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Functional Outcome of Distal Femur Fracture Treated with Minimally Invasive Percutaneous Plate Osteo-Synthesis Technique Using Locking Compression Plate in A Tertiary Care Centre of Chengalpattu District

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ABSTRACT

Distal Femur fracture is one of the common fractures of the femur. The purpose of this study is to evaluate the functional outcome of Distal Femur fracture treated with MIPPO-minimally invasive percutaneous plate osteo-synthesis technique using locking compression plate. The study was conducted as descriptive cohort study among patients who present with distal femur fracture (Muller's type A and C) willing for locking compression plate with MIPPO fixation in a tertiary care hospital over a period of 18 months. All the cases with closed fracture of distal femur Muller's type A and C will be treated at a tertiary care hospital in Chengalpattu District. The method used for fracture fixation will be closed reduction and internal fixation with MIPPO with locking compression plate. Locking compression plate is a good fixation system for distal end femoral fractures particularly in type I and type III distal femoral fracture. The mean score of our subjects treated with MIPPO with locking compression plate was around 37.33 with the score of minimum 12 and maximum 48. Around 53% of our subject (16 subjects) had excellent scores, 30% (9 subjects) had good score, 10% (3 subjects) had moderate score and only 6% (2 subjects) had poor score. The mean score of our subjects treated with MIPPO with locking compression plate was around 37.33 with the score of minimum 12 and maximum 48. Around 53% of our subject (16 subjects) had excellent scores, 30% (9 subjects) had good score, 10% (3 subjects) had moderate score and only 6% (2 subjects) had poor score.

INTRODUCTION

Femur is one of the strongest and longest bones in the human body. The head of the femur articulates with the acetabulum in the pelvic bone forming the hip joint, while the distal part of the femur articulates with the tibia (shinbone) and patella (kneecap), forming the knee joint.

Locking compression plate has the advantage of combination of conventional compression plating and locked plating techniques which enhances the plate osteo-synthesis. Anatomically pre-contoured built locking compression plate reduces soft tissue problems and acts as internal external fixator. Modern usage of prophylactic antibiotics, sterilisation techniques can be helpful in fixing strong plates with minimal tissue dissection. Furthermore, invention of biological plating i.e, minimally invasive plate osteo-synthesis (MIPO) 2, makes the procedure less invasive and provides effective stabilisation. This has transformed the management of distal femoral fractures.

Fractures of the distal femur are rare and severe. The estimated frequency is 0.4% which varies epidemiologically. Around 1% of all fractures is distal femur fractures and it was found that 3-6% of all femoral fractures are distal femur fractures[1]. There is a classic bimodal distribution, with a frequency peak for men in their 30s and a peak for elderly women; however, currently it is found predominantly in women especially in the elderly women aged above 65 years who comprises more than 50% in that category. Younger individuals usually have high impact fracture due to road traffic accidents and older individuals have low impact fracture even during trivial fall due to osteoporosis[2].

Distal femur fractures involve the femoral condyles and the metaphysis[3]. Shortening of the fracture with varus and extension of the distal articular segment is the typical deformity seen in distal femur fracture[4]. Quadriceps and hamstring muscles cause shortening. Unopposed pull of the hip adductors and gastrocnemius muscles causes the varus and extension deformities.

The distal articular segment has a trapezoidal shape on its axial section. Ignorance of this geometry can lead to medialization, anterior displacement and external rotation of the femoral condyles, articular penetration by implants or excessive penetration of the medial cortex while using conventional and locked fixed-angle implants[4].

Furthermore, it can be applied through minimally invasive technique, which help in prompt healing, reduce the rate of infection, reduces the bone resorption and preserves the blood supply[5]. A distal femoral locking compression plate (DFLCP) provides fixed angle contact at several points between the plate and screws in the distal end of the femur even with a small epiphyseal segment, reducing the tendency for varus collapse, which can be a complication with traditional lateral plates[6].

In addition, a locking compression plate has got distinct advantages of unicortical fixation and least chance of plate back out as the screw gets locked to the plate. When closed reduction and MIPPO technique was used together soft tissue injuries were greatly reduced.

In this study we have analysed the functional outcome of distal femur fractures treated by MIPPO with locking compression plate.

MATERIALS AND METHODS

The Study Involves 30 Patients admitted and diagnosed clinically and radiologically (Muller's type A and C) as Distal 3rd Femur Fracture in a tertiary care hospital. Sampling for the selection of study subjects was patients with distal femur fracture with indication of MIPPO with Locking Compression plate.

Study approval: Institutional Ethical Committee approval 2021/653, dated 29/01/2021 and 30/01/2021.

Inclusion criteria: Patients were selected above 18 years of age with distal 3rd femur fractures which needs to be internally fixed and radiological diagnosis of femur fractures with classification based on Muller's classification (type A and C).

Exclusion criteria: Young patients with open physis, Muller's type B fracture, patients with co-morbid conditions unfit for surgery were exempted from the study.

Methods of data collection: The study was conducted as descriptive cohort study among patients who presented with distal femur fracture (Muller's type A and C) willing for locking compression plate with MIPPO fixation in department of orthopaedics over a period of 18 months. After approval of our ethical committee, a total of 30 patients, scheduled for elective surgery- Locking compression plate with MIPPO fixation. A written and informed consent in their vernacular language was obtained from all patients before enrolling them in the study. Patients were monitored by the surgeon and the outcome was monitored.

Sample size: Sample size calculation based on the previous study of Ali and Saleh[7] the proportion of both the groups are 50% of distal femur fractures excluding hip involvement and 8.3% of all femoral fractures with 5% level of significance and 80% power the total sample size is 30 including 10% non-response error.

Study procedure: In this study 30 patients with closed fracture of distal femur were studied. All the cases with closed fracture of distal femur Muller's type A and C were treated in a tertiary care hospital.

The method used for fracture fixation was closed reduction and internal fixation with MIPPO with locking compression plate. The duration of follow up ranged from 3-6 months.

Fractures were classified with the help of radiographs according to the AO-ASIF classification. Preoperative calculation was done on radiographs to ascertain the size of the plate, accurate size of locking, cortical and cancellous screws after subtraction of the magnification factor. Prophylactic antibiotics were injected previous night and early morning on the day of surgery. The patient was placed supine on the fracture table with limbs attached firmly to the foot holders. Affected limb was extended (with no traction) whereas the unaffected limb was flexed at knee and abducted. Then affected limb was scrubbed, painted and draped from proximal tibia to iliac crest. The approach of distal femur in MIPPO is a shorter version of open lateral approach. The distal skin incision was started from the joint line on the lateral aspect of about 5-7 cm. Fascia incised in line with the skin incision. Branches of superior geniculate artery/vein was ligated. The joint was opened if there was an intra-articular fracture. Fractures were anatomically reduced and fixed using Locking Compression Plate. Post operatively a series of knee range of movements was assessed using Modified Oxford Knee scoring at regular intervals of time.

Study parameters: Age, Gender, Muller's classification of femoral condylar fractures, Radiological evidence of union, Modified Oxford Knee Score, Time taken for wound healing, AO classification were used as the study parameters.

RESULTS

The total number of subjects underwent MIPPO was 30 and their mean age is 41.06 years. The minimum age of the subject was 18 years and maximum age was 60 years (Table 1).

Table 2 shows the frequency distribution of age of distal femur fracture patients. Out of total 30, 15 of them were between 18-40 years of age and remaining 15 of them were between 41-60 years of age.

Table 3 illustrates the frequency distribution of gender of distal femur fracture patients. Out of 30 subjects, 20 were males which constitute around 66.7%.

Table 4 represents the frequency distribution of mode of injury of distal femur fracture. About 90% had distal femur fracture due to road traffic accident and remaining had fracture due to self-fall.

Table 5 demonstrates the frequency distribution of Muller's Fracture Types of distal femur fracture patients. 16 out of 30 had type I fracture which was around 53% and remaining 14 had type III fracture which was about 47%.

Table 6 demonstrates the frequency distribution of radiological evidence of union in distal femur fracture after treatment with MIPPO with locking compression plate. Around 23 subjects had union in 2 months and remaining 7 had in 3 months. So overall 100% of our subjects had successful union

Table 7 shows the descriptive statistics of Modified Oxford Knee Score in distal femur fracture after treatment with MIPPO with locking compression plate. The mean score was around 37.33 with the score of minimum 12 and maximum 48.

Table 8 illustrates the frequency distribution grade of Modified Oxford Knee Score in distal femur fracture after treatment with MIPPO with locking compression plate. Around 53%[8] had excellent scores, 30%[9] had good score, 10% [10] had moderate score and only 6%[11] had poor score.

Table 9 shows the frequency distribution of complication of distal femur fracture after treatment with MIPPO with locking compression plate. Around 80% of the subjects don't have any complications. About 6.7% had infection and knee stiffness and malunion and shortening of limb was noticed 3.3% each.

DISCUSSIONS

Minimally invasive plating technique is one of the advance techniques to treat distal femoral fracture in order to maintain the structure and integrity of bone and to reduce the soft tissue injury. For maintaining the bone anatomy and to promote early fracture healing and mobilisation these techniques have been used.

Currently in distal femur fractures, locking plate systems have been widely used. It not only reduces the risk of early loosening of implant but also encourages early mobilization and quick healing without bone grafting with low risk of infection[12,13]. Past studies have demonstrated productive initial clinical results and comparatively reduced complication rates using

Table 1: Descriptive statistics of age of distal femur fracture patients

Parameter	No. of sample	Mean (years)	Standard deviation	Minimum	Maximum
Age	30	41.06	12.69	18	60

MIPPO: Minimally invasive percutaneous plate osteo-synthesis technique

Table 2: Frequency distribution of age of distal femur fracture patients

Distribution of age	Frequency	Percentage
18-40	15	50
41-60	15	50
Total	30	100

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Table 3: Frequency distribution of gender of distal femur fracture patients

Distribution of Gender	Frequency	Percentage
Male	20	66.7
Female	10	33.3
Total	30	100

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Table 4: Frequency distribution of mode of Injury of distal femur fracture patients

Distribution of mode of Injury	Frequency	Percentage
Road Traffic Accident	27	90
Self Fall	03	10
Total	30	100

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Table 5: Frequency distribution of Muller's Fracture types of distal femur fracture patients

Distribution of muller's fracture type	Frequency	Percentage
Type I	16	53.3
Type III	14	46.7
Total	30	100.0

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Table 6: Frequency distribution of radiological evidence of union in distal femur fracture after treatment with MIPPO with locking compression plate

Distribution radiological evidence of union	Frequency	Percentage
2 Months	23	76.7
3 Months	07	23.3
Total	30	100.0

MIPPO: Minimally invasive percutaneous plate osteo-synthesis technique

minimally invasive plating techniques for the fractures of distal femur. So the purpose of this study is to analyse the functional outcome of distal femur fractures treated by MIPPO with locking compression plate.

In this study, totally 30 subjects with distal femur fracture were recruited. All of them were treated with MIPPO with locking compression plate. Out of 30 subjects, 20 were males which constitute around 66.7%.

The mean age of our subjects was 41.06 years. The minimum age of the subject was 18 years and maximum age was 60 years. Out of total 30, 15 of them were between 18-40 years of age and remaining 15 of them were between 41-60 years of age. So our study had binominal distribution in regard to age of the subjects i.e., 50% of them belongs to younger adults category and remaining 50% belongs to 41-60 years, older adults category.

Type of fracture among our subjects: As reported by the past literatures, femur fractures are bimodal in distribution. High energy impact during road traffic accidents affect young adults especially in males aged between 15-50 years and low energy impact even during trivial fall noticed especially in osteoporotic aged females aged >50 years.

In our study, about 90% had distal femur fracture due to road traffic accident that comprises of around 27 subjects and remaining 3 subjects had fracture due to self-fall. Among the road traffic accidents, 14 subjects had type I and 13 subjects had type III fracture. 2 subjects had type I and one had type III fracture in self-fall category.

Frequency distribution of Muller's Fracture in our study showed that around 16 subjects i.e., 57% of our subjects had type I Muller distal femur fracture. About 47% of our subjects had type III Muller fracture. So overall in our study, we had patients with type I and type III Muller's classification of distal femur fracture. The average age of subjects undergone type I fracture was 39.00±11.46 and 38.50±11.21 is the average age of subjects with type III fracture. Type I distal femur fracture was seen in 13 males and 3 females and it totals around 16 subjects. Type III distal femur fracture was seen in 7 males and 7 females.

Radiological union: Around 23 subjects had union in 2 months and remaining 7 had in 3 months. So overall 100% of our subjects had successful union in 3 months. Saini RA et, al, reported that the duration of union in their study ranged from 12-20 weeks. Rajaiah *et al*.[14] reported 14-25 weeks while Yeap *et al*.[15] reported 6-36 weeks. In our study we have observed that the duration of union was much earlier that is between 8-12 weeks. Around 76.7% had union at two months and remaining had at three months.

We have observed that out of 16 subjects with type I fracture, 11 subjects had union in 2 months and 5 subjects had union in 3 months. Among the 14 subjects, who had type III distal femur fracture 12 had union in two months and 2 subjects had union in three months. Thus, the mean duration of type I fracture was 2.31±0.476 months and type III fracture was 2.14± 0.363 months.

Modified oxford knee score: Oxford knee scoring is a simple scoring system provides an overall scale for assessing outcomes of knee interventions. The Oxford Knee Score is a functional knee score of consisting of 12 questions. Total score is taken as 48. Grading is done according to the score. It is designated as follows: Excellent: More than 41, Good: 34-40, Fair: 27-33 and Poor: <27.

The mean score of our subjects treated with MIPPO with locking compression plate was around 37.33 with the score of minimum 12 and maximum 48. Around 53% of our subject (16 subjects) had excellent scores, 30% (9 subjects) had good score, 10% (3 subjects) had moderate score and only 6% (2 subjects) had poor score.

Table 7: Descriptive statistics of Modified Oxford Knee Score in distal femur fracture after treatment with MIPPO with locking compression plate

Parameter	No. of sample	Mean	Standard deviation	Minimum	Maximum
Modified oxford knee score	30	37.33	9.08	12	48

MIPPO: Minimally invasive percutaneous plate osteo-synthesis technique

Table 8: Frequency distribution Grade of Modified Oxford Knee Score in distal femur fracture after treatment with MIPPO with locking compression plate

Grade of modified oxford knee score	Frequency	Percentage
Excellent	16	53
Good	09	30
Moderate	03	10
Poor	02	06
Total	30	100

MIPPO: Minimally invasive percutaneous plate osteo-synthesis technique

Table 9: Frequency distribution of Complication of distal femur fracture after treatment with MIPPO with locking compression plate

Complication	Frequency	Percentage
No	24	80
Infection	02	6.7
Malunion	01	3.3
Knee Stiffness	02	6.7
Shortening	01	3.3
Total	30	100

MIPPO: Minimally invasive percutaneous plate osteo-synthesis technique

Jati *et al*.[15] observed that in their study 85% of their subjects had excellent functional outcome, whereas, 10 and 5% had good and moderate outcome, respectively. There was no case with a poor functional outcome in this study[16]. Jhatoth[16] reported similar findings and in their study the functional outcome was Excellent in n = 19 (59.38%) subjects, Good in n = 6 (18.75%), Fair in n = 5 (15.63%) and Poor in only 2 (6.25%) cases[17]. In our study we have observed that around 53% of our subject (16 subjects) had excellent scores, 30% (9 subjects) had good score, 10% (3 subjects) had moderate score and only 6% (2 subjects) had poor score.

When we compared type I and type III fracture scores in our study, Group 1 subjects who had type I fracture had the mean score of 37.50±8.60 and group 2 subjects who had type III fracture had the mean score of 31.14±9.92. So both the groups had good score.

Complications: The treatment modalities of distal femur fracture leads to common complications such as loss of reduction, excessive soft tissue stripping and violation of joint, joint stiffness, non-union, malunion, implant failure, malalignment and infections. The mechanism behind this complication is due to the fact that these treatments need excessive stripping to achieve accurate anatomical reduction and prolonged immobilization due to compromised stability[11,18].

In our study around 80% of the subjects don't have any complications. 93.8% (15 subjects) of Group 1 subjects with type I fracture had no complications. In group 2 around 71.4% of the subjects i.e, about 10 subjects had no complications.

Non-union: In our study none of the subject had non-union. Among the total 30 subjects enrolled, around 23 subjects had union in 2 months and remaining 7 had in 3 months. Thus 100% of our subjects had successful union within 8-12 months.

Knee stiffness: One of the commonest complications of distal femur fractures is knee stiffness. Past studies have shown that distal femoral locking compression plate overcomes both the drawbacks of excessive stripping as it can be done via minimally invasive methods. It also provides stable relative stability which can enhance early joint mobilization and thus prevents joint stiffness leading to, good to excellent functional outcome.

We have noticed that no one had knee stiffness in group 1 and 2 subjects had knee stiffness in group 2 which makes the overall percentage of knee stiffness to be 6.7% in our study.

Infection: The other dreaded complication is infection. Extensive soft tissue injury and prolonged operating time are the factors that increase the rate of infection. In group 1 subjects with type I fracture none of them had infection. In group 2 only one had infection. We have reported only one case of infection in overall 30 subjects which was around 3.3%.

Neer *et al*.[18], has reported 20% infection rate while Siliski *et al.*[19] have reported 5.7% infection rate. Our study had lower percentage of infection reported.

Malunion: In our study, around 3.3% of the subjects had mal-union. Out of 16 subjects, only one in group one subject with type I fracture had mal-union. Ramu *et al*.[20] had observed mal-union in 6.7%. Our study had lower percentage of mal-union.

Shortening of limb: We have observed shortening of limb in 3.3% subjects. It is noticed in group 2 subjects. Among the 14 subjects, only one had shortening of limb. A multi-centric study done in Europe on LISS showed 20% incidence of varus/valgus deformity greater than 5 degrees[19].

Our study has shown excellent to satisfactory results in both type I and type III fractures. It also showed better functional outcomes in both older and

younger age groups. Our study subjects had lesser complications compared to studies related to traditional treatment. Therefore MIPPO with locking compression plate makes the best treatment option because of the increased rate of union and range of motion, better healing, restoration of articular surface, improved biomechanical stability, decreased complication rate and early rehabilitation.

CONCLUSION

Locking compression plate is a good fixation system for distal end femoral fractures particularly in type I and type III distal femoral fracture.

The mean age of our subjects was 41.06 years. The minimum age of the subject was 18 years and maximum age was 60 years. Out of total 30, 15 of them were between 18-40 years of age and remaining 15 of them were between 41-60 years of age. So our study had binominal distribution with regards to age of the subject i.e., 50% of them belongs to younger adults category and remaining 50% belongs to 41-60 years, older adults category.

In our study, about 90% had distal femur fracture due to road traffic accident that comprises of around 27 subjects (type I: 14 subjects and type III: 13 subjects) and remaining 3 subjects (type 1: 2 subjects and type III: One subject) had fracture due to self-fall. We have observed that around 23 subjects had union in 2 months and remaining 7 had in 3 months. So overall 100% of our subjects had successful union in 3 months. The duration of union in our study was much earlier that is between 8-12 weeks.

The mean score of our subjects treated with MIPPO with locking compression plate was around 37.33 with the score of minimum 12 and maximum 48. Around 53% of our subject (16 subjects) had excellent scores, 30% (9 subjects) had good score, 10% (3 subjects) had moderate score and only 6% (2 subjects) had poor score.

Around 80% of the subjects don't have any complications. About 93.8% (15 subjects) of Group 1 subjects with type I fracture had no complications. In group 2 around 71.4% of the subjects i.e., about 10 subjects had no complications.

We have noticed that no one had knee stiffness in group 1 and 2 subjects had knee stiffness in group 2 which makes the overall percentage of knee stiffness to be 6.7% in our study.

Only one case of infection in overall 30 subjects which was around 3.3% was noticed in our study only one in group one subject with type I fracture had mal-union which was around 3.3%.

Shortening of limb was noticed in one subject in group 2 subjects that was around 3.3%.

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