

**ROLE OF SUPRACONDYLAR NAILING IN DISTAL FEMORAL FRACTURES**Abhishek Pathak<sup>1</sup>, Suneet Tandon<sup>2</sup>, Sanjiv Gaur<sup>3</sup>**HOW TO CITE THIS ARTICLE:**

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**ABSTRACT: BACKGROUND:** Fractures of distal femur are complex injuries that can be difficult to manage. Due to poor bone stock, less cortical bone in this region, wide medullary cavity and frequently associated severe soft tissue damage. **METHODS:** From June 2008 to April 2012, a prospective study of 46 patients, with distal femoral fractures, including supracondylar and inter condylar fractures, treated with intramedullary supracondylar nail, was done to evaluate its results and final functional outcome and its applicability in open as well as closed distal femoral fractures. Four cases were lost to follow up; six had followed up for less than six months. These ten cases were excluded from the study hence effectively the study included total thirty six cases. Average age of patients was 41.7 yrs. with Male: Female ratio of 2.6:1. Among 36 fractures 16.6% were of type A1, 44.4% were of type A2, 27.7% were of type A3 and 11.1% were of type C1. 27.7% fractures were open and associated injuries were present in 22.2% of cases. Second generation supracondylar nail was used for definitive fixation in all eighteen cases, through percutaneous patellar tendon splitting approach in 26 patients and medial parapatellar arthrotomy approach in ten patients. **RESULTS:** At an average follow up of 9 months, final functional outcome was evaluated as per Neer's criteria (1967). Average time of union was 17.5 weeks, with an average range of movement being 101.38. Functional results were excellent in 20 (55.5%) cases, satisfactory in 10 (27.7%) cases, unsatisfactory in 2 (5.5%) and poor in 4 (11.1%) cases. No significant correlation was observed in this study between the age of the patient, fracture type and the final functional outcome achieved. Similarly no significant difference was observed between the final functional outcomes achieved in open versus closed fracture. However patients treated with medial parapatellar arthrotomy approach were found to be associated with increased incidence of complications and relatively low range of movement at knee joint. **CONCLUSION:** According to this study it is concluded that supracondylar nailing is useful for fixation of closed as well as open distal femoral and less comminuted inter condylar fractures, preferably to be done by percutaneous patellar tendon splitting approach. The simplicity of the procedure also facilitated fracture fixation in those with multiple fractures.

**KEYWORDS:** Distal femoral fracture, fixation.

**INTRODUCTION:** Distal femoral and supracondylar fracture, continue to perplex the surgeon and poses a considerable therapeutic challenge. Their management still evokes much controversy because of the consistently poor results obtained. Operative treatment has become a standardized procedure for distal femoral fractures. Improved surgical experiences have brought the surgical fixation of distal femoral fractures in to the realm of respectability.

The choice of appropriate implant to be used for fractures of the distal femur is critical in the surgical reconstruction of these fractures. There is simply not one device that can be commonly used for every fracture.

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Considerable professional judgment is required to select most suitable surgical intervention and fixation orthopedic device, keeping in mind the age of patient, degree of comminution, and quality of bone in terms of osteoporosis or osteopenia.

As reported by Henery et al<sup>1</sup> and Muller et al,<sup>2</sup> the retrograde supracondylar nail was developed in 1987 by Green, Seligson, and Henry to address complex supracondylar fractures of the femur. Thus the treatment of choice for supracondylar fractures of the femur is still evolving and the results of different methods are still incomplete and controversial.

An interest in the end result and functional outcome of distal femoral and supracondylar fractures of the femur treated with supracondylar nail, to fulfill the main aim of fracture management i.e. restoration of optimal function in the shortest time by the most reliable and the safest method in our hand; is the original impetus for this study.

**MATERIAL AND METHODS:** A prospective study of 46 patients, with distal femoral fractures including supra condylar and inter condylar fractures, treated surgically with retrograde intramedullary interlock supracondylar nailing, was carried out from June 2008 to April 2012 at department of Orthopaedics and Traumatology, Gandhi Medical College and Hamidia Hospital, Bhopal.

Four cases lost to follow up, six had follow-up of less than six months. These ten cases were excluded from the study hence effectively it is a study of total thirty six cases.

In this series selection criteria included the skeletal maturity and the patient who met the following indications for supracondylar nail fixation:

1. Simple or Comminuted distal femoral metaphyseal and supracondylar fractures (Muller A-0 Type A1, A2, A3),
2. Inter condylar fractures (Type C1),
3. Open supracondylar and distal femoral fractures (up to Gustilo grade IIIB),
4. Fractures in patients who presented with multi-system trauma,
5. Multi skeletal trauma especially floating knee fractures,
6. Bilateral distal femur fractures,
7. Osteoporotic fractures in elderly.

**Exclusion Criteria Included:**

1. A history of septic arthritis of knee,
2. An extension contracture of the knee with the inability to attain at least 45 degree of flexion,
3. Active infection,
4. Massive intra articular comminution/ bone loss (Type C3),
5. Unicondylar (Type B) fractures,
6. Patient not willing for surgery.

**Patient Population:**

- A total of 36 patients, in the age range of 19 to 70 years. (Average age = 41.7 yrs.).
- 26 patients were men with the age range of 19-70 yrs. (Average age = 41.5 yrs) while 10 patients were women with the age range of 26 to 63 yrs (Average age = 42.2 yrs).

## Fracture Type:

- Out of 36 patients, 28 (77.7%) were having fracture supracondylar femur while 8 (22.2%) were having fracture femur lower third.
- Left femur was object in 26 cases (72.2%) while right femur was object in 10 cases (27.7%).
- 26 fractures were closed (72.2%) while 10 fractures were open (27.7%) with Gustilo grade II in four and Gustilo grade IIIB in one.
- As per Muller's A-0 classification, 6 fractures were type A1 (16.6%), 16 were type A2 (44.4%), ten were type A3 (27.7%) and two four were of type C1 (11.1%).
- Eight patients (22.2%) were having associated injuries, two with ipsilateral fracture calcaneum, two with crush injury left thigh and open comminuted supracondylar fracture femur left with dislocation of left ankle, two with ipsilateral fracture both bones leg (m/3<sup>rd</sup>), one with contralateral fracture shaft femur (m/3<sup>rd</sup>) and one with ipsilateral intracapsular neck femur fracture
- Duration lag between the time of injury and the definitive treatment ranged from 8 hrs. to 30 days, average being 12.05 days.

**Operative Technique:** Implant used for surgical fixation of all fractures was second generation intramedullary supracondylar nail four hole type. The most used length of the nail was 250 mm (28 cases) and diameter 10 mm (24 cases).

In type C fracture the reduction of articular fracture lines was supplemented by closed manipulation, unicortical steinmann pins, or a large tenaculum clamps. In one of the two cases of type C fractures acceptable anatomic reduction with congruent articular surface was achieved by closed manipulation only, and an open arthrotomy was required in other case. Now the compression of articular condylar fragments was obtained with 6.5 mm cannulated screws placed anteriorly and posteriorly, percutaneously.

The distance between the screws was a minimum of 14 mm to accommodate the diameter of the supracondylar nail. Thus the basic strategy was to assemble a condylar block and then fix it to the femoral shaft with the nail. In one case of type A3 open fracture, open reduction of fracture was done. Location of the open wound governed the skin incision and approach to the fracture.

For insertion of supracondylar nail, the percutaneous, patellar tendon splitting approach was used in fifteen cases while in five cases including one of type – C fracture open arthrotomy by medial para patellar approach was used. The same approach was exploited in a case of type A1 supracondylar fracture femur with ipsilateral fracture both bones leg for insertion of tibial interlock nail in the same sitting.

**Post-operative after Treatment:** Post operatively knee immobilizer was applied to all the patients who were removed periodically for physiotherapy. Isometric quadriceps exercise started by third day of surgery in all patients. Simultaneously those treated with percutaneous technique were instructed to start active assisted and passive range of motion exercises of knee by third post- operative day while it was delayed for two weeks in those treated with medial para patellar arthrotomy approach.

At the same time non weight bearing gait training started with the help of crutches or walker. Touch down partial weight bearing started at on an average of 8<sup>th</sup> weeks, until there were radiographic signs of callus formation.

Full weight bearing started only when there were clinical and radiological signs of union.

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**Follow up Protocol:** These patients were clinically and radiologically examined and followed up from the time of their OPD attendance/ admission, their stay in the hospital to the subsequent follow up, at every four weeks.

Functional evaluation of each patient was done as per Neer's criteria<sup>4</sup>. At the time of final follow up, all these patients were given a final over-all rating using the system of Neer et al (1967)<sup>4</sup> (Table No. 1).

The evaluation scale assessed pain, walking capacity range of movement, work capacity, anatomy and roentgenogram.

<b>Pain (20 Points)</b>		<b>Anatomy (15 Points)</b>	
None	20	Only enlargement	15
Intermittent of during changes in weather	16	5° angulation or rotation 0.5 cm shortening	12
When fatigued	12	10° angulation or rotation 2.0 cm shortening	09
Limits function	08	15° angulation or rotation 3.0 cm shortening	06
Constant or at night	04	Healed with considerable deformity	03
<b>Walking capacity (20 Points)</b>		Pseudoarthrosis or chronic infection	00
Some as before accident	20	<b>Roentgenogram (15 Points)</b>	
Some limitation	16	Almost normal	15
Clearly limited	12	5° angulation or rotation 0.5 cm lateral displacement	12
Uses cane or severely limited	08	10° angulation or rotation 1.0 cm displacement	09
Uses crutches or other walking aid	4-0	15° angulation or rotation 2.0 cm displacement	06
<b>Joint Movements (20 points)</b>		Healed but with considerable deformity	03
Normal or 35 degree	20	Pseudoarthrosis or chronic infection	00
100°	16		
80°	12		
60°	08		
40°	04		
20° or less	00		
<b>Work capacity (10 points)</b>			
Same as before accident	10		
Regular but with handicap	08		
Changed occupation	06		
Light work	04		
Not working	2-0		

**TABLE NO. 1: CRITERIA FOR EVALUATION OF THE RESULTS**  
(According to Neer et al. 1967)<sup>4</sup>

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Excellent, more than 85 points; satisfactory, 70-85 points; unsatisfactory, 55-69 points; and poor, less than 55 points.

**RESULTS:** Residual angular deformity was determined on antero posterior and lateral radiographs. Limb length and rotational deformity were evaluated by physical examination.

A satisfactory union was defined as less than 5° of varus-valgus or procurvatum-recurvatom angulation, malrotation of less than 10° and not more than 0.5 cm of limb length discrepancy.

Union was further defined as bridging callus as seen in four quadrants or 3/4<sup>th</sup> circumference of the cortex and a fading away of fracture line in antero-posterior and lateral radiographs, and the absence of pain, tenderness or mobility at the fracture site at physical examination (Neer et al. 1967).

The period of follow up was from a minimum of 6 months to a maximum of 20 months, the average length being 9 months.

Time to union was ranged from 14-24 weeks average being 17.5 weeks with one case of non-union while, time to full weight bearing ranged from 12-22 weeks, average being 17.7 weeks. Percentage of cases showing full union was 94.5% except one case (5.5%) who showed non-union. There was no incidence of delayed union.

Sl. No.	Type of Fracture	Approach Used		Average ROM at Knee	
		Med. Para Patellar Arthrotomy	Percutaneous Patellar Tendon Splitting	Med. Para Patellar Arthrotomy	Percutaneous Patellar Tendon Splitting
1	A1	4	2	70°	135°
2.	A2	2	14	40°	111.4°
3.	A3	2	8	80°	110°
4.	C1	2	2	80°	130°
5.	C2	-	-	-	-

**TABLE 2: SHOWING AVERAGE RANGE OF MOVEMENT AT KNEE AND ITS CORRELATION WITH OPEN ARTHROTOMY TECHNIQUE AND PERCTANEOUS TECHNIQUE, AND TYPE OF FRACTURE**

It shows that range of movement at final follow up is significantly better with percutaneous patellar tendon splitting approach.

At the time of final follow up more than half of the patients were having range of movement of more than 90° at knee, average being 101.38°. The average range of knee motion in patient with para patellar arthrotomy approach was 67.5° while it was 121.6° in those treated with percutaneous patellar tendon splitting approach. All patients were found to have normal extension without any extensor lag.

Sl. No.	Type of fracture	No. of fractures	Average range of movement at knee
1.	Closed	26	99.61°
2.	Open	10	106°

**TABLE 3: SHOWING AVERAGE RANGE OF MOVEMENT AT KNEE AND ITS CORRELATION WITH CLOSED VERSUS OPEN FRACTURE**

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The average range of movement of knee obtained at final follow up, in open fractures was quite comparable with that in closed fractures, infact slightly better. Because, out of 13 closed fractures medial para-patellar approach was done in 4 cases where average range of movement was much lesser.

The commonest complications encountered in this study was patellar impingement seen in 6 cases (16.66%) because of faulty technique nail protruding >5 mm in knee joint. In two cases each other complications were deep infection, implant failure (broken distal locking screws), loosening and spontaneous migration of distal locking bolt, deep vein thrombosis, iatrogenic fracture of medial femoral condyle while nail insertion. Knee stiffness (range of movement <60°) was observed in 4 cases and all these cases were operated by medial para patellar arthrotomy approach and one got infected. There was no case of malunion or delayed union while only two cases of nonunion were encountered.

No significant correlation was observed in this study between the age of the patient, fracture type and the final functional outcome achieved. Older patients did as well as the younger ones. In non-comminuted fractures the outcome was similar to that in comminuted factures. Similarly no significant difference was observed in this study between the final functional outcomes achieved in open versus closed fractures. There was no incidence of infection, either superficial or deep, in open fractures.

Fracture type	Excellent	Satisfactory	Unsatisfactory	Poor
A1	0 (0%)	4 (66.6%)	-	2 (33.3%)
A2	10 (62.5%)	4 (25%)	-	2 (12.5%)
A3	6 (60%)	2 (20%)	2 (20%)	-
C1	4 (100%)	-	-	-
C2	-	-	-	-
C3	-	-	-	-

**TABLE 4: SHOWING CORRELATION OF FRACTURE TYPE WITH FUNCTIONAL OUT COME**

There was no relevant difference between type A and type C fractures in functional, clinical and radiological outcome.

Final functional outcome as per Neers criteria (1967) revealed that among a total of 36 cases 20 (55.5%) were having excellent results. Results were satisfactory in 10 (27.7%) patients, unsatisfactory in 2 (5.5%) patients and poor in 4 (11.1%) patients.

**DISCUSSION AND CONCLUSION:** Intramedullary positioning of the nail also proves 3-point fixation of the fracture to prevent flexion/ extension displacement of the distal fragment. It supplies a fixation in line with the intramedullary canal and interlock the nail distally and proximally, control the displacement and rotation of fragment, supply effective mechanical stability and facilitate early joint mobilization. The combination of early union and stability of fixation seen with this approach effectively reduces the risk of angular malunion.<sup>8</sup>

Loss of alignment and fixation failure could be a problem with supracondylar nail due to relatively less rigid fixation, but in this study no such incidence occurred and a stable fixation is achieved, in spite of widening canal, thin cortices and relatively poor bone stock. Being a load sharing

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device, no risk of relative osteopenia at the proximal end of the nail, as seen with load shielding lateral fixation devices, hence there is no risk of re fracture which is important in elderly patients with osteoporotic bone. Still the intraoperative determination of alignment and avoiding shortening were the major difficulties especially with long oblique and comminuted fractures.<sup>5</sup>

Hence a constant vigil was kept while insertion of nail. Although misalignment did not affect function, the problem is thought to be related to the use of the shorter 150 mm nails. The longer 250 mm nail was used in this series because it prevents toggle or drifting of the implant along the proximal locking screws, as the nail enters and engages the isthmus of the femur.

In view of the observation made that the critical variables that determine the applicability of closed nailing to fractures of the distal part of the femur are the pattern and reducibility of the inter condylar fracture and the extent of metaphyseal and condylar comminution, i.e. condylar fragment must not be comminuted to prevent secure purchase of distal locking screws.<sup>9</sup> Thus in this series type C3 fractures were not included.

Present study shows 94.5% union and only two cases of nail failure (broken distal locking screws). In the series of Lucas et al (1993) four patients required bone grafting in contrast to the present series in which such a high rate of union obtained without need for bone graft, in any patient.

Innacone et al (1994) reported on a larger series of 41 patients with supracondylar femur fractures who were treated with Green – Seligson – Henery Supracondylar nail with five non unions, five delayed unions and four fatigue fractures of the supracondylar nail. They attributed these complications to the use of an open technique.

However no implant failures occurred in patients treated with second-generation nails and percutaneous technique. This was also proved by the study of Watanabe Y et al (2002) who used 2<sup>nd</sup> generation intramedullary supracondylar nail in 24 patients. There were three varus valgus deformities, two cases with loosening and two with breakage of the distal locking screws, but no failure of nail itself. In his study second generation intramedullary supracondylar nail was found to be satisfactory in patients younger than 60 yrs.

Considering this fact we used second generation intra medullary supra condylar nail four to five hole type in all our patients. As fatigue strength of the five hole nail was reported to be much higher than the multi hole type.<sup>6</sup> Similarly fatigue strength of second-generation intramedullary supra condylar nail with 5 mm interlocking screws was reported to be much higher than that of first generation nail of 6.4 mm interlocking screws.<sup>2</sup>

Among them 72.2% i.e. 13 were less than 60 yrs of age and out of these 13, 10 patients had excellent to satisfactory results. In contrast to series of Watanabe Y et al, in this study there was no varus valgus deformity; loosening and spontaneous migration of distal locking screws was seen in only one case. Breakage of distal locking screws was seen in one case, without any case of failure or fatigue fracture of the nail itself.

The complication of breakage of the distal locking screws with resultant non-union could be attributed to the non-compliance and early weight bearing by the patient, but surprisingly that patient was having painless full range of movement at the knee joint. In this patient implant removal and re fixation of fracture with dynamic condylar screw with bone grafting was done at 18<sup>th</sup> months of follow-up.

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The significant morbidity resulting from complications of supra condylar femoral fractures is well documented. In this study the common complications including mal union, shortening and nerve palsy were not common.

Most patients had their heel in excellent alignment without shortening. Of greater concern than loss of alignment is the problem of nail impingement. Patellar impingement was the most common complication in this study, seen in 6 patients.

In this study average range of knee motion in those treated with medial para patellar arthrotomy was less ( $67.5^{\circ}$ ) than that in those treated with percutaneous technique [average range of movement ( $121.6^{\circ}$ )].

One case of post-operative chronic knee sepsis with residual knee stiffness and other case of associated ipsilateral fracture both bone leg, both were treated with open arthrotomy must have contributed to low average range of movement with open arthrotomy approach. Henery S. L. (2000) also found in his series a low incidence of mal alignment and a greater postoperative range of movement at knee with percutaneous technique when compared with open arthrotomy approach.

Long term effects on the knee joint following nail entry through the inter condylar notch are not clear. Although this study did not observe any significant deterioration of joint congruency or reduction in the thickness of the articular space based on X-ray evaluation, no conclusion can be reached since the number of cases was small and the duration of follow up was relatively short.

The use of inter condylar retrograde nailing of the femur has expanded the treatment options for patients with multi skeletal or multisystem trauma. In this series also supracondylar nailing was done in three patients of multi skeletal injuries. In one patient contralateral femoral shaft fracture dynamic compression plating was done while in other contralateral knee arthrodesis nail was inserted in same sitting. Results were found to be satisfactory in these patients.

In patients with multiple fractures, simultaneous fracture fixation in more than one limb may be desirable. Supracondylar nailing is performed supine on a normal operating table, allowing simultaneous procedure for upper limb and the opposite lower limb. When there is an indication for life saving procedures, such as craniotomy or laprotomy, repositioning of the patient is not necessary for subsequent fracture fixation.

Hence it is concluded that supracondylar/distal femoral fractures can be effectively treated by closed supracondylar nailing. It leads to rapid bone healing despite of severe comminution, avoiding the need for bone grafting is because of less soft tissue dissection and periosteal stripping and non-interference with fracture hematoma.

The load sharing mechanism of intramedullary nailing promotes secondary bone healing and morselized bone from medullary reaming extravasated in to the fracture site serves as a bone graft. All these factors contributed to the good union rate seen and the low incidence of soft tissue complications, specially infection. It is also concluded that supracondylar nailing is useful for fixation of closed as well as open distal femoral and less comminuted intercondylar fractures.

Since postoperative knee stiffness was higher in medial para patellar arthrotomy technique, this supracondylar nailing is preferably be done by less traumatic percutaneous patellar tendon splitting technique. This procedure provides stable fracture fixation and allows early mobilization and early rehabilitation of patients. The simplicity of the procedure also facilitated fracture fixation in those with multiple fractures.



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Figure 1a: Preoperative X-rays

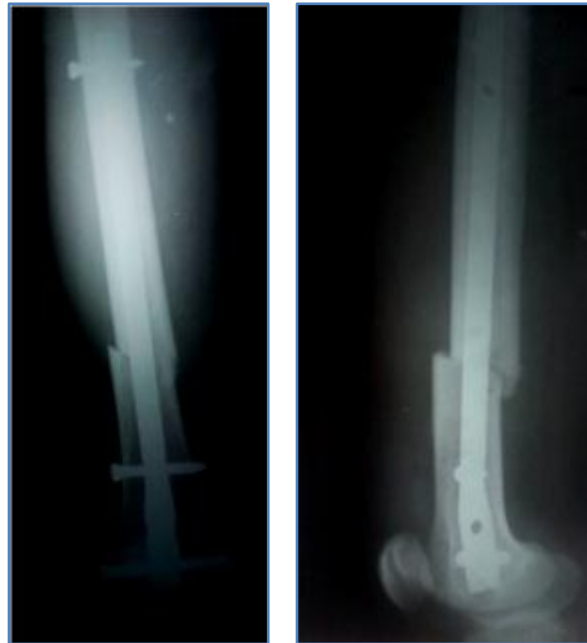


Figure 1b, 1c: Immediate Post Op X-ray



**Figure 1d, 1e: X-rays at 6 month follow up showing callus and union**

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