

## Study on effectiveness of retrograde nailing with long intramedullary supracondylar nail for shaft and supracondylar fractures of femur

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### Abstract

**Introduction:** Due to modern lifestyle changes, the incidence of distal femur fractures has risen and more so in association with shaft fractures of femur because of fast world and high velocity trauma occurring in road traffic accidents. Dilemma arises when we face distal third shaft and associated supracondylar or inter-condylar fracture of femur. The aim of this study is to remove the hesitancy of performing retrograde nailing by long IMSC nail without any complications.

**Materials and Methods:** A prospective study of 150 patients with fracture of femur shaft and supracondylar fractures was done. They were treated by using this technique, from January 2003 to September 2017. These patients were followed up till fracture union & evaluated further postoperatively for finding its benefits.

**Results:** In our study, the mean age of patients was 35 years. 65.3% were males and 34.7% were females. The mode of injury in case of majority of the patients had RTA (road traffic accident) 93 patients (62%). In the present, surgical and technical related complications were encountered in 10 patients (6.7%). Our patients had a mean value of 80 points according to Neer score.

**Conclusions:** We conclude that retrograde long IMSC nail is reliable as an alternative for conventional procedures like antegrade nailing and plate fixation in femoral fracture shaft and supracondylar region. It is especially beneficial in conditions like osteoporosis, pregnancy & previous implant or prosthesis on ipsi-lateral side and ankylosed hip. Retrograde nailing can be done on simple radio-luscent top operating tables which are commonly available everywhere.

**Keywords:** Femur shaft fractures, Supracondylar femur fractures, Retrograde long IMSC nailing, Fracture union.

### Introduction

Femur fractures are common occurrence in orthopaedic practice. Incidence of distal femur fractures is 37/100,000 patients per year.<sup>1, 2</sup> The mechanism of injury is thought to be axial loading with varus, valgus or rotational forces.<sup>3</sup>

These fractures have a bimodal incidence, occurring in young adults and elderly people.<sup>4</sup>

These can be encountered due to,

1. Low energy trauma like a trivial fall (in case of osteoporotic bones)
2. Fall from height
3. High velocity trauma (in young adults as in road traffic accidents).
4. Notching of the anterior cortex of distal femur during or after knee arthroplasty.<sup>5</sup>

When the patient sustains this fracture, his quadriceps and hamstrings often have spasm and irritation leading to limb shortening with varus angulation at the fracture site as a result of strong pull of adductor muscles. Also the contraction of gastrocnemius often produces apex posterior angulation and displacement of distal fragment. In fractures with intracondylar extension, soft tissue attachments to the respective femoral condyles tend to produce splaying and rotational mal-alignment of the condyles that contributes to joint incongruity.<sup>5</sup>

Hence the management of femur fractures must be such that it leads to minimum systemic complications & maximum orthopaedic advantage. It means that early stability and near normal range of motion should be

achieved as quickly as possible to prevent further soft tissue trauma to the area and other complications.



**Fig. 1:**

For satisfying the above, retrograde nailing with long IMSC seems to be best available option in today's era. It has many advantages like no postoperative abductor weakness, no postsurgical heterotopic ossification in hip, no pudendal nerve injury as it occurs in antegrade nailing.<sup>6, 7</sup>

It can be used in cases where antegrade nailing is impossible. As in ankylosed hip, fractures of pelvis, unstable pelvis, dislocated hip, previous operated hip with prosthesis & implant, skin infection in hip area, floating knee injury & in morbidly obese patients and in emergency situations like supracondylar with shaft fractures of femur associated with vascular injury and vascular repair can be done in supine position itself.<sup>8-10</sup>

As this procedure is closed reduction it doesn't compromise local vascularity, no invasive incision and soft tissue stripping.

Few drawbacks observed over time are peri-prosthetic fractures through distal interlocking screws, nail penetration in knee joint, anterior perforation of nail, patella-femoral arthroses, knee stiffness, quadriceps atrophy, intra-articular infection, synovial metallosis & implant removal.<sup>11-14</sup> These can be overcome by careful case selection, well experienced surgeons and technique. Recent nail designs are considering AP free hand locking options to overcome the proximal locking challenge.

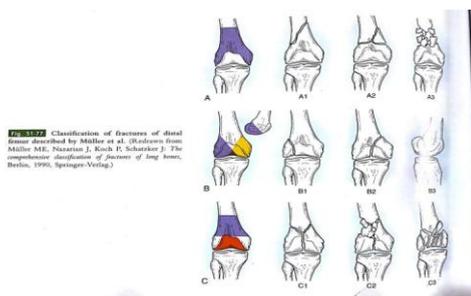
The rationale behind choosing the present study was that after extensive review of literature in other studies, we have not found any paper dealing with management of shaft and supracondylar fractures of femur simultaneously using long IMSC.

### Objectives

1. To assess the effectiveness of retrograde nailing with long intramedullary supracondylar nail for shaft and supracondylar fractures of femur.
2. To evaluate the ease of the procedure & providing treatment to multiple cases which otherwise wouldn't have been treated with the conventional methods.

### Materials and Methods

Prospective study of 150 patients was done. These were having distal third shaft fractures with supracondylar fractures of femur with or without polytrauma & with or without co-morbidities. They were treated with retrograde nailing using long IMSC from January 2003 to September 2017 after approval from institutional ethical committee. All relevant data were collected in a standardised proforma. One patient was lost to follow up, as he was from a distant place.



**Fig. 2:** Classification of fractures of distal femur described by Muller et al.<sup>5</sup>

### Inclusion Criteria

1. For Supracondylar/intracondylar and shaft fractures of femur.
2. Segmental shaft femur fracture in distal half
3. Fracture shaft femur with implant or prosthesis proximally arthrodesis hip and ankylosed hip.
4. Communited fracture shaft (diaphysis-metaphysis junction)

5. Ipsilateral shaft /tibia fracture.
6. Antegrade nailing at lower third shaft at times is unstable even after distal interlocking because of wide medullary canal-causing instability of distal segment and breakage of antegrade nail.
7. Vascular injury with segmental fracture femur supracondylar and shaft can be operated in supine position
8. As a quick procedure in obese patients, polytrauma, pelvic fractures and pregnancy (2<sup>nd</sup> and 3<sup>rd</sup> trimester). When positioning is difficult or not possible for some or the other reason.

### Exclusion Criteria-

1. C2 and C3 fractures and B3.
2. Bone infection.

Rest were followed up to fracture healing (average of 24 weeks) & were evaluated postoperatively on basis of Tegner and Lysholm activity score<sup>15, 16</sup> and Neer score.<sup>17</sup>

### Operative Procedure Long IMSC

#### Anaesthesia: Spinal anaesthesia

Retrograde Femur nailing LONG IMSC is done in supine position on a radioluscent top table

Primary scrubbing of full lower extremity is done and free full draping done.

Powerful Gastrocnemius muscles pull distal portion of femur (Condylar part) into flexion.

A thick bolster is kept below knee joint to nullify the pull of this muscles by keeping knee in 45\* to 60\* flexion over the supporting bolster. In this position posterior neuro vascular structures fall back away from posterior surface of distal femur and entry is just in front of you.

Primary screening of fractured bone is done under C-arm in AP and Lateral views to see fracture geometry and its displacements and alignment.

#### Surgical Technique:

1. Incision: We used midline infra Patellar tendon splitting incision.
2. Entry point: is one cm anterior to Posterior cruciate ligament attachment in the trochlear (condylar) notch as seen in lateral view of c arm and central in AP view.
3. A thin guide wire is drilled through trochlear notch of condyles and checked under c arm to confirm the placement in AP and Lateral views. The Guide wire should be in centre in AP view and in long axis of shaft femur in lateral view anterior to Blumensaat's line. Now a cannulated drill is drilled over guide wire and later entry is enlarged with solid 6 mm reamer to open upto metaphysis. Then a long Guide wire is passed through entry hole and negotiated at fracture sites into proximal segments under c arm with gentle traction alignment and manipulation.

4. Check that guide wire placement is in the medullary canal in all proximal middle and distal segments under c arm in AP and Lateral views at different steps at fracture levels.
5. Once the guide wire is in medullary canal, gradual reaming is done with solid cannulated reamers or flexible reamers over the guide wire to accommodate largest diameter nail in the canal. We reamed one mm larger than the proposed diameter of nail. Reaming was done upto lesser trochanter level proximally to accommodate longest length of nail to have longer working length of the nail for the fracture to be stabilized.
6. Long IMSC nail and jig assembly is threaded over guide wire into the medullary canal. In majority of average build and stature patient long IMSC nail of length of 36 to 38 cms was sufficient. But in taller patients we had to use upto 40 cms length IMSC nail.
7. The distal tip of IMSC nail is properly placed at subchondral level in the intercondylar notch and is confirmed under c arm in AP as well as lateral view.
8. Distal interlocking is done through jig to fix the distal femur. All three holes in the distal part of IMSC nail were interlocked in majority cases. But when there was fracture obliquity or comminution we saw that atleast two holes are interlocked safely to provide stability.
9. Proximal interlocking is done by free hand technique. Earlier versions of long IMSC nails have mediolateral Interlocking holes which was difficult to interlock at proximal level. Nowadays long IMSC nails have come up with Antero posterior interlocking holes and free hand interlocking becomes easy under c arm. In many of the cases we did not interlock proximally as nail was snugly fit in the isthmus region of the canal and is in dynamic mode from the beginning. In osteoporotic bones with wide medullary canal we did proximal interlocking to avoid rotational instability.
10. Incisions were closed and pressure bandage was applied.
11. In cases of supracondylar with intracondylar fractures, the intercondylar fracture was stabilized first with anterior and posterior cannulated cancellous screw percutaneously. Then entry was made in between 2 cannulated cancellous screws.

3rd Fig. shows fracture shaft femur with an undisplaced supracondylar fracture



Shaft femur plus undisplaced supracondylar fracture .



CLOSED LONG IMSC nailing done Immed PO

**Fig. 3**

4th Fig. shows comminuted fracture of shaft and supra with intercondylar fracture along with popliteal artery injury. This was an emergency, had to be dealt with eager management without losing precious time in an attempt to salvage the limb with bony stabilization and vascular repair.

As there was comminuted shaft fracture of femur the desired appropriate length of IMSC nail was not available. An idea struck by putting a standard antegrade nail in a retrograde fashion with additional custom made interlocking hole in the antegrade nail itself. This took care of both supra and intercondylar fractures with added intercondylar fixation with anterior and posterior cannulated cancellous screws.



**Fig. 4**



**Fig. 5**



**Fig. 5** shows a x-ray of 50 year old male patient presented to us with femoral shaft and tibial fracture he was dealt with using a single patellar incision

6<sup>th</sup> Fig. shows a xray of young athletic male of 28 years, faced a comminuted fracture of shaft femur which was operated elsewhere with open Kuntschner nailing. In due course of follow-up, after a month, the nail migrated proximally patient was re-operated at the

index hospital itself. The nail was hammered in and the X-ray showed that the nail was in knee joint.

This was the clinical scenario when the patient presented to us.

We planned for removing the earlier nail, and putting a long IMSC nail.



Fig. 6

**Postoperative Management**

Post operatively IV antibiotics were administered for five days and followed by oral antibiotics for further five days. Non weight bearing walking with walker was started on third post-operative day. In non comminuted fractures knee flexion movements are started on fifth day on CPM where as in comminuted fractures knee movements were started later as per tolerance of patient. Patients with polytrauma were gradually mobilized later as per conditions permitted.

Patients were watched for symptoms of fat embolism. DVT prophylaxis was started in

morbidly obese patients with injection heparin subcutaneously, twice for 5 days.

Sutures were removed on 10-12th day and discharged and followed up at six week intervals upto six months to assess clinical, radiological and functional assessment. Clinical assessment included checking incision site healing, knee stability, alignment, and range of knee movements. Absence of pain and tenderness at fracture site suggested clinical improvement. Radiological assessment included watching bridging callus at fracture site.

## Results

**Table 1: Demographic variable details**

Variable	Frequency	Percentage
Sex		
Male	98	65.3
Female	52	34.7
Age group (year)		
21-30	18	12.0
31- 40	60	40.0
41-50	10	6.7
51-60	17	11.3
61-70	30	20.0
71-80	15	10.0

In the present study, Male subjects (65.3%) were more than female subjects (34.7%). The average age of subjects was 35 yrs

**Table 2: Mode of injury**

Mode of Injury	Frequency	Percentage
Road traffic accidents	93	62.0
Sports injury	02	1.3
Fall from height	10	6.7
Trivial trauma	43	28.7
Others	02	1.3
Total	150	100

The mode of injury in case of majority of the patients had RTA (road traffic accident) 93 patients (62%). Rest of the patients had trivial trauma (28.7%), fall from height 10 patients (6.7%), sports injury 2 patients (1.3%) and other injury 2 patients (1.3%)

**Table 3: Types of fracture on radiological assessment**

Type of fracture	Frequency	Percentage
Closed		
Transverse	11	7.3
Spiral	06	4.0
Oblique	08	5.3
Communitied	02	1.3
Inter-condylar	07	4.7
T- shaped fracture	13	8.7
Compound	22	14.7
Isolated femoral	46	30.7
Poly-trauma	35	23.3

Out of all study participants 47 patients (31.3%) had closed fractures followed by isolated femoral (30.7%), Polytrauma (23.3%) and 22 patients (14.7%) had compound fractures

**Table 4: Co-morbidities**

Co-morbidities	Frequency	Percentage
Diabetes	40	26.7

Hypertension	15	10.0
Osteoporosis	45	30.0
No co-morbidities	50	33.3

In the present study, out of all study participants 50 patients (33.3%) had no co-morbidities. Osteoporosis (30%) followed by diabetes (26.7%), and 15 patients (10%) had hypertension.

**Table 4: Complications**

Complications	Frequency	Percentage
Yes	10	6.7
No	140	93.3

In the present, surgical and technical related complications were encountered in 10 patients (6.7%).

Mean time of the patient from facing the trauma and receiving the treatment was 4 days.

The approximate duration of surgery in the present study ranged from 60-90 minutes and average duration of 75 mins was observed.

**Table 5: Postoperative evaluation**

### 1. Neer Score<sup>17</sup>

Parameter	Unit value
A) Functional (70 units)	
Pain (20 units)	
5 No pain	20
4 Intermittent or bad weather	16
3 With fatigue	12
2 Restrict function	08
1 Constant or at night	4-0
Function (20 units)	
5 As before injury	20
4 Mild restriction	16
3 Restricted: stairs sideways	12
2 Cane or severe restriction	08
1-0 Crutches or brace	4-0
Motion (20 units)	
5 Normal or 135°	20
4 100°	16
3 80°	12
2 60°	08
1 40°	4
0 < 40°	0
Work (10 units)	
5 As before injury	10
4 Regular but with handicap	08
3 Changed work	06
2 Light work	04
1-0 No work	2-0
B) Anatomic (30 units)	
Gross anatomy (15 units)	
5 Thickening only	15
4 5° angulation or 0.5 cm short	12
3 10° angulation or rotation, 2 cm	09

short	
2 15° angulation or rotation, 3 cm short	06
1 Union, but with greater deformity	03
0 Non-union or chronic infection	00
Roentgenogram (15 units)	
5 Near normal	15
4 5° angulation or 0.5 cm displacement	12

3 10° angulation or 1 cm displacement	09
2 15° angulation or 2 cm displacement	06
1 Union, but with greater deformity: spreading of condyles, osteoarthritis	03
0 Non-union or chronic infection	00

## 2. Lysholm & Telgen Score<sup>15,16</sup>

Shortening (mm)	Varus / valgus (°)	Antecurvatum/ retrocurvatum (°)	Total scoring
0-9 (4 points)	0-3 (4 points)	0-3 (4 points)	Excellent (10-12 points)
10-19 (3 points)	4-7 (3 points)	4-7 (3 points)	Good (7-9 points)
20-29 (2 points)	8-12 (2 points)	8-12 (2 points)	Fair (4-6 points)
> 30 (1 points)	> 12 (1 points)	> 12 (1 points)	Poor(2-4 points)

Our patients had a mean value of 80 points according to Neer score. Patients having an extra-articular fracture had a score of 9-11 and intra-articular had a score of 7-9 according to Lysholm and Telgen score; suggesting a positive outcome.

3. HEALING TIME- 26 weeks.
4. INFECTION RATE-1.7%
5. STIFFNESS-6-8 cases (had bad communitated condyle fracture).
6. DVT- 2 cases
7. RANGE OF MOTION- in patients having supra-condylar with inter-condylar fractures, terminal motion was restricted.

## Discussion

Operative treatment of distal fractures is frequently problematic, as in young patients & high energy trauma poly-trauma and communitated fractures is a common entity. While in elderly patients osteoporotic bones or underlying implants create difficulty in management.

Conventional methods like antegrade nailing or plating are routinely done.

Plating causes considerable surgical trauma & impairment of local vascularity which is reflected in high rates of septic complications & primary non union. Further it provides stability from one side only hence in osteoporotic bones is of less value as IMSC provides intramedullary support.

Antegrade nailing for distal third fracture shaft femur- it is most frequently done procedure. Also distally the medullary canal of femur is large and these nails though interlocked nicely have place to move about failing to provide the needed stability and may break in due course.

Patients after this procedure have higher incidence of thigh pain, abductor weakness, altered gait & severe discomfort while climbing stairs. Similar findings have been stated by Bain et al in his study.<sup>18</sup>

Green Seligson Henry nail was first to use standard retrograde IL nail to treat supracondylar fracture femur<sup>19, 20</sup> through intercondylar approach.

Our method of retrograde nailing is highly beneficial in such circumstances. The standard IMSC nail comes in size of 18 cm to maximum 25 cm. This is ideal for supracondylar fracture only and fall short for stabilizing associated fracture shaft higher up. So the nail used is 'long supra-condylar IL nail' and is available in sizes beyond 25 cms up to 42 cm to manage the supracondylar/intercondylar/shaft femur fracture. It has 3 interlocking holes mediolaterally to have a good hold of distal segment & 2 interlocking holes proximally. Long IMSC is preferred as, they reach upto lesser trochanter and avoids potential problem with injuring local anatomy with proximal AP interlocking and prevent windshield wiper by crossing the isthmus and improving stability.<sup>21</sup>

Berg and Watson have also stated similar results from their study.<sup>22</sup>

The entry point is between the inter-condylar part, which is non-weight bearing hence causes minimum postoperative pain/ complications. Carmack has stated that identification of an optimal entry point by c-arm alone resulted in 100% of portals located within a safe area in relation to the patella-femoral joint causing no harm to PCL.<sup>23</sup>

However leaving the nail proud by even 1mm in notch or inadvertently reaming the patella, places the patella-femoral joint at risk for destruction.<sup>3</sup>

Mean operative time, and estimated blood loss were lower in the nailing group (P<0.001).<sup>3</sup>

Thomson et al evaluated outcomes at an average of 6.7 years for 11 patients with traditional open reduction internal fixation 11 others treated with limited open reduction with Retrograde Intramedullary Nail for C-type distal femur fractures. The rate of subsequent bone grafting procedures (67% v/s 9%) and malunion (42% v/s 0%) were significantly higher in open reduction

internal fixation compared with less invasive Retrograde Intramedullary Nailing treated.<sup>24,25</sup>

This procedure has resulted in earlier healing without compromising the mobility and strength of the bone. El Kawy has proved that early mobilization was achieved with this technique.<sup>26</sup>

Similarly, Henderson CE et al. discovered a 2-4 times more callus formation at the fracture site, at 12 weeks after fixation in nailed patients than in plated ones.<sup>27</sup>

Also in cases of poly-trauma, where tibia fracture also needs to be fixed this method proves to be the best. Through a single incision both can be dealt with in the same sitting.

Janzig et al. attributed better results in femoral shaft fractures, young age and absent pre-existing lower extremity pathology.<sup>28</sup>

Retrograde nailing has been proved to be superior than antegrade nailing by Nagla et al.<sup>2</sup>

The incidence of fat embolism remains same in both technique (antegrade/retrograde).

Ricci et al. have found mal-reduction rate of 0-3% in both methods.<sup>29</sup>

Tornetta & Tiburzi et al. also Ostrum et al. found no difference in knee or hip range of motion with both the procedures.<sup>9, 30</sup>

Quadriceps weakness is a potential problem with retrograde nailing. However this can be overcome by exercise regimen. Herscovici & White et al series has accounted the reduced strength in affected leg which has responded well to exercise.<sup>31</sup>

Moed and Watson et al in their study, stated cases where implant removal was indicated, arthroscopic evaluation was performed. No new bone formation was seen. Entrance port had fibro-cartilaginous tissue on biopsy. Synovial fluid had catalytic enzymes & growth inhibiting factors.<sup>32</sup>

## Conclusion

From the present study, it was found that, retrograde nailing using long IMSC the most convenient way to deal lower third fractures of femur and supracondylar fractures.

Being a closed reduction procedure, it eliminates the problems which would have occurred due to an open surgery. Lower infection rate eliminates the need of higher dose and higher generation antibiotics.

It does not compromise the biomechanical stability, rather has a quicker and a better response.

Patients having distal femur fractures with other hip co-morbidities like ankylosed hip, pelvis fractures, unstable pelvis, implant /prosthesis in hip, floating knee can also be dealt with ease using this procedure.

Technique related advantage is that when dealing with distal segment is short so entry and control of segment is easy than compared to nailing ante-gradely, whereas it is difficult to have control over distal

segment for reduction, alignment and negotiating the nail intra-operatively.

This procedure can be advantageously used in cases of ipsilateral tibia and femoral fracture also bilateral lower extremity fractures. Very safe and easy in obese patients also patients having prosthesis or implant in hip. It does not add to the cost or treating time rather it reduces the economic burden on the patient. They can return to work early without having increased non-union, mal-union or infection rates.

The inherent complications of the procedure like knee pain, stiffness, atrophy of quadriceps & joint infection can be minimized by careful case selection & a well experienced surgeon with his technique.

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