In our research, all patients were impacted in one way or another, with 8 patients afflicted on the right side and 12 patients affected on the left side. The AO/OTA classification method for distal femoral fractures was used to classify the fractures. One patient had a delayed union and needed a bone transplant at the six-month mark because the callus had shrunk in size. Nonunion was found in two patients, and both were treated with open reduction and internal fixation, as well as bone grafts. 1 case with deep infection treated with 2 stages surgery ,1st removal of plate ,wash and temporary bridging external fixator, then 2nd stage plating and bone grafting.

Lastly, the outcomes of this work were acceptable to majority of our patient.

5. Conclusion

This technique uses a locked plate with fixed-angle construction to maintain distal femoral fixation, resulting in minimal intra-operative blood loss, soft tissue stripping, and a small, aesthetic scar. It is the best option for fixing distal femoral fractures in adults because of the following advantages: high union rates without bone graft; low infection rates; stable fixation; and a small, aesthetic scar.

Another benefit is that the patient will spend less time in the hospital, as the perforating and nutrient vessels will be maintained using minimally-invasive plate osteosynthesis techniques. This will improve fracture healing and local infection resistance, as no or only small compression forces occur between the plate and periosteum, so periosteal blood supply will be disrupted.

Age, gender, side effects, cause of injury, profession, and concurrent illnesses had no significant impact on the outcomes, while fracture type, related injuries, and the time gap before surgery did.

Complication rates were lower in patients treated with the MIPO distal femur than in other methods of treatment especially post-operative wound infection and union rate.

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Author contribution

Authors contributed equally in the study.

Conflicts of interest

No conflicts of interest.

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