ORIGINAL ARTICLE

Clinical Outcome of MIPO Technique in Complex Multi-fragmentary Distal Femoral Fractures

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ABSTRACT

Objective: To evaluate clinical outcome of minimally invasive plate osteosynthesis (MIPO) in complex multifragmentary distal femoral fractures.

Study design: Prospective interventional study

Place and duration of study: The study was conducted at Combined Military Hospital (CMH) Multan, CMH Muzaffarabad, CMH Gujranwala and CMH Rawalpindi from 1 March 2008 to 1 February 2013.

Methods: 41 patients underwent MIPO for open and closed comminuted distal femoral fractures. Fractures were classified according to AO system. Open fractures were graded using Gustilo and Anderson classification. Dynamic Compression Screw (DCS) was used for fixation in 5 cases whereas 36 fractures were fixed with Anatomic Distal Femoral Locking Compression Plate (DF-LCP). Post-operative clinical and radiological assessment was done at monthly interval until radiological union and three monthly thereafter. The minimum follow-up period was eight months with a mean of 18 months: Range (8-37) months. Functional outcome was assessed in each case at final follow-up.

Results: There were 35 males and 6 females with mean age of 30.3 years (Range 17-56). Radiological and clinical union was achieved in all cases. Augmentation autogenous cancellous bone grafting was done in 1 case fixed with DCS. Only 1 case got infected which was treated. Insignificant radiological mal-alignment (<5°) was observed in 4 cases. 3 cases were seen in DCS group (varus < 5° in 2 and and 4° recurvatum in 1 patient). 1 patient in DF-LCP operated group had varus of 3°. 1 plate broke in DCS group due to early weight bearing which was replaced. 2 screws broke in DCS group of delayed healing, but did not affect ultimate outcome. Mean ROM of knee at 6 months was 5-125°.

Conclusion: Our experience with MIPO in appropriately indicated distal femoral fracture pattern is encouraging. However, using anatomical DF-LCP for distal femoral fractures is better than DCS due to superior biomechanical properties. Where cost is not a concern, we recommend use of anatomical locking compression plates.

Key words: MIPO, DF-LCP, distal femoral fracture, internal fixators, bridge plating

INTRODUCTION

Fractures of the distal femur comprise 4% to 6% of all femoral fractures.[1] Distal femoral fractures are associated with high-energy trauma in young people and osteoporotic bones in the elderly.[2] Metaphyseal comminution and intra-articular fractures are real challenge with conventional plate fixation. Operative treatment is generally needed to permit early mobilization and rehabilitation. Although open reduction, combined with stable internal fixation, is achievable in some cases, a wide surgical exposure particularly in the complex fracture patterns risks non-union and infection due to the compromise in fixation stability and the local blood supply.[3] The internal fixation of fractures has evolved in recent years with a change of focus from mechanical to biological. The aim is to preserve maximal blood supply. Biological fixation encourages the formation of callus while less precise, indirect reduction will reduce operative trauma and maintain blood supply.[4] Complex multi-fragmentary distal femoral fractures not amenable to fixation with interlocking nails do pose a management challenge. The concept of bridge plating with locking plates has

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enabled a minimally invasive approach and indirect reduction techniques, with the aim of preventing above-mentioned problems. Minimally Invasive Plate Osteosynthesis (MIPO) is fast becoming established technique for treating complex peri-articular and metaphyseal fracture patterns of distal femur.[5] The distal femoral locking compression plate (LCP) forms a fixed angle construct and enables placement of the plate without any contact to the bone. It can therefore be used in multi-fragmentary peri-articular and intra-articular fracture with metaphyseal comminution. The pull-out strength of locking screws is substantially higher than that of conventional screws.[6]

We report our experience with MIPO technique for such fracture pattern, using Dynamic Condylar Screw (DCS) in earlier, and anatomical distal femoral locking plates in later cases.

PATIENTS AND METHODS

The study was conducted at Combined Military Hospital (CMH) Multan, CMH Muzaffararbad, CMH Gujranwala and CMH Rawalpindi from 01/03/08 to 01/02/13. 41 patients with open and closed distal femoral fractures underwent fracture fixation with MIPO technique. Fractures were classified according to AO classification system. Open fractures were graded using Gustilo and Anderson classification. Dynamic compression screw (DCS) was used in 5 cases and 36 cases were fixed with distal femoral locking compression plate (DF-LCP). Patients with Gustilo type III B/C fractures or with infection at presentation were excluded. The cause of injury was road traffic accident and bullet injuries.

Above knee POP back slab was applied until surgery. Open fractures were thoroughly debrided and intravenous antibiotics (cefoperazone+sulbactum 2g intravenous BD and amikacin 500mg intravenous BD) were administered for 2 days before surgery. The wounds were partially closed after fracture fixation.

DCS and DF-LCP (pre-contoured) stainless steel implants were used for fracture fixation. Operation was carried out under tourniquet. Before inflating the tourniquet intravenous injection Cefoperazone + sulbactum 2g with injection Amikacin 500mg were administered. The operation was carried out on fracture table. Under fluoroscopic guidance, a transverse incision was given over the lateral aspect of the distal femur at the level of the intercondylar notch. The length of the incision was 3 to 5 cm. The fascia lata was split along the direction of its fibres. A submuscular tunnel was created using a bristow.

Maximal reduction was achieved by indirect methods. Reduction clamps, fracture elevation with spikes and traction were used to correct alignment and length. Under image intensifier guidance, alignment and rotation were restored by judging the hip rotation on the uninjured side using the lesser trochanter as a guide. The distal fragment was held in the same position as that for the intact femur. Following reduction, DCS was carried out in 5 cases. DF-LCP appropriate-sized plates (with 6 to 12 holes) were slid in a distal-to-proximal direction over the lateral aspect of the distal femur. The length of the plate was determined intra-operatively after reduction. At least 3 locking screw holes were aimed to be engaged beyond the proximal extent of the fracture, and distally the plate did not extend beyond the joint line. A threaded drill sleeve was provided with the instrumentation set and enabled accurate drilling of screw holes and therefore proper alignment of screws for proper mating of the plate and screw threads. A small incision was also given over the proximal portion of the plate. It enabled proximal control of the plate, helped in reduction of the fracture and placement of compression screws/locking screws as necessary. Under fluoroscopic guidance, stab incisions were made over the lateral aspect of the thigh at respective screw holes. Screws were inserted through stab incisions. Postoperatively, the operated limb was kept in elevation on a splint with the knee in 10º to 15º of flexion. Active and passive hip and knee mobilisation and static quadriceps exercises were allowed at postoperative day 1. The patient was allowed to walk on crutches non-weight-bearing next day. Weight bearing was initiated depending on the radiological evidence of bone union. Full weight bearing was allowed at clinical and radiological union of the fracture. The progress of healing was assessed with routine antero-posterior and lateral radiographs at 4 weekly intervals for 6 months, 3 monthly for a year and then 6 monthly. The minimum follow up period was 8 months and maximum 37 months (mean 18 months). Bone union was defined as bridging callus across the fracture site on both antero-posterior and lateral radiographs in the absence of migration, loosening or breakage of hardware, and a painless fracture site during weight bearing. Clinical and functional outcomes were assessed using the Knee Society Scores. The data was analysed on SPSS 20.

RESULTS

The mean age was 30.3 yrs. Male to female ratio was 35: 6. 38 were closed fractures and 3 were open. 6 fractures were of type A1, 4 of A2, 14 of A3, 2 of B1, 1 of B2, 5 of C1, 7 of C2 and 2 of C3 types. 5 fractures were fixed with DCS implant and 36 with distal femoral locking compression plate. All cases had clinical and radiological union. 1 patient had delayed union, which was bone grafted and it united. 1 developed superficial wound infection, which was treated. 1 started walking early, therefore broke the DCS implant; it was replaced. 1 patient broke 2 screws of DCS implant. His weight bearing was delayed. The bone ultimately united. 3 cases had varus mal-alignment of less than 5 degrees and 1 had recurvatum of less than 5 degrees. 4 patients had leg length discrepancy of less than 2 cm, which did not require any sole raise. Knee society scores at 6 months were, mean knee score for type A1was 90.16 and function score 82.66, mean knee score for type A2 was 89.25 and function score 80.75, mean knee score for type A3 was 83 and function score 79.1. Mean knee score for type B1was 85.5 and function score 80.5, mean knee score for type C 1 was 79.6 and function score 75, mean knee score for type C2 was 72.2 and function score 69.42, mean knee score for type C3 was 68 and function score 64.5. Therefore, overall functional outcome was graded excellent to good in all of the cases as shown in Figure 1. Figures 2, 3, and 4 are illustrative of our technique and results in three cases.

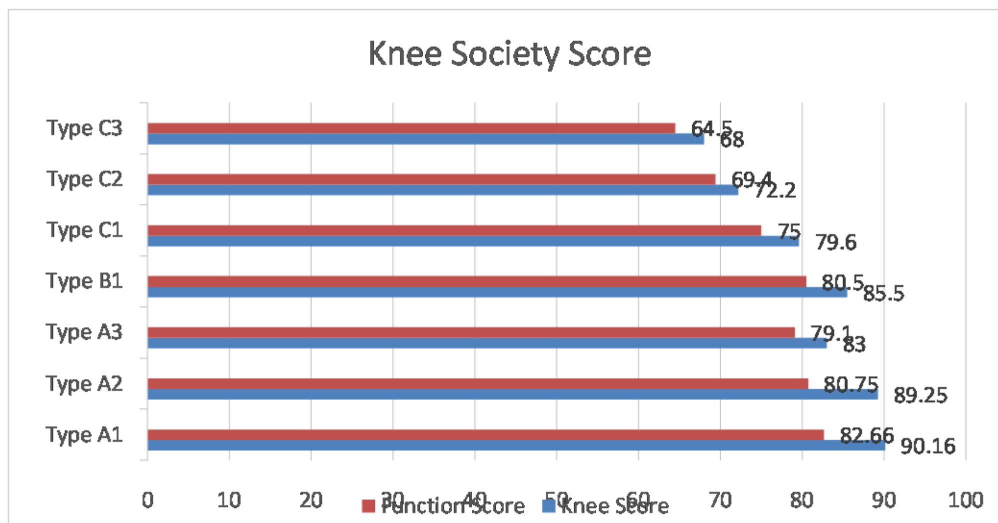
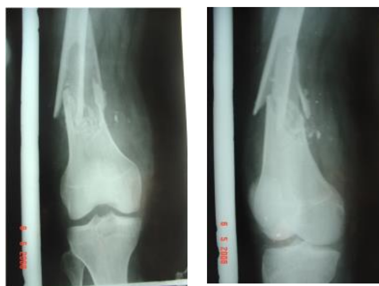


Figure 1: Knee Society Scores (Functional and Knee score) in various types of distal femoral fractures.

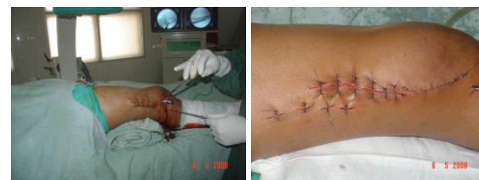
Figure 2:

MIPO with Dynamic Compression Screw in a young male

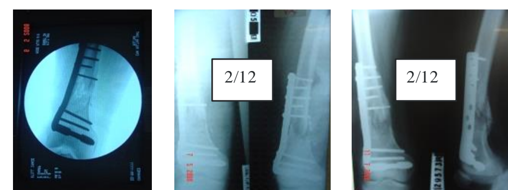
After a GSW (Gustilo 3A injury)



2a 2b 2c 2d



2e 2f 2



2a, 2b. Fracture femur Right (33A3) AP & L views. 2c. Insertion of DCS with MIPO technique after wound

debridement. 2d. Final picture after wound closures 2e. Immediate post-operative x-rays. 2f. Post-operative x-rays at 2 months. 2g. Post-operative x-rays at 4 months

Figure 3

MIPO with Distal femoral LCP in a 50 year old man in road traffic accident

3a 3b 3c 3d

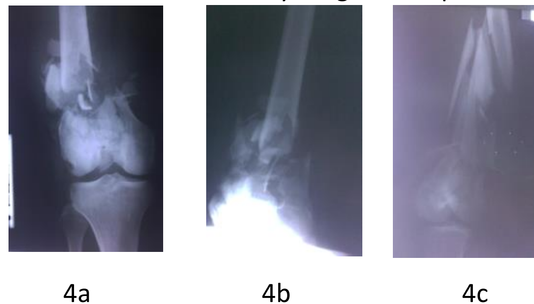
3e 3f 3g 3h

3I 3J

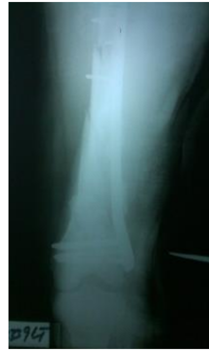
3a.Fracture femur right (33C3 open G3A). 3b,3c,3d. Per-operative photos just at the end of procedure. 3e,3f. Immediate post-operative x-rays. 3g, 3h.At 4 months showing union. 3I,3J. At 4 months showing healed scars.

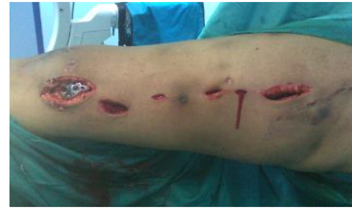
Figure 4

MIPO with distal femoral LCP in bilateral 33C3 fractures in young female patient



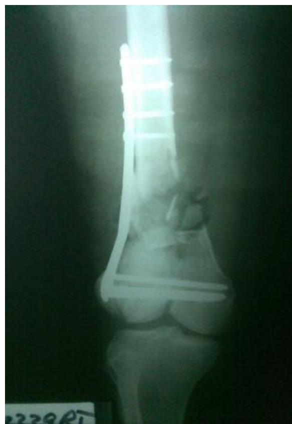
4a 4b 4c

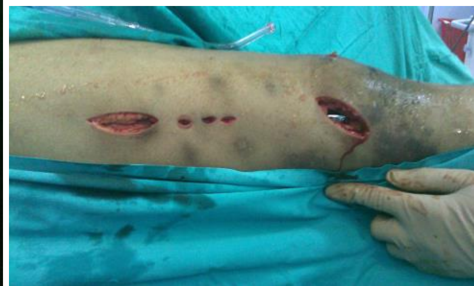




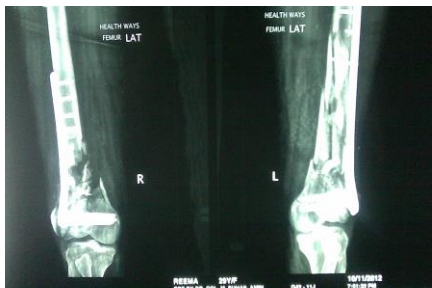
4d 4e

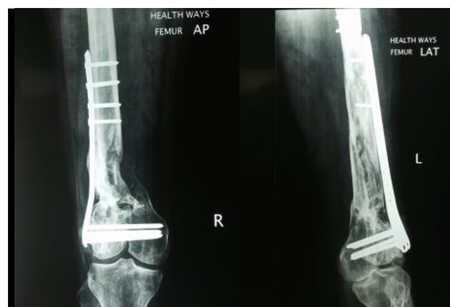
Figure 4 (Continuation…)
MIPO with distal femoral LCP in bilateral 33C3 fractures in young female patient





4f 4g





4h 4I

4a, 4b,4c. Fr femur 33C3 bilateral. 4d. Immediate post-operative. 4e. Per-operative (at the end of procedure). 4f. Immediate post-operative. 4g. Per-operative (at the end of procedure, right). 4h. At 4 months shows reasonably good union. 4I. At 22 months showing consolidation.

DISCUSSION

Minimal surgical trauma and relative bone fixation allow prompt healing while the blood supply to bone is maintained. This approach is described as 'biological internal fixation'. It involves the use of locked internal fixators which have minimal implant-to-bone contact, long-span bridging and fewer screws for fixation. Formerly, internal fixation with a plate, aimed at absolute stability to avoid micro-movement. It sometimes result in loosening of the implant and a

delay in healing. This new technique of internal fixation, however, permits some degree of mobility at the interface of the fracture. The contact between implant and bone is kept stable using screws which function like locked threaded bolts.[4]

The indication of MIPO in distal femoral fractures is comminuted juxta-articular fractures not amenable to biological fixation with interlocking intramedullary nail or reconstruction nail. Secondly, it is done in articular fractures of distal femur with metaphyseal comminution after anatomic fixation of articular surface.[5,6] The stability of conventional screw-plate systems (condylar buttress plates and dynamic condylar screws) depend on the bone-plate interface .[2, 7] When screws are tightened, the plate compresses against the cortex and maintains stability. The stability of the standard screw depends on bone quality. Since pull out strength of standard screw is less in osteoporotic bones and in metaphyseal comminution, there is high chance of failure of the screw-plate system. In addition, such systems have technical failures like loss of primary and secondary reduction. There is also compression of the periosteum leading to disturbance of the cortical blood supply.[8] Fixation with the dynamic condylar screw requires at least 4 cm of non-comminuted bone in the femoral condyles above the intercondylar notch.[9] This limits its use in more distal extra-articular fractures. Soft-tissue stripping during conventional plating adds a biologic insult to more severe fracture pattern as in metaphyseal comminution and osteoporotic bones. These may lead to poor outcomes such as non-union; implant failure, mal-union, and infection.[10]

Intramedullary nailing involves issues like opening the joint, nail protrusion into the joint [9], joint pain [11, 12], knee stiffness, patello-femoral problems, knee sepsis and more complications within 5 cm of the intercondylar notch.[13] Locked plates are increasingly used for indirect reduction in diaphyseal/metaphyseal fractures in osteoporotic bones and for bridging severely comminuted fractures.[14] The MIPO techniques complement locking plate technology. Careful handling of tissues helps to maintain tissue viability through preservation of the periosteal blood supply to maximize healing potential. Minimally invasive approach allows fixation of a bone through smaller surgical footprints. The plate is placed in sub-muscular plane.[15]

A recent study in Asia reported cases of failures when short locking plates were used. [16] The use of long plates theoretically increases the plate's working length and hence improves the number of load cycles it can withstand until failure.[17]

In our study, the functional outcome was good at 6 months with satisfactory range of motion. All patients had a minimum of 90 degrees of flexion, with the maximum range of flexion achieved being 140 degrees. Complications seen in our study were; 1 (n=41) patient had delayed union, which was bone grafted and it united. 1 developed superficial wound infection, which was successfully treated with antibiotics. 1 started walking early, therefore broke the DCS plate that had to be replaced. 1 patient broke 2 screws of DCS implant. His weight bearing was halted and delayed. The bone ultimately united. 3 cases had varus mal-alignment of less than 5 degrees and 1 had recurvatum of less than 5 degrees. 4 patients had leg length discrepancy of less than 2 cm. However, none of them warranted any sole raise. We had no mortalities. Nayak et al[6] reported one case of implant failure, none with angular/rotational deformity of more than 10 degrees or leg length discrepancy of more than 2 cm, which were almost similar to our study.

CONCLUSION

The MIPO technique using a distal femoral locking plate achieved favourable clinical outcomes in our case series. Bone grafting is generally not needed even in cases of metaphyseal comminution. Proper patient selection and preoperative planning are essential to prevent complications. The technique is found useful and safe. All patients treated with this technique healed and had satisfactory functional outcomes with no mortalities and few postoperative complications.

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