Original Article ISSN (O):2395-2822; ISSN (P):2395-2814

A Comparative Study of Supracondylar Nail Versus Locking Compression Plate in Distal Femur Fractures.

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Received: May 2017
Accepted: May 2017

ABSTRACT

Background: There are different mechanisms of injury and different types of fractures for femur. Surgical procedures also differ based on the complexity and site of the fracture. In the present study, we have compared two different surgical techniques for fracture of distal femur and analysed the results for various parameters. **Methods:** This was a prospective study carried out in the department of Orthopaedics, Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar, over a period of two years. Fifty seven patients with distal femur fractures were studied. Retrograde nailing and Locking compression plate procedure was done in 28 and 29 cases respectively. Functional outcome was done with NEER Score. The intention was to provide good functional outcome with perfect anatomical restoration of articular surface, stable fixation and early mobilization. **Results:** In the study there were 31 (54.38 %) males and 26 (45.61 %) females and the mean age was 51 years. The average time of surgery in Nailing and Plating was 104.8 and 117.5 minutes respectively. The average time of union in Nailing and Plating group was 13.4 and 15.6 weeks respectively. The average range of knee flexion in Nailing and Plating group was 0-112 and 0 -107 degrees respectively. Implant failure was almost equal in both groups. There was no neurovascular damage in any of the cases. Functional outcome was done with NEER Score and the difference in functional outcome in both the groups was statistically insignificant. **Conclusion:** Both retrograde IM nailing and LCP plating may be adequate treatment options for distal femur fractures.

Keywords: Fracture distal femur, Nailing, Plating, Complications, NEER'S score.

INTRODUCTION

The incidence of distal femur fractures is around 37/100,000 patients per year.[1] Mainly two different mechanisms of injury cause fractures of distal femur. In the older population who are already osteoporotic distal femoral fractures occur predominately after low-energy trauma like falls and sprain injuries and have complications associated with comorbidities.[2] In young patients high-energy trauma causes complex injury with comminuted and open fracture pattern. Many patients also suffer polytrauma, soft tissue injury, ligament or meniscal tears, dissected cartilage fragments and patellar fractures. In this prospective study, we evaluated and compared clinical and radiological outcomes of distal femur fracture stabilization using Retrograde Nailing (RN) and Locking compression plate (LCP) techniques.

Our aim of the study is to evaluate and compare the results and outcome of retrograde nail and locking compression plate in distal femur fractures, and to study the functional outcome in both procedures with the help of NEER'S score.

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MATERIALS AND METHODS

This was a prospective study carried out in the department of Orthopaedics, Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar, over a period of two years from November 2014 to November 2016.

Fifty seven patients with fracture distal femur, indicated for surgical management were studied.

Inclusion criteria

1. All cases of fractures of distal femur medically fit for surgery
2. Age 15 to 85 years
3. Patients with compound injuries
4. Fractures with or without intercondylar extension

Exclusion criteria

1. Patients treated with other than locking compression plate and retrograde nail
2. Fracture involving patellar fractures,neurovascular injuries
3. Pathological fractures

Informed consent was taken from all the subjects or gaurdians. A thorough history and clinical examination was done including the status of vascular or neurological injury.

The distal femur fractures were temporarily immobilized by using plaster of Paris slab or by using upper tibial skeletal traction in elevation with Bohler Braun splint.

Intraarticular anterior approach for retrograde nailing. Lateral approach for locking compression plating. All the surgeries were conducted in the same centre by orthopaedic surgeons who were trained in both the procedures. The patients were followed up until union was achieved or was categorized as delayed union (>20 weeks). Each case was reviewed clinically and radiologically during the follow up period every month. If there was no clinical or radiological union by the end of 20 weeks it was categorized as delayed union. We used Neer's score to functionally assess the patient. This was done after the fracture had united clinically and radiologically or at the end of 36 weeks whichever was earlier.

Haemogram, blood glucose, blood urea, serum creatinine, liver function tests, blood group and Rh typing, bleeding time and clotting time, Chest X-ray, electrocardiography, X-rays and computed tomography scans of the fracture site were done. Doppler study and angiography were done wherever required.

Fractures were classified with the help of radiographs according to the AO-ASIF classification. Preoperative calculation was done on radiographs to ascertain the length of supracondylar nail, maximum possible diameter and lengths of interlocking bolts after subtraction of the magnification factor.

Retrograde Nailing Procedure

The implant used was supracondylar nail system with instrumentation set. The nails are available with outer diameter of 9, 10, 11 and 12 mm and lengths of 150,200, 250,300 mm. The distal end is expanded to outer diameter of 13 mm. There is 5 degree anterior bend and an anterior bow for anatomic fit. All sized nails have five interlocking holes in entire length, two proximal and three distal holes, which accept interlocking screws of 4.9 mm and 6.5 mm thread diameter respectively. The interlocking holes are directed laterally to medially. The interlocking screws have self-tapping tip trocar tip and are fully threaded. The nails are manufactured from 316 L stainless steel alloy with gun drilling.

Figure 1: Supracondylar nail system with instrumentation set

Operative Procedure

Intravenous antibiotic (cefazolin) was given on the table just before starting surgery. After induction of patient with regional or general anesthesia a bolster was kept underneath the knee so that knee was in 50 to 60 degree flexion. Cotton padding was used to prevent neurovascular injury.

All aseptic precautions were adhered to. After painting and draping a midline incision of 4 cm was taken from inferior pole of patella up to tibial tuberosity. The Parthenon over patellar tendon was sharply incised and patellar tendon was split in the midline along the direction of its fibres.

A straight bone awl was inserted into the joint through the split tendon and positioned against the inter-condylar notch. The femoral attachment of Posterior Cruciate Ligament was palpated and the bone awl was kept just anterior to the Posterior Cruciate Ligament attachment. The position of bone awl was checked under image intensifier in antero-posterior and lateral position. An entry point was made above the blumescant line in lateral view under c-arm. The bone awl was then removed and guide wire passed through the entry point. The fracture was reduced under image intensifier control and guide wire passed in proximal fragment. The distal fragment was then reamed with cannulated reamer. The predetermined nail of adequate diameter and length was then loaded over the jig with the help of conical bolt. The nail was then inserted over the guide wire through the entry point made previously through distal and then proximal fragment. Its position was confirmed on image intensifier and then depending on the length of the nail, the proximal holes were locked with the help of corresponding markings on the jig. After taking stab incision over the corresponding lateral skin, the soft tissues were separated by blunt dissection with the help of hemostat and drill sleeve and drill guide for 4.5 mm drill bit were inserted through the fenestrations provided over the jig, through the stab incision flush with the lateral cortex. The lateral and medial cortex was drilled with 4.5 mm drill bit. The required length of locking bolt was measured with the help of depth gauge and self-tapping interlocking bolt of 4.9 mm

thread diameter passed from lateral to medial cortex engaging the locking hole in the nail. Either single or both holes were locked proximally and distally. The jig was then disengaged, the joint was washed thoroughly to remove the debris, hemostasis was achieved and incision was closed in layers. Particular attention was paid to repair paratenon of patellar tendon.

Post operatively Limb elevation, injectable analgesics and antibiotics for 5 days and oral antibiotics for another 5 days were given. Static quadriceps exercise on 1st post-operative day and active bedside knee mobilization was started from second postoperative day. Suture removal was done on 11th postoperative day. .Before discharge, patients were given crutch training and were made ambulatory on bilateral axillary crutches/walking frames without weight bearing.

Toe touch walking was allowed by the 6th week. Further, weight bearing was allowed depending on the clinical and radiological picture.

At each follow-up patient was assessed regarding clinico-radiological union in the form of pain, thickening, warmth at fracture site, radiographic alignment, evidence of callus, range of motion, extensor lag and shortening.

Clinically, fracture was considered to be united when there was no pain on palpation and no discomfort on weight bearing.

Locking Compression Plating

The plate and screws are manufactured from 316L stainless alloy with gundrilling technique

The locking compression plates are available from 4 holed to 14 holed, with 4.5 mm thickness plate for lower end of femur.

Anatomically precontoured plate head with soft edges.

Locking screws in the head of the plate for a secure support.

The head of the locking screw is threaded which gets locked to the plate as it is tightened.

LCP combi-holes in the plate shaft – Intraoperative choice between angular stability and/ or compression.

Surgical procedure:

Under appropriate anaesthesia, we used the standard lateral approach to distal femur, with patient in supine position and a sand bag was kept below the operating knee and one below the ipsilateral hip. Skin and subcutaneous tissue were cut, superior geniculate artery was identified and ligated. Care was taken not to incise the lateral meniscus at the lateral joint margin. The vastus lateralis muscle was carefully elevated from intermuscular septum and retracted anteriorly and medially.

Operative steps

The articular fragments were temporarily secured with pointed reduction forceps and/or K wires. If a posterior Hoffa fragment was present, it was reduced and provisionally stabilized with K wire inserted from anterior to posterior. The condyles were secured with 6.5 mmcancellous screws. A condylar plate guide was held laterally on the condyle to select an area, where screws would not interfere with plate placement.

A K wire was placed across the femoral condyle, at the level of the knee, to indicate the joint axis and a second K wire was placed across the patello-femoral joint on the trochlear surface.

Using anatomic landmarks and C – arm imaging, the plate was mounted on the intact / reconstructed condyle without attempting to reduce the proximal portion of the fracture. The wire guides were threaded into the plate prior to placing the plate on the bone. The guide wire inserted in through the central hole should be parallel to both distal femoral joint axis and patello femoral joint. Screws were inserted starting from central hole in the condylar portion and checked under image control. The plate shaft may be fixed with appropriate cortical screws after confirming final reduction of the fractures.

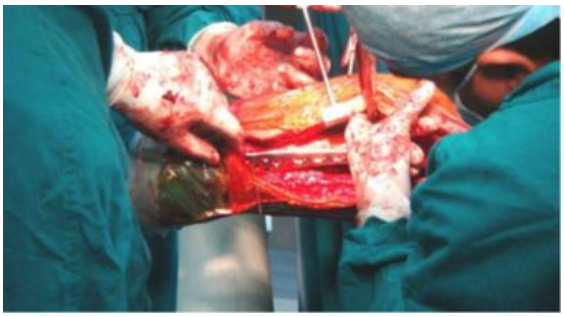

Figure 2: Plate fixed to femur.

Quadriceps strengthening and hamstring stretching exercises were encouraged.Gentle hip and ankle mobilization exercises were continued. Non – weight bearing with crutches or walker support was initiated in 1st week if fixation was stable. Sutures were removed between 10th - 12th postoperative days. Continued isometric quadriceps exercises, active and passive range motion exercises, seated knee extension procedures were encouraged. Partial weight bearing was allowed after 3rd week. Full weight bearing was allowed after radiological evidence of healing. (6- 12 weeks). Patients with inter condylar fractures (AO types B and C fractures) were not allowed full weight bearing for at least 12 weeks.

Periodic monitoring of knee flexion at end of 1st, 2nd, 3rd, week and after completion of therapy, with concomitant isometric quadriceps exercises and knee mobilization exercises was done.

Neer's score takes into account functional (70 points) and anatomical aspects (20 points). The functional scoring includes pain scoring, walking capacity and degree of possible flexion. The

anatomical scoring includes assessment of gross anatomy and roentgenograms.
The scoring is Excellent (> 85 points), Good (70 to 84 points), Fair (55 to 69 points) and Poor (< 55 points).

RESULTS

In the present study, there were 31 (54.38 %) males and 26 (45.61 %) females. Right femur was involved in 30 (52.63 %) cases and left femur in 27 (47.36 %) cases.

Table 1: Age Distribution of Patients.

Age In Years	Number of Patients	Percentage (%)
< 30	6	10.52
31-40	8	14.03
41-50	12	21.05
51-60	17	29.82
61-70	5	8.77
71-80	7	12.28
80-90	3	5.26

51-60 yrs age group is most common group effected. In this study most of the patients belonged to middle age –old age group. Average age 51.05 years.

Table 2: Type of Fracture and Operative Time.

Type Of Fracture	Operative Time In Minutes						Average Operative Time	
	</= 90		90-120		>120			
	Nailing	Plating	Nailing	Plating	Nailing	Plating		
A 1	2	-	8	-	0	-	101	-
A2	2	0	9	1	3	0	105	115
A 3	1	1	1	1	2	1	111	124
B 2	-	1	-	1	-	0	-	125
C 1	-	0	-	3	-	2	-	122
C 2	-	1	-	4	-	2	-	116
C 3	-	1	-	9	-	1	-	113
Total	5	4	18	19	5	6	104.8	117.5

Out of 57 patients under study for distal femur fractures 29 were treated with locking compression plate 28 were treated with retrograde nail. Plating was done in 29 (50.87 %) cases and nailing in 28 cases (49.12 %).Slip and fall was seen in 26 (45.61 %), RTA in 29 (50.87 %), and implant failure in 2 (3.50 %) cases.

Table 3: Healing Time in Nailing and Plating Procedures

Time In Weeks	Nailing		Plating	
	No. Of Cases	Percentage	No. Of Cases	Percentage
10-14	22	81.48	14	56
15-19	6	18.51	11	44
20 Or More	0	0.00	0	0.00
Total	28	100	25	100

The p value was 0.04. In this study, healing time was better in Nailing group compared to Plating group. 81.48 % of nailing patients and 56% of plating patients showed healing within 14 weeks (statistically insignificant): Type A fracture was present in 32 (56.1 %) patients and had a healing time of 15.9 weeks. Type B fracture was in 1 (1.7 %) patient with a healing time of 14 weeks. Type C fracture was in 24 (42.1 %) with a healing time of 18 weeks.

Table 4: Knee flexion range in nailing and plating groups.

Knee Flexion (Degrees)	Nailing		Plating	
	No. Of Cases	Percentage	No. Of Cases	No. Of Cases
< 90	2	3.7	3	10.3
90-110	9	33.3	13	44.8
> 110	17	62.9	13	44.8
Total	28	100	29	100

Table 5: Functional Outcomes by Neer Scores for Nailing and Plating.

Functional Outcome By Neer Scores	Nailing	Plating
Excellent (>85 Points	-	-
Good (70 To 85 Points)	13 (46.4%)	10 (34.5%)
Fair (55 To 69 Points)	15 (53.6%)	17 (58.6%)
Poor (<55 Points)	-	02 (6.9%)
Total	28 (100%)	29 (100%)

The p value was 0.2 which was statistically insignificant.

Table 6: Types of Complications

Type Of Complication	Nailing	Plating	Total
Implant Failure With Re-Fixation Of Lcp Plate	1 (3.7 %)	1 (3.4 %)	2
Non-Union	2 (7.4 %)	2 (6.8 %)	4
Pain On Weight Bearing	1 (3.7 %)	1 (3.4 %)	2
Anterior Knee Pain	1 (3.7 %)	1 (3.4 %)	2
Local Symptoms At Distal Screw	3(11.1%)	-	3
Superficial Infection	1 (3.7 %)	-	1
Delayed Union	-	-	0
Knee Stiffness	-	04(13%)	4
Total	09	9	18

For the Nailing and Plating procedures complications were seen in 10 (35.7 %) andin 9 (31 %) cases respectively. The p value was 0.7. 11.1% of patients had local symptoms at distal screw.7.4% patients had non-union, 3.7% each of implant failure, pain on weight bearing, anterior knee pain, superficial infection, delayed union.13% of patients had knee stiffness 6.6% non-union, 3.4% each of implant failure, anterior knee pain and pain on weight bearing.

DISCUSSION

Distal femur fractures occur following high-energy impact in young patients often resulting in comminuted and open fractures, whereas, low-energy injury is sufficient to cause distal femoral fractures in elderly patients with osteopenic or osteoporotic bone. For the treatment of distal femoral fractures, two major therapeutic principles can be employed: retrograde IM nailing or locking plate osteosynthesis.[4] Protection of soft-tissue envelope due to the minimally invasive approach and closed reduction techniques is better realized using IM nailing. Aim of this study was to evaluate and compare clinical and radiological outcomes of distal femur fracture stabilization using nailing and locking compression plate.

No statistically significant differences between the nail and the LCP group were found for the parameters of healing, rate of non-union and postoperative complications. Healing rates were little early in IM nailing but were statistically insignificant. Both stabilization systems, the Nailing and the locking plate osteosynthesis, require precise preoperative planning. Comprehension of fracture anatomy and knowledge of advantages and limitations of implants are essential for successful operative treatment of distal femoral fractures. In the past, attention was given to the soft-tissue envelope based on the concept of biological osteosynthesis and minimally invasive approaches that resulted in decreased complication rates. Minimally invasive technique of osteosynthesis can be achieved by using two concepts: minimally invasive plating with an internal fixator - the LCP and even more by RN.[4] In this study, we focused on comparing treatment of distal femur fractures using RN or LCP plating and did not consider additional types of implants.

LCP the LCP system is an extramedullary, anatomically contoured internal fixator. Locking plate provides good fixation in osteoporotic bones in elderly patients.[5-7] 57,58,59 Previously, implants were selected depending on fracture type, whereas the LCP system can be universally applied for the treatment of all distal femoral fractures AO type A to C with the exception of AO type B Hoffa fractures, which are preferentially stabilized using lag screw osteosynthesis. The LCP plate provides enhanced distal screw fixation, even in osteoporotic bone, at the expense of more displacement at the fracture site. Compared with results published in the literature with non-union rates following LCP plate osteosynthesis ranging from 1.6% to 6.1%.[8] The high rate of nonunion in the LCP group found in our study may be attributed to the high incidence of open and comminuted C-type fractures in the cohort group. Main advantage of the anatomically precontoured LCP. Fracture stabilization with the LCP system may render adequate reduction more difficult since the plate and the locking screws are not designed to approximate the fracture toward the plate. In fact, prior to plate fixation, fracture reduction has to be performed and completed. Once a locking screw has been placed through the plate into bone, this particular bone segment can no longer be manipulated by insertion of additional screws or by using compression devices. The sequence of screw placement has to be well planned to avoid fracture mal-reduction. Distal screws are inserted perfectly parallel to the distal femoral joint line. Any angulation of screws in projection to the joint line may result in increased valgus or more detrimentally, in varus deviation. The concept of bridging osteosynthesis implicates that the final fracture construct should be elastic and not too stiff to prevent formation of non-union. Therefore, the screws should not be positioned too close to the fracture line in order to allow for elastic deformation of the plate-screw construct, thereby preventing the screws adjacent to the fracture from failing and being pulled out. The combination of a stiff plate, stiff screws, and fracture distraction is a formula for non-union. The size and contour of the plate may result in irritation of the iliotibial tract and may cause persistent pain. Symptomatic hardware has to be removed.[9] 60. Additional disadvantages include the complexity of insertion instruments, cross-threading of the screw-plate interface that is detrimental to biomechanical stability.

Retrograde nailing

Nailing provides favourable IM stability and can be successfully implanted in bilateral or multisegmental fractures of the lower extremity. In addition, a variety of distal femur fractures ranging from AO type a extra-articular metaphyseal, supracondylar, as well as intra-particular type C1 fractures can be stabilized. In these fractures, retrograde IM nailing may be used and closed indirect fracture reduction is achieved by inserting the nail at a correct insertion point leaving the soft-tissue envelope intact. Intra-articular C1 fractures may also be treated with the retrograde nail but only if direct visualization and perfect reduction of the articular surface is possible. Therefore, exposure of the joint line is required. In our series

we excluded type C2 and C3 fractures for the use of IM nail osteosynthesis. In contrast to the position of the distal screws in LCP plating which have to be positioned perfectly parallel to the joint line, distal interlocking screws of the retrograde nail have to be inserted at a valgus angle of approximately 7 degrees to the joint line. Only then the physiological valgus angle of the femoral condyle and the femoral shaft is respected and can be reconstructed. Compared to plate fixation techniques, advantages of IM fixation systems, such as a retrograde femoral nail or an SCN, include soft-tissue protection due to small incision, decreased blood loss following limited exposure, "percutaneous" joint fixation, and the increased stability by IM fixation, load-sharing, and support of a long nail. Earlier biomechanic studies demonstrated that in distal supracondylar femur fractures, long nails reaching the intertrochanteric region provide increased fracture stability compared to short retrograde nails. The snug IM nail-bone fit improved the mechanical interaction between the femoral diaphysis and the nail.[10] 61In our series, predominant indications for osteosynthesis using the retrograde nail included distal femur fractures AO type A and C1, and open wound around the knee.

Contraindications for retrograde IM nailing include open epiphyseal cartilages, bone infection, pathologic fractures, total hip arthroplasty, and lung contusions.

The nailing technique has disadvantages of lack of alignment control, the intra-articular insertion, and intra-articular distribution of reaming debris.[4]

Age incidence: In present study, the mean age was 51 years which is comparable to the observations of Gellman et al and Schutz et al who reported mean age as 50 and 52 years respectively.[13,14] Watanabe et al reported it as 64 years and Lucas et al as 39 years.[15,16]

Distal femur fractures occur following high energy impact in young patients resulting in comminuted and open fractures in elderly patients with osteopenic or osteoporotic bone. In current study, mean age group was 51 years with male predominance as ours was a rural area with men working mostly as labourers.

Gender predilection: In the studies conducted by Gellmann et al and Watanabeet al female predominance was seen and the age group under consideration was older in contrast to the study by Lucas et al and the present series,[13,15,16] where male predominance in the younger age group was observed. The reason might be road traffic accident being the predominant cause of trauma.

Mode of injury: In the present study, road traffic accident accounted for 56% of cases. Gellman et al and Schatzker et al observed 63 % and 58 % of their cases respectively having trauma as their cause.[13,17]

Time taken for union for Plating: In present study, time taken for union for Plating was around 15 weeks,which was comparable to Henderson et al and Markmiller et al who observed it to be 12 and 14 weeks respectively.[5,18] Radiological union was defined as bridging callus across three cortices. Weight and Collinge et al achieved union at an average of 13 weeks,Kregor et al at 11 weeks,[19,20] Schandelmaier et al at 13 weeks, Schutz et al at 14 weeks,and Henderson et al around 12 weeks.[8,14,18]

Time taken for union for Nailing:In present study, average healing time in weeks was 13 which was comparable to Gellmann et al 12 weeks, Kumar et al 14 weeks and Ingman et al 12 weeks.[3,13,21]

Comparison of average union in weeks for Nailing and Plating: Average healing time for Nailing was 13.4 weeks and was better than Plating for which it was 15.6 weeks. The more complex fractures (Muller type C) are managed by Plating and hence, the healing time is more for Plating technique.

Comparison of knee flexion in plating and nailing: In this study, range of motion is more in Nailing series (112 degrees) than in Plating (107 degrees). As knee mobilization is started early in Nailing than Plating. Complex comminuted fractures which need immobilization are treated by plating and hence, the delayed mobilization. Lucas et al, Gellman et al,[16] Kumar et al,[13] Watanbe et al,[3] Ingmanet al reported 104, 106, 100, 102 and 101 degrees for nailing procedure. Whereas Kregor et al,[15,22] Schutz et al,[20] Markmiller et al reported 103,107 and 110 degree average knee flexion for Plating.[5,14]

Average time of surgery: In the present study for nailing it was 104.8 minutes and for Plating it was 117.5 minutes.

Comparison of complications of Non-union in Nailing and Plating: In the present study for Nailing procedure the rate of non-union was 7 % which is comparable to observation by Kumar et al of 2 %.[3] For Plating, we observed non-union in 7 % which is similar to reports byKregor et al as 7 % and by Schutz et al as 5 %.[14,20] When comparing non-union rates, there is no much difference between nailing and plating series.

Implant failure rate in Nailing and Plating: In the present study for Nailing, 3 % cases had implant failure, which compares well with the observation of Obgemudia et al of 3.4 %.[22] For Plating series, present study had implant failure in 3.4 % cases. Kregor et al and Schutz et al had rates of 1.5 % and 6 % respectively.[14,20] In present study,Implant failure rates were similar in nailing and plating series. In previous studies failure rate was predominantly seen in plating series when compared to nailing series. Improved plating procedures have decreased the failure rate.

Other complications: Number of complications were more in nailing series than plating series.

CONCLUSION

Both retrograde IM nailing and LCP plating may be adequate treatment options for distal femur fractures. Early healing, increase range of movement, less average surgical time, more complications are seen in nailing compared to plating but are statistically insignificant, the reason for these results is mostly due to simple fractures treated by nailing and complex ones by plating.

No significant differences in outcome between implants regarding fracture healing, non-union were found for both the techniques.

However, both procedures need correct preoperative planning and adequate surgical experience so as to avoid revision surgery.

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How to cite this article: Jillala SR, Ahmed SMW, Shruthi A, Gajul R, Katikitala A, Rakesh K. A Comparative Study of Supracondylar Nail Versus Locking Compression Plate in Distal Femur Fractures. Ann. Int. Med. Den. Res. 2017; 3(4):OR35-OR41.

Source of Support: Nil, **Conflict of Interest:** None declared