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Dr. HS Chandrashekar
Professor and Director,
Department of Orthopedics,
Sanjay Gandhi Institute of
Trauma and Orthopedics,
Bangalore, Karnataka, India

Dr. Chidanand KJC
Assistant Professor, Department
of Orthopedics, Sanjay Gandhi
Institute of Trauma and
Orthopedics, Bangalore,
Karnataka, India

Dr. Anil Kumar SN
Post Graduate, Department of
Orthopedics, Sanjay Gandhi
Institute of Trauma and
Orthopedics, Bangalore,
Karnataka, India

Dr. Rajendra K
Post Graduate, Department of
Orthopedics, Sanjay Gandhi
Institute of Trauma and
Orthopedics, Bangalore,
Karnataka, India

Corresponding Author:
Dr. Anil Kumar SN
Post Graduate, Department of
Orthopedics, Sanjay Gandhi
Institute of Trauma and
Orthopedics, Bangalore,
Karnataka, India

A prospective study of functional outcome of comminuted metaphyseal distal femur fracture treated with lateral locking compression plate and medial augmentation with TENS

Dr. HS Chandrashekar, Dr. Chidanand KJC, Dr. Anil Kumar SN and Dr. Rajendra K

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Abstract

Background: Distal femur fractures are complex injuries producing long term disability and present considerable challenges in management. These fractures poses challenges to the treating surgeon because of thin cortex of the femoral condyles, wide medullary canal, relative osteopenia, short condylar fragment and comminution involving articular surface. Distal femur fracture disrupts normal knee joint functioning, hence needed anatomical reduction and stable internal fixation to prevent crippling disabilities and hardware failure.

Objective: To evaluate the functional and radiological outcome of comminuted metaphyseal fracture of distal femur treated by Lateral locking compression plate and medial TENS nail using NEER'S score.

Methods: In this study, 20 cases of comminuted metaphyseal fracture of distal femur were operated between November 2018 to April 2020 with distal femur lateral locking compression plate and medial augmentation with tens nail. Patients were selected based on inclusion and exclusion criteria and were followed up for 12 months. The results were analysed with NEER'S score.

Results: Out of 20 patients with comminuted metaphyseal distal femur fractures AO-Muller type A3 - subtypes 15 and C2 subtypes 5 patients were studied. Mean age of the patients was 45.5 years with age ranging from 20 years to 80 years. Right sided fractures were predominant. In 65% cases mode of injury was road traffic accident and rest were self-fall. 2 cases were operated under MIPPO technique and rest all were operated on with standard open lateral approach. Average surgical procedure timing was 119.5 minutes in our study. Average duration of radiological union was 18.6 weeks and average duration of weight bearing was 20.5 weeks. Complications such as superficial wound infection, knee pain and stiffness were observed in 9 patients. The NEER'S score was excellent in 45%, good-fair in 50% and 5% poor outcome.

Conclusion: Comminuted distal femur fracture needs dual column fixation to achieve bone healing and restore function of the affected limb in shortest time without compromising stability. The advantage medial augmentation with TENS is active range of motion can be started earlier, stable internal fixation that does not allow varus collapse, mal-union and further implant failure.

Keywords: Comminuted metaphyseal, LCP, TENS nail, Neers score, varus collapse

Introduction

In the last few decades, rapid industrialization and the fast pace of life have brought both comforts and catastrophe like road traffic accidents and crippling many young lives. Distal femur fractures are complex injuries producing long term disability and present considerable challenges in management. It constitutes 4 to 7% of all femur fractures. Distal femoral fractures occur predominantly in two patient population -young persons, especially men, after high energy trauma and elderly persons especially women after low energy injuries.¹ These fractures poses challenges to the treating surgeon because of thin cortex of the femoral condyles, wide medullary canal, relative osteopenia, short condylar fragment and comminution involving articular surface.

Most supracondylar fractures were treated non-operatively till 1970; however, loss of knee motion, angulatory deformities, knee joint incongruity, as well as the complications of

recumbency led to better methods of treatment [2, 3].

Anatomic reductions of the articular surface, restoration of limb alignment, and early mobilization have been shown to be effective ways of managing most distal femoral fractures. The majority of distal femoral fractures require surgical stabilization as the results of conservative treatment are frequently unsatisfactory [4].

Supracondylar femur fractures were historically treated with condylar buttress plates [5]. Fixed-angle implants, angle-blade plates, intramedullary retrograde nails and dynamic supracondylar screws were found to have a superior biomechanical design for decreasing varus collapse events compared to condylar buttress plates [6, 7]. Locking plate evolved along the line of Dynamic Compression Plate (DCP). Locking plates have increased biomechanical resistance with the possibility of greater numbers of fixation screws in the distal femur metaphysis. Regular Distal Femur-Locking Compression Plate is unable to hold on to every fragment because of its prefixed screw trajectory. Variable Angle-Locking Compression Plate (VA-LCP) has overcome this angular deficit of prefixed trajectory of screws [8]. Fracture type, muscle forces acting on the distal part of the femur, the weight of the lower extremity and natural gravity of the entire limb may increase lever arm and affect fracture stabilization and warrant load neutralization. Numerous bio-mechanical studies have been performed in the past and many others are currently ongoing with the aim of achieving an optimal stable construct [9].

Complications of distal femur fracture are mal-union, non-union, implant failure, varus angulation, limb length discrepancy, infections and secondary osteoarthritis.

As for comminuted metaphyseal fractures of distal femur an important factor for instability of fixation mechanics is medial cortical defect varus or collapse, which leads to early failure of internal fixation. Single LCP often lacks adequate support for medial cortical defects so the vertical load may cause a bending tendency and instable fixation, delayed healing, or nonunion. An option to improve medial stability is by medial augmentation [10, 11].

1. The purpose of this study is to evaluate outcome in the treatment of distal femur fracture with lateral LCP and medial augmentation with TENS nail.

Materials and Methods

The study was conducted in the Department of Orthopaedics, Sanjay Gandhi Institute of Trauma and Orthopaedics, Bangalore. This study consisted of 20 patients visiting outpatient department, emergency department of the hospital. Patients diagnosed with distal femur fractures (AO Muller subtype-A3, C2) were included in the study who were operated during the period from November 2018-April 2020. The follow up duration range varied from 6 months to 12 months.

Method of collection of data

Study design: Prospective study.

Sample size: It was a hospital based study with sample size of 20 (calculated based on previous studies) who were fulfilling the inclusion criteria.

Inclusion criteria

1. Patients with age group >18
2. Patients willing to participate in the clinical investigation.
3. Patient who are medically fit for surgery and willing for surgery.

4. Closed distal femur fractures

Exclusion criteria

1. Patients <18 yrs. of age.
2. Open fractures
3. Pathological fracture
4. Polio affected limb
5. Associated fracture in the same limb

Patients admitted with distal femur fracture after meeting inclusion and exclusion criteria were selected for the study. Prior informed consent, pre-operative anesthetic evaluation was done. P re-op planning of fixation was done and proceeded with surgery.

Surgical procedure

After the patient is anaesthetised, the patient is placed in supine position over a radiolucent table. A sand bag is placed under the ipsilateral hip and a pillow is placed under the knee joint. The limb is painted and draped up to the level of iliac crest. The fracture is approached by a longitudinal incision over the lateral aspect of distal thigh centred over the lateral epicondyle extending distally up to the level of Gerdy's tubercle distally and proximal extension as required. Fascia lata is incised longitudinally along the skin incision up to iliotibial band. The incision extends distally through lateral joint capsule and meniscal injury is avoided.

Vastus lateralis is reflected off the intermuscular septum along the linea aspera in the anterior direction. Perforating vessels transversing the muscular plane are ligated. Care is taken to avoid unnecessary stripping of soft tissue at the fracture site. Once the fracture site is exposed, haematoma is drained. The fracture fragments freshened and cleaned.

In case of fracture extending to articular area the first step is reduction of femoral condyles with maintenance of articular congruity. The medial and lateral femoral condyles are reduced and held together with the help of patella clamp. The condyles are secured through k wires and once reduced; the next step after reduction of femoral condyles is the alignment of condyles with the femoral shaft. In case of difficult reduction of condyle with shaft, reduction is aided with femoral distractor or knee flexion with pillow under the knee joint. Once the fracture site is reduced fracture ends are held with bone clamps and secured with temporary k-wires. K-wires are placed in such way that they are not in the way of plate. Distal femoral LCP is applied along the lateral aspect of the distal femur and the plate is reduced to the bone with cortical screw. Partial number of screws are applied proximally and distal as planned (two screws distally and only one screw proximally).

By using C-arm guidance, a two cm incision made over medial aspect of distal femur centered over medial epicondyle. Entry portal was made with the help of curved Awl about 2cm from the articular surface. Initially entry of bone awl is perpendicular to bone and then advance at an angle of 45 degree to femur. An appropriate size TENS nail was pre-curved and then fixed from medial side into the medullary canal of the femur up to lesser trochanter. The final position was then checked under C-arm guidance and remaining screws were put to fix the lateral plate. The wound was then closed in layers, drain and antiseptic dressing was applied.

Post-operative wound care and physiotherapy was done according to hospital protocol. Mobilization with Non weight bearing was started from the first post-operative week till 6-8

weeks depending on the fracture pattern and then partial weight bearing after confirmation of beginning of healing process till fracture union. Further, full weight bearing was allowed depending on the progress of fracture healing pattern clinically and radiologically.

Patients followed up at every 4 weeks up to 3 months post-operatively and then on monthly until 6 months and on 9th month and 1 year. Based on data final outcome was assessed according to NEERS scoring system.



Fig 1: Skin incisions (Lateral and medial)

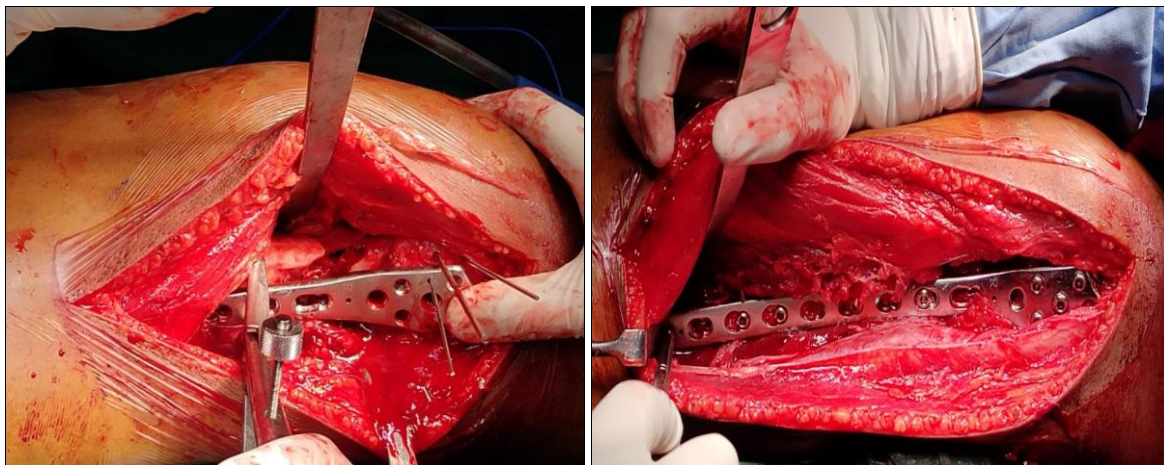


Fig 2: Fracture reduction and plate fixation



Fig 3: Intra op images after tensiometer insertion

Observation and Results

Results were analysed in terms of functional outcome of postoperative knee range of movement after union, time for fracture union, early and late post-operative complications. The Excel and SPSS (SPSS Inc., Chicago v 18.5) software

packages were used for data entry and analysis respectively. The results were averaged (mean + standard deviation) for each parameter for continuous data and numbers and percentage for categorical data presented in Table and Figure.

Table 1: Distribution of age of patients

Age	Frequency	Percent
20-29 yrs.	5	25.0
30-39 yrs.	2	10.0
40-49 yrs.	4	20.0
50-59 yrs.	4	20.0
>=60 yrs.	5	25.0
Total	20	100.0

Patients in the age group of 20-80 years were considered for the study with average age of 45.5 years. Males were the majority patients in the study group with 70% of total cases. Right sided fractures were more common than left side. Most common mode of injury in the study group was road traffic accident 65% followed by self-fall 35%.

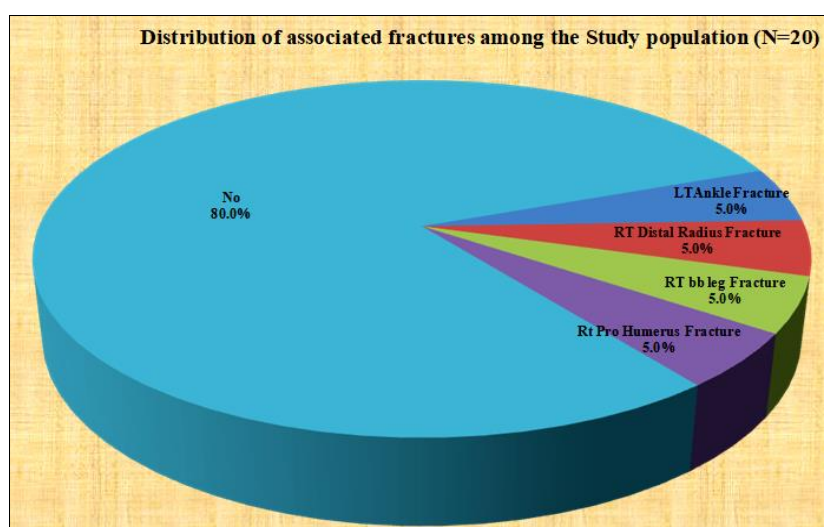
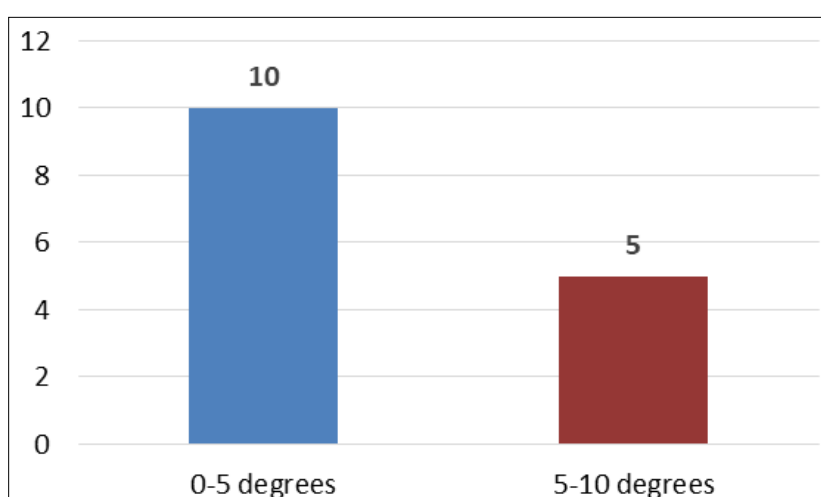
Table 2: Distribution of Muller classification subtypes fractures in the study group

Classification	Frequency	Percent
A3	15	75
C2	5	25
Total	20	100

Majority of patients in the study group were the Muller subtype A3 with 75% and rest were C2

Table 3: Distribution of associated fracture in the study

Other Injuries	Frequency	Percent
Ankle Fracture	1	5
Both bone leg Fracture	1	5
Distal Radius Fracture	1	5
Proximal Humerus Fracture	1	5
No associated fractures	16	80
Total	20	100

**Fig 4:** Graph of distribution of associated fractures**Fig 5:** Distribution of extensor lag in study group in percentage

2 patients in the study group had an extensor lag of 5 degrees while one patient had an extensor lag of 10 degrees. 75% of the population in the study group had a knee flexion of between 95-120 degrees, 20% had flexion >120 degree and only 5% of the patient had knee flexion less than 90 degree. Mean time of duration of surgery in minutes was 119.5 mins in the study population.

Table 4: Distribution of time period in weeks for complete radiologic union in patients studied

Time in weeks	Number of patients	Percent
14-16 Wks.	7	35
17-19 Wks.	6	30
>=20 Wks.	7	35
Total	20	100

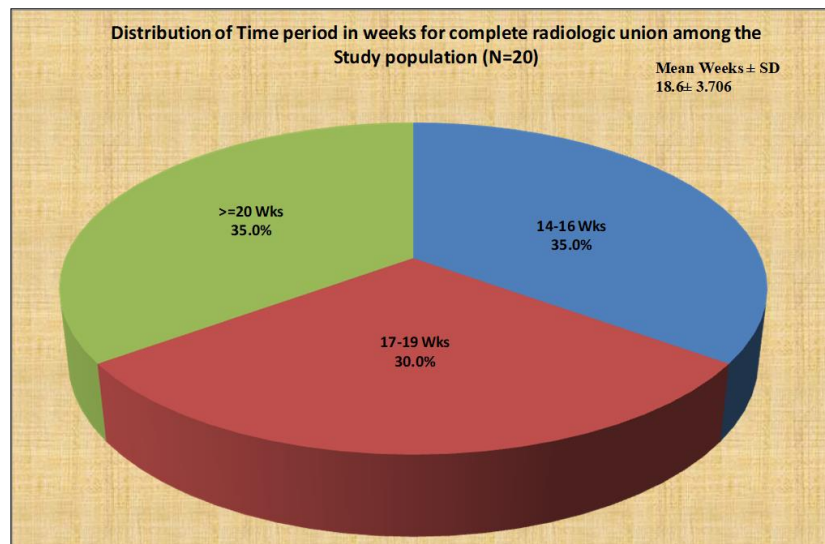


Fig 6: Distribution of time period in weeks for complete radiologic union in patients studied in percentage

Average time period for radiological union was 18.6 weeks in the study population.

Table 5: Distribution of time for full weight bearing in weeks

Time in weeks	Frequency	Percent
16-20	12	60
21-25	5	25
>25	3	15
Total	20	100

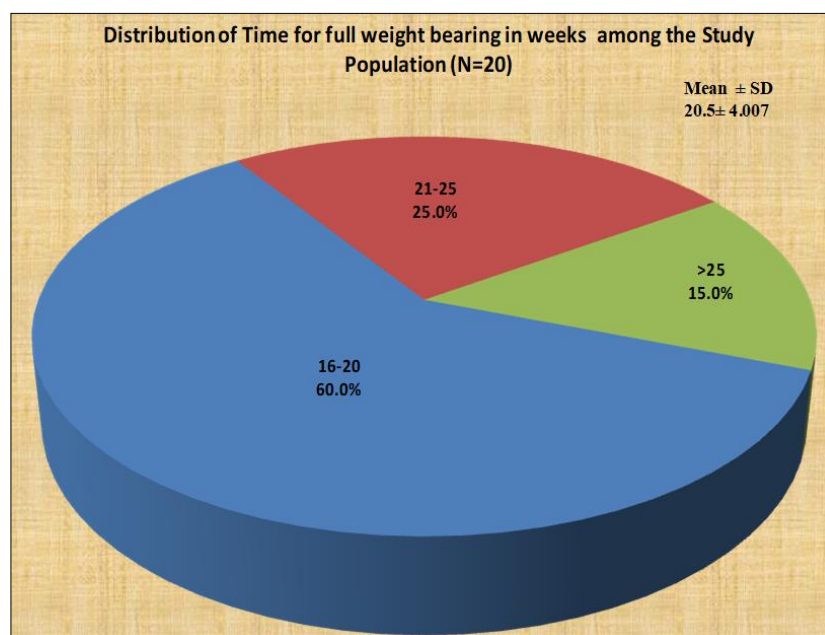


Fig 7: Distribution of time for full weight bearing in weeks expressed in percentage

Average time for full weight bearing in the study population was 20.5 weeks.

Table 6: Distribution of Neer's score in the study population

Result	Frequency	Percent
Excellent	9	45
Good	8	40
Fair	2	10
Poor	1	5
Total	20	100

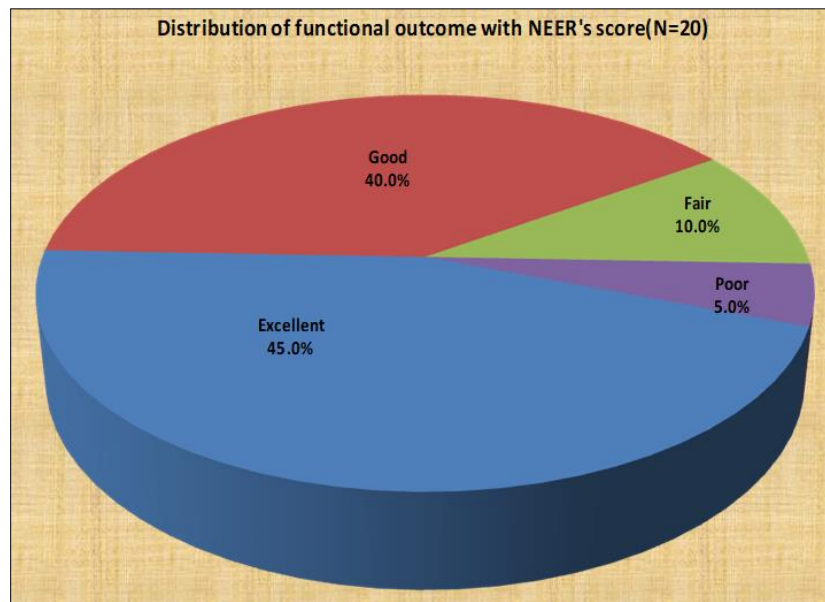


Fig 8: Distribution of Neer's score in the study population in percentage

In our study 45% of the patients had excellent Neer's score, 40% had good, 10% had fair and 5% had poor Neer's score.

Table 7: Distribution of complications in the study population

Complication details	Frequency	Percent
Knee Pain	3	15
Infection	3	15
Stiffness	1	5
Stiffness + Knee Pain	1	5
Stiffness + Shortening	1	5
No Complication	11	55
Total	20	100

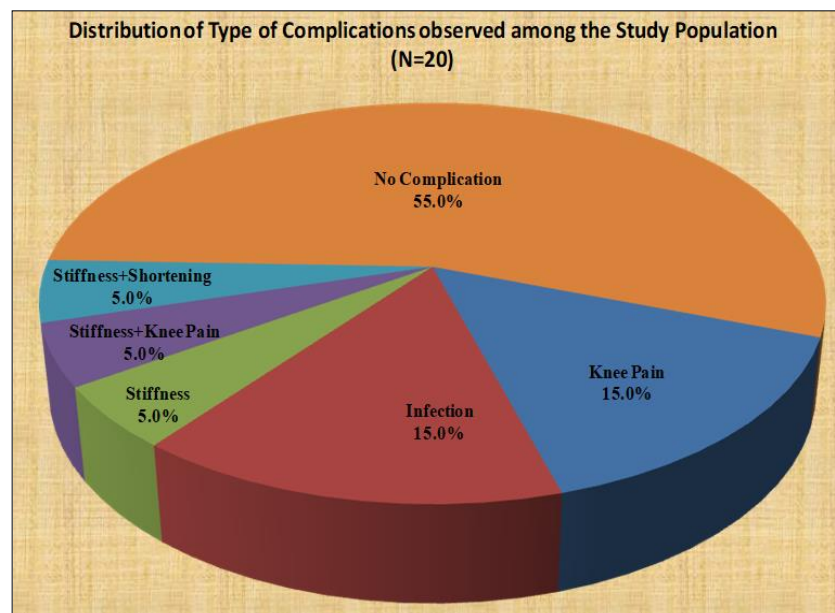


Fig 9: Distribution of complications in the study population in percentage

In our study 3 patients had knee pain (medial aspect of knee over the tens cut ends), 3 had infection at TENS insertion

site, 2 cases of stiffness, and 1 case of shortening and stiffness of knee.

Table 8: Comparison of mean Neer's score between different intervals in study group

Neer's score	N	Mean	SD	Median	Min.	Max.
3 Months	20	69.3	6.775	70	50	78
6 Months	20	76.2	8.377	78.5	52	87
9 Months	20	82.4	9.023	84.5	54	92

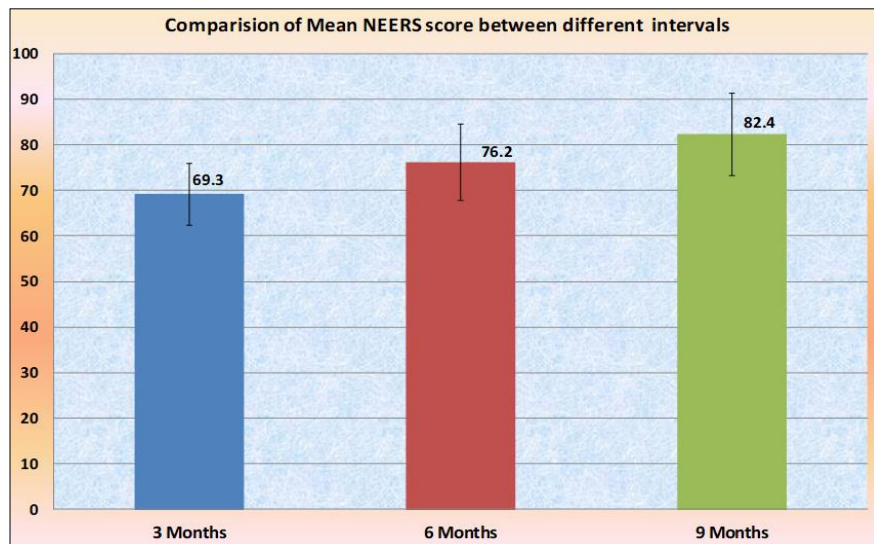


Fig 10: Comparison of mean Neer's score between different intervals

Mean Neer's score improved with time from 69.3 at 3 months to 82.4 at end of 9 months.

Case-1





Clinical pictures at end of 6 months

Discussion

Out of 20 cases there were 14 males and 6 females. Mean age of the patients was 45.5 years with age ranging from 20 years to 80 years. In our study the mean age of the patients was 45.5 years which was comparable to previous studies done by Lucas *et al.* ^[12] (mean age of 39 years), Yeap *et al.* ^[13] (mean age of 44 years). Right distal femur was involved in 15 cases and left distal femur in 5 cases. The study included only closed femur fractures.

The mode of injury was RTA in 13 cases and 7 cases had history of self-fall. In our study most common mode of injury was RTA (65%) followed by self-fall (35%). This result was comparable with results of study done by Lucas *et al.* ^[12] (RTA-79%) and Christian *et al.* ^[14] (RTA-69%).

Out of 20 cases 4 cases had associated (not in ipsilateral limb) injuries. In patients with associated injuries early rehabilitation were delayed but results were comparable with other cases of the study.

In our study we studied only the comminuted metaphyseal distal femur fractures Muller type A3-subtypes 15 and C2 subtypes 5 patients. 2 cases were operated under MIPPO technique and rest all were operated on with standard open lateral approach. All patients were approached medial side with mini incision of 2 cm for medial TENS insertion. Average surgical procedure timing was 119.5 minutes in our study. Our study when compared similar study with Manish singh *et al.* ^[15] (92 minutes) and when compared with dual plating studies such as Radwan *et al.* ^[16] (148 minutes),

Zhibiao Bai *et al.* ^[17] (180 minutes) and Mohammed A imam *et al.* ^[18] (213 minutes) our had less operative time.

Most of our patients had excellent postoperative knee flexion with average knee flexion of 110.2 degrees. 2 cases had an extensor lag of 5 degree while 1 patient had an extensor lag of 10 degrees. Our study when compared with Mohammed A imam *et al.* ^[18] (114.6 degree), weight *et al.* (114 degree) had acceptable knee flexion.

Average duration of radiological union in our study was 18.6 weeks which was comparable with Yeap *et al.* (18 weeks), Manish Singh *et al.* (14.2 weeks), Zhibiao Bai *et al.* (18 weeks) and Mohammed A imam *et al.* (24 weeks) studies. Average duration of full weight bearing in our study was 20.5 weeks. Based on radiological union of the fractures the medial TENS nail was removed 6months.

11 cases in the study had fracture union without any complications. 3 patient had knee pain more over the medial aspect of knee at TENS insertion site due chronic irritation, Infections were reported in 3 cases which was at tens insertion site which were treated with culture specific antibiotic and tens were removed at 6month.

1 patient reported with knee stiffness which was put on rehabilitation continuous passive motion, 1 reported with knee stiffness + knee pain, 1 patient presented with shortening and stiffness, for which knee manipulation was done and shortening was compensated with shoe rise and Functional outcome was poor in this patient.

The functional outcome evaluated by Neer's scoring system

was excellent in 45% of patients, good in 40% of cases, We had 85% good to excellent outcome as per Neer's Score in our study, comparable to Ketterel *et al.* (90%) and Hann *et al.* (86%). We had fair results in 10% and one patient had poor result. The patient with poor result had lost follow up and presented late with stiffness and shortening.

Conclusion

The high energy trauma in young individuals and low energy osteoporotic fracture in elderly patients is challenging task to treating surgeons, nature of fracture and complexity of fracture makes single column fixation unsatisfactory. So comminuted distal femur fracture needs dual column fixation to achieve bone healing and restore function of the affected limb in shortest time without compromising stability.

Dual plating results in extensive soft tissue stripping on both sides of femur resulting in reduced blood supply, delayed union, on-union and failure of implant. So medial column was fixed with least possible damage to periosteum with TENS nail. Medial augmentation with TENS has considerable reduced the operating time and complications.

The advantage of lateral LCP and medial augmentation with TENS is active range of motion can be started earlier, stable internal fixation that does not allow varus collapse, mal-union and further implant failure. Maintenance of articular congruity is better.

The end functional results depends on age of patient, nature of bone, complexity of fracture and optimum post-operative rehabilitation

Though out of purview of our present study with lateral LCP and medial augmentation with TENS have been significantly better

The long term results using medial TENS nail needs further study for a longer period in a larger sample.

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