Section: Orthopaedics

Original Research Article

EVALUATE THE EFFECTIVENESS AND PITFALLS OF TREATMENT OF COMMINUTED FRACTURE DISTAL FEMUR TREATED WITH DOUBLE DISTAL FEMUR LCP

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Abstract

Background: Fractures within 15cm from articular surface of distal femur i.e., between articular surface and junction of metaphysis to femoral diaphysis are defined as distal femoral fractures which constitute around 5-6% of femoral fractures. This study aimed to evaluate the effectiveness and pitfalls of treatment of comminuted fracture distal femur treated with double distal femur LCP in terms of range of motion, rate of union, and time of mobilization. **Materials and Methods:** This Prospective study was conducted at the Department of Orthopaedics and Regional Spine Injury Centre N.S.C.B. Medical College & Hospital, Jabalpur (M.P.) from 1st Jan 2021 to 31st June 2022 with the sample size of 30 diagnosed cases satisfying the inclusion-exclusion criteria. The analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, version 23.0. **Result:** Total of 30 patients, majority were male (83.3%) with the age group from 16 years to 80 years with mean age of 43 +_ 15.18 years. The most common type of fracture 11 (36.7%) was comminuted supracondylar femur fracture with intercondylar extension. The union rate was 100% and average healing time between 18-24 weeks both clinically and radiologically and a mean healing time of 21.3 weeks (5 months) with no cases of varus deformity or malunion. **Conclusion:** Dual plating provides successful results for the treatment of both extra articular and intra articular unstable fractures of distal femur. This method, which is effective in anatomic realignment, allows early joint motion, owing to its fixation strength. Minimal invasive osteosynthesis approach provides both access with minimal surgical trauma on distal femur and fixation with a better adaptation to surrounding tissues?

INTRODUCTION

Fractures within 15cm from articular surface of distal femur i.e., between articular surface and junction of metaphysis to femoral diaphysis are defined as distal femoral fractures which constitute around 5-6% of femoral fractures. Distal femur fractures are commonly associated with severe metaphyseal comminution and significant soft tissue injury. Distal femoral fractures are mostly caused by high-energy injuries, such as falling injury and traffic accidents, and fractures are often severely comminuted. Despite the recent advances in techniques and implants, the treatment of intra-articular multi- fragmentary distal femoral fractures remains a challenge. Long-term disability can occur in patients with extensive articular cartilage damage and marked comminution. Distal femur fractures in the elderly are complicated by poor bone quality (severe osteoporosis), a distal segment that is too short for adequate fixation, blood loss, malunion and non-union, and increased mortality.[1-3]

These fractures often are unstable and comminuted and tend to have a bimodal distribution, occurring in elderly or younger multiple-injured patients. Because of the proximity of these fractures to the knee joint, regaining full knee motion and function may be difficult. The incidences of malunion, nonunion, and infection are relatively high in many reported series. Muscular forces acting on distal femur, weight bearing and gravity all affects fracture stabilization. When there is short distal fragment and metaphyseal comminution with defect in medial cortex, chances of varus collapse due to

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increased bending tendency caused by vertical load are common in internal fixation of distal femur fracture with single lateral locking plate alone. So additional support of distal femur fracture stabilization by using double-plating technique provides additional support and prevents complication like varus collapse and decreased incidence of non-union.[4,5] Therefore, this study aimed to evaluate the effectiveness and pitfalls of treatment of comminuted fracture distal femur treated with double distal femur LCP in terms of range of motion, rate of union, and time of mobilization.

MATERIALS AND METHODS

The proposed study was conducted in the department of Orthopedics, NSCB Medical College and hospital after obtaining Ethical consideration from the Ethical committee and informed consent from study patients to maintain their confidentiality.

Study Period

The study was conducted from the duration of 1st Jan 2021 to 31st June 2022 at the Department of Orthopedics N.S.C.B. Medical College & Hospital Jabalpur (M.P.)

Sample Size

A Total number of 30 patients were selected and followed up for 6-12 months after the intervention.

Inclusion Criteria

- Age more than 16 years and less than 80 years
- Patients with complete clinical records.
- All comminuted intraarticular fracture distal femur AO type C
- Patients with comminuted fracture distal femur (Muller type A2, A3 & type C2, C3 distal femur fractures)
- Medically and surgically fit for surgery.
- Capability to give informed consent.

Exclusion criteria

- Age less than 16 years and more than 80 years –
- Compound grade II and III fractures
- Muller type A1, type B1, B2, B3 and type C1 distal femur fractures.
- Associated with Distal neurovascular deficit.
- Systemic conditions such as osteoarthritis, malignancy, immunocompromised states.

Technique

Pre-operative Planning

- Patient will undergo a pre-operative evaluation
- Clinical examination - Palpation revealed abnormal mobility and crepitus. Distal vascularity was assessed by anterior & posterior tibial artery pulsations, capillary filling, pallor and paresthesia at tip of toes.
- Baseline investigations
- Radiograph – x-ray thigh with knee AP, lateral & oblique views, CT femur with knee with 3D reconstruction.
- Primarily immobilization of the fracture done with upper tibial pin traction with bohler braun splint.
- Informed consent from the patient.
- Anesthesia – regional anesthesia

Operative procedure:

Minimal invasive approach

Lateral fixation: Minimal invasive approach for distal femur

Patient lying supine on the table with a bolster under the thigh so that the knee rests in approximately 30 degrees of flexion. Longitudinal incision is given over the lateral aspect of shaft of femur. Skin and subcutaneous tissue incised in line of skin incision. Lateral retinaculum is incised to expose joint capsule. At the proximal end of distal window, a plane is developed between vastus lateralis anteriorly and lateral intermuscular septum posteriorly. Proximally subcutaneous fat is incised in the line of skin incision and then the deep fascia in longitudinal fashion. Distally knee joint capsule and synovium divided longitudinally to expose entire distal end of femur. Patella is retracted using retractor and all aspect of joint is visualized by flexion and extension at knee joint. Proximally vastus lateralis muscle is spitted in line of its fiber to give direct access to periosteum Finally an epi-periosteal plane is developed between the two windows on lateral aspect of femur using a blunt dissector and plate is introduced.

Medial fixation

Medial fixation: Antero-medial approach

After lateral fixation, medial fixation through medial approach proceeded. An anteromedial incision from anterior margin of pes anserinus following the adductor canal, then fascial envelope surrounding the vastus medialis incised along the posterior margin of the muscle. Blunt dissection done to elevate the muscle off the periosteum and the

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intermuscular septum from adductor tubercle to intact proximal femur shaft. Distally vastus medialis tendinous insertion incised 2-3 cm wide into the medial capsule. Then the joint exposed through medial Para patellar arthrotomy now the medial plate is placed after reduction found satisfactory and fixed using screws with traverse portion placed distally. Thorough wound wash given and wound closed in layers.

Post operative protocol

- 1st check dress - 2nd Post op day
- 2nd, 3rd check dress – 5th,8th Post op day
- Suture removal – 10-12th Post op day continuous passive mobilization exercises with range of motion started at 30 degrees and then advanced on daily basis
- Non-weight-bearing using walker after 2 weeks.
- Partial weight-bearing using underarm crutches after 6 weeks
- Full weight-bearing after radiological evidence of bony union (minimum of 12 weeks postoperatively)
- Follow-up: Patients were advised to report for follow up at 4 weeks, 12weeks,24 weeks and at the end of one year. At every follow up a detailed clinical examination was done, patients were assessed subjectively for the symptoms like pain, swelling and restriction of joint movements. Patients were on physiotherapy in the form of active flexion & extension exercises without loading.

Out Come Assessment

- Clinical and functional outcome was assessed using knee society score, Knee outcome survey-ADLS (Activities of daily living scale)
- Radiological parameters were assessed on x-ray film on Anteroposterior and Lateral view, radiological signs of union (callus size, cortical bridging, progressive closure of fracture line).
- Clinical union was assessed by pain at fracture site on weight bearing (VAS SCORE), range of motion, stability, wound status, ability to bear weight.
- Complications were assessed with patient's complaints, clinical examination, and radiological examination.

RESULTS

[Table 1] concluded that, out of the 30 study subjects, 83.3% were male and only 16.7% were females.

[Figure 1] depicted that, out of the total 30 subjects, majority of the patients (66.7%) had right side of limb involved and only 33.3% had left side of limb involved (n=10).

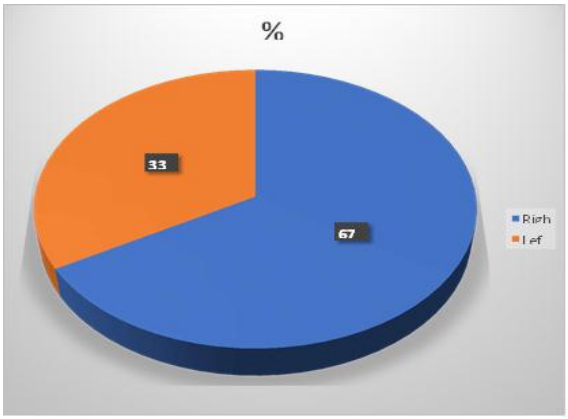

Figure 1: Distribution of study participants according to laterality of fractures

[Figure 2] stated, that 12 patients (40.0%) had 9-hole DFLCP, 7 patients (23.3%) had 7-hole DFLCP, 8 patients (26.7%) had 11-hole DFLCP, 2 patients had 8-hole DFLCP and single patient (3.3%) had 10-hole DFLCP

In [Figure 3], as per knee outcome survey 9 patients (30.0%) had excellent outcome, 7 patients (23.3%) had good outcome, 6 patients (20.0%) had fair outcome and 8 patients (26.7%) had poor outcome.

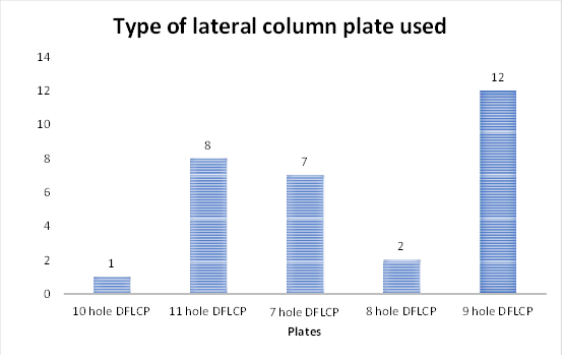

Figure 2: Distribution according to the types of lateral column plates used

Figure 3: Proportion of the Knee Outcome Survey in the study participants

Out of the 30 subjects taken in our study, 11 Patients (36.7%) had supracondylar femur fracture with intercondylar extension,7 patients had osteoporotic supracondylar femur fracture (23.3%), 6 (20.0%) patients had distal one third femur fracture with bone loss, 3 patients (10.0%) had distal one third femur fracture with medial Hoffa's fracture, 2 patients (6.7%) had peri implant distal femur fracture, and 1 patient (3.3%) had non-union

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supracondylar femur fracture with lateral column plating. [Table 2]

In our study, out of 30 patients 6 patients (20.0%) had three-hole L buttress, 3 patients (10.0%) each had five-hole L buttress and six-hole posteromedial plate each and seven-hole T plate respectively, 2 patients (6.7%) each had two-hole T plate, ten-hole LCP and eight-hole T plate, whereas 1 patient (3.3%) each had four hole posteromedial plate, four hole T buttress plate, 6 hole T buttress plate, 7 hole RAFT plate and 9 hole T plate respectively. [Table 3]

Out of 30 patients, 15 patients (50%) belonged to AO type C2, 8 patients (26.7%) had type C3, 5 (16.7%) patients had AO type A3 and 2 (6.7%) patients had AO type A2 fracture. [Table 4]

[Table 5] reported that, the mean value of VAS score at pre-op month, 3,6, and 12 months is 9.57 ± 0.50, 7.60 ± 049, 5.43 ± 0.67, 3.46 ± 0.57 and 1.53 ± 0.50 respectively. There is significant decline in VAS score mean value from pre-op 9.57 to at the end of twelve month of follow up 1.53. The Paired sample test was applied with each showing p value <0.05 and hence statistically significant (p-value<0.5).

Table 1: Sex distribution of Study subjects

Sex	N	%
Male	25	83.3
Female	5	16.7
Total	30	100

Table 2: Distribution according to the types of the Fractures

Site	N	%
Distal one third femur with bone loss	6	20
Distal one third femur with medial hoffa's fracture	3	10
Non-union Supracondyle femur with lateral column plating	1	3.3
Osteoporotic supracondylar femur	7	23.3
Peri implant distal femur	2	6.7
Supracondylar femur with intercondylar extension	11	36.7
Total	30	100

Table 3: Distribution according to types of medial column plates used

Type of medial column plate used	N	%
10-hole distal end radius T plate	2	6.7
10-hole LCP	2	6.7
3-hole L buttress	6	20.0
4 hole posteromedial	1	3.3
4-hole buttress plate	1	3.3
5-hole L buttress	3	10.0
6-hole distal end radius	2	6.7
6-hole L buttress	2	6.7
6-hole posteromedial	3	10.0
6-hole T buttress	1	3.3
7-hole distal end radius T plate	3	10.0
7-hole RAFT	1	3.3
8-hole distal end radius T plate	2	6.7
9-hole distal end radius T plate	1	3.3
Total	30	100.0

Table 4: Distribution of AO classification

Fracture type	N	%
C2	15	50.0
C3	8	26.7
A3	5	16.7
A2	2	6.7
Total	30	100.0

Table 5: Comparison of mean value of VAS score at pre-op, one, three and six months

VAS Score	Mean ± SD	t value	p value
Pre-op VAS score	9.57 ± 0.50	19.37	0.001
Post-op VAS score at one month	7.60 ± 049		
Pre-op VAS score	9.56 ± 0.50	36.00	0.001
Post-op VAS score at three months	5.43 ± 0.67		
Pre-op VAS score	9.56 ± 0.50	50.49	0.001
Post-op VAS score at six months	3.46 ± 0.57		
Pre-op VAS score	9.56 ± 0.50	73.13	0.001
Post-op VAS score at twelve months	1.533 ± 0.50		
Post-op VAS score at one month	7.60 ± 0.49	13.00	0.001
Post-op VAS score at three months	5.43 ± 0.67		
Post-op VAS score at one month	7.60 ± 0.49	39.62	0.001

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Post-op VAS score at six months	3.46 ± 0.57		
Post-op VAS score at one month	7.60 ± 0.49	51.95	0.001
Post-op VAS score at twelve months	1.53 ± 0.50		
Post-op VAS score at three months	5.43 ± 0.67	14.08	0.001
Post-op VAS score at six months	3.46 ± 0.57		
Post-op VAS score at three months	5.43 ± 0.67	39.00	0.001
Post-op VAS score at twelve months	1.53 ± 0.50		
Post-op VAS score at six months	3.46 ± 0.57	15.31	0.001
Post-op VAS score at twelve months	1.53 ± 0.50		

Table 6: Comparison of Mean values according to Knee Outcome Survey for 1st, 3rd, and 6th months.

KOS Score	Mean ± SD	t value	p value
One Month	37.00 ± 13.50	18.61	0.001
Three Month	47.3 ± 14.65		
One Month	37.00 ± 13.50	21.95	0.001
Six Month	55.5 ± 15.43		
One Month	37.00 ± 13.50	20.83	0.001
Twelve Month	64.70 ± 17.70		
Three Month	47.3 ± 14.65	15.09	0.001
Six Month	55.5 ± 15.43		
Three Month	47.3 ± 14.65	15.76	0.001
Twelve Month	64.70 ± 17.70		
Six Month	55.5 ± 15.43	11.94	0.001
Twelve Month	64.70 ± 17.70		

In our study the mean value of KOS, at the end of 1st month is 37.00 ± 13.50, at the end of 3 month is 47.3 ± 14.65 and at end of six months is 55.5 ± 15.43. For all scales paired sample test was applied with each showing p value is 0.0001 which is found out to be significant (p-value<0.5).

DISCUSSION

Treatments of distal femoral fractures is a cumbersome subject. There have been changing principles towards surgical treatment for supra condylar fractures of femur. Close management of these fractures was the treatment of choice until 1970. This was mainly due to lack of proper techniques and appropriate implants. Conservative methods at any age may be complicated by knee stiffness, malunion and nonunion. Early surgical stabilization will facilitate care of the soft tissue, reduces bedridden period and the complexity of nursing care.

In cases where fracture fragments in the medial side were severely comminuted or having massive bone defect, single lateral plate fixation may fail to stabilize fracture sites, resulting in knee varus deformity, breaking of plates and screws and nonunion. One such case was included in this study where the patient undergone single lateral fixation for comminuted distal femoral fracture resulted in union after two months of surgery. redo surgery with medial column plating was done for that patient. At the end of one-year follow-up, patient had bony union with more than 90 degrees of knee flexion. In cases involving single lateral plating, the rates of varus collapse and non-union were high but in our study the addition of medial plating has not yielded any case of varus deformity or malunion.[6]

In our study age group ranged from 16 years to 80 years with mean age of 43 +_ 15.18 years. Stover et al. reported that almost 60% of distal femoral fractures occur in the age group >50.[7] The osteoporosis within this group may pose problems for fixation. Court-Brown et al,[2] reported fractures of the distal femur as a classic fragility fracture, with the mean age of patients reported as 67.3 years and the vast majority of fractures (83%) occurring in women. It is likely that the demographic shift towards an aging population will result in an increasing incidence of distal femur fractures in the future.

In our study most common fracture presentation belonged to AO classification type C2. Khan et al,[8] found that fracture patterns A1, B1 and B2 were the most common. Smith et al,[5] determined A1 and C1 to be the most common in their study of 105 distal femoral fractures across four trauma centers. Pietu et al,[3] reported that AO type C fractures accounted for 37.2% which was the 2nd most common type of fracture reported in their study.

In our study most common type of fracture was comminuted supracondylar femur fracture with intercondylar extension. Similarly, Nork et al,[9] examined 202 patients with fractures of the distal femur with intercondylar involvement and showed that 38% of fractures are including the condyles by coronal fracture extension.

In our study total 30 patients were assessed for six months and average healing period was found out to be 21.13 +_ 2.27 weeks (5 months). Khalil et al,[10] treated twelve patients who were polytraumatized adult patients with closed comminuted distal femur fractures using a lateral distal femur locked plate and a medial contoured plate through a modified Olerud extensile approach. Mean radiological healing time was 18.3 weeks (range 12–28 weeks), and four cases (33.3 %) had union delayed for more than 24 weeks.

In 2018 Imam et al. did a prospective study on 16 patients with distal femoral fractures of Muller type C3. These patients were treated using dual plating

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and analyzed the outcomes including clinical and radiological outcomes and postoperative complications. Their results shown 68.75% of the studied patients had good-excellent functional outcome with 68.75% of patients having range of motion (90degree – 120 degree) during follow-up. The mean time of radiological union in their study was 6.0 +3.5 months with a range of 3-14 months. There is no postoperative varus or valgus deformity in their study.[11] Our study also had a similar result with union rate of 100% and average healing time between 18-24 weeks both clinically and radiologically and a mean healing time of 21.3 weeks (5 months) with no cases of varus deformity or malunion. 56% of patients had good-excellent functional outcome in our study with 70% of patients having range of motion more than 90 degree.

Major contributing factors responsible for poor outcomes are

1. Improper fixation may be due to complexity of fracture comminution
2. Elderly patient with less motivation to begin exercise and low osteogenic potential.
3. Delay in surgery causing increase in interval between injury and surgery
4. Open fractures.

Limitations

- Our Study comprises of relatively small number of patients and not a strict random controlled trial design.
- Repair of injured ligaments of knee joint not done during acute phase along with fracture fixation in our study.
- Stainless steel plates are used in both medial and lateral sides due to economical constraints which limits the use of MRI for the evaluation of ligament injuries of the joint during follow-up.

CONCLUSION

Due to aging society, & enormous increase of high-speed motor vehicle accidents, the number of distal femur comminuted fractures can be expected to increase in the coming decades. In this study, thirty cases of distal femur fractures who were treated with open reduction and internal fixation with dual plating were followed up and functional outcomes were analyzed and discussed. From this sample study, we conclude that dual plating provides successful results for the treatment of both extra articular and intra articular unstable fractures of distal femur. This method, which is effective in anatomic realignment, allows early joint motion, owing to its fixation strength. Minimal invasive osteosynthesis approach provides both access with minimal surgical trauma on distal femur and fixation with a better adaptation to surrounding tissues.

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