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### A clinical study of management of supracondylar femur fracture with retrograde nailing

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#### Abstract

**Introduction:** Supracondylar femur fractures are fractures that involve the distal 15cm of the femur. Because of the proximity of these fractures to the knee joint, regaining full knee motion may be difficult. Earlier a nonsurgical approach was used. Later in 1970s to early 1990s open reduction and internal fixation by means of plate and screw osteosynthesis, has emerged. Later Flexible intramedullary nailing, modified antegrade nailing, allowed fracture fixation with minimal exposure of the fracture site. However, axial and rotational stability of these implants are inferior. To counter these problems, retrograde supracondylar nailing was developed for stable interlocked nailing. The advantages of the supracondylar nail include a reduction in operating time and blood loss with reduction of devascularization of fracture fragments.

**Aim of the Study:** The present study is undertaken to evaluate and explore supracondylar nailing in supracondylar fractures of femur with emphasis on a stable fixation with minimal exposure, early mobilization, less complications and a better quality of life.

**Materials and Methods:** The present study was conducted in the department of orthopaedics at Alluri Sitarama Raju academy of medical sciences Hospital, Eluru, September 2016 and January 2019 (over a period of 28 months). 33 adult patients with supracondylar Fracture Femur were selected for the present study.

**Results:** All fractures had a good clinical and radiological union. The fractures were stabilized with retrograde nailing in this series, the majority of the patients with distal femur fractures were due to road or automobile accidents upto the extent of 54.6%. The operative time for 42.4% of cases is 1 to 1and1/2 hr. Functional evaluation was done using Sanders 40 point functional evaluation scale. At the end of study, 87.9% cases had good to excellent results and 12.1% cases had fair results and no patient had poor results.

**Conclusion:** From this study, it is concluded that, supracondylar nail is the optimal tool for many supracondylar fractures of femur. It provides rigid fixation, with significantly less periosteal stripping and soft tissue exposure than that of lateral fixation devices.

**Keywords:** Distal femur, Retrograde nailing, Biological fixation

#### 1. Introduction

Supracondylar femur fractures are fractures that involve the distal 15 cm of the femur including the distal femoral metaphysis with or without involvement of the articular surface of the distal femur [1]. These fractures occur at approximately one-tenth the rate of proximal femur fractures and make up six percent of all femur fractures. The most common high-energy mechanism of injury (between 15 to 50 years) is a road traffic accident (53%) and the most common low-energy mechanism (in osteoporotic women > 50 years) [2, 3] is a fall at home (33%). High-energy injury leads to severe comminution. Long-term disability can occur in patients with extensive articular cartilage damage and severe soft tissue injury. Because of the proximity of these fractures to the knee joint, regaining full knee motion may be difficult. The incidences of malunion, nonunion and infection are relatively high in many reported series [3-5]. The goal in treating supracondylar and intercondylar femur fractures, as with any per articular fracture in a weight bearing bone, is restoration of a stable limb for functional, pain-free ambulation, maintaining anatomic alignment, length and preventing stiffness to restore function of knee joint [1, 4]. Earlier a nonsurgical approach was recommended for supracondylar

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femur fractures. Early conversion to cast bracing after a period of traction was later introduced, claiming to offer better functional outcomes compared with prolonged casting across the knee. The number of complications were unacceptably high [2].

Since late 1970s to early 1990s open reduction and internal fixation by means of plate and screw osteosynthesis (condylar blade plate and dynamic condylar screw) has emerged as the gold standard of operative treatment. The advantages of internal fixation (early mobilization) can be off set, however, by the required access route, leading to iatrogenic periosteal stripping of the bone. Additionally revision surgery due to pseudoarthrosis and infection is common. Rigid fixation is often difficult to achieve particularly in osteoporotic bone because of the degree of comminution and poor holding power of the bone [6].

Flexible intramedullary nailing, modified antegrade nailing, and external fixation allowed fracture fixation with minimal exposure of the fracture site. However, axial and rotational stability of these implants are inferior in distal femur and early mobilisation of the limb could result in loss of reduction [2]. To counter these problems, retrograde supracondylar nailing with cannulated stainless steel GSH nail was developed for stable interlocked nailing in 1988 [7].

The advantages of the supracondylar nail include a reduction in operating time and blood loss with reduction of devascularization of fracture fragments. In cases with severe metaphyseal comminution, supracondylar nailing offers a more biological method of fixation with less devitalisation of soft tissue. Fixation of intercondylar fractures is also possible with additional compression screws to stabilise the intra-articular fragments. Metaphyseal fragments are left undisturbed, which limits the need for bone grafting. It is especially useful in obese patients and in fractures occurring below hip implants or above total knee implants that have an open notch design. It provides good axial and rotational stability for treating both open and closed fractures resulting in early mobilization. Furthermore, small incision area results in early recovery with minimal morbidity for the patient [8,9].

In view of the above context the present study is undertaken to evaluate and explore supracondylar nailing in supracondylar fractures of femur with emphasis on a stable fixation with minimal exposure, early mobilization, less complications and a better quality of life.

## 2. Materials and Methods

The present study was conducted in the department of orthopaedics at Alluri Sitarama Raju academy of medical sciences Hospital, Eluru, September 2016 and January 2019 (over a period of 28 months). 33 adult patients with supracondylar Fracture Femur were selected for the present study. A total number of 1336 bony injuries were reported to casualty and Orthopaedic OPD during the above said period. Out of which 927 were lower limb fractures. The femoral fractures 437(47.14%) and the supracondylar femoral fractures are 54. By deducting patients who come under exclusion criteria, 36 patients were selected for retrograde nailing. Two patients died due to associated medical comorbidities, one patient was lost for follow up hence functional assessment was done on 33 patients.

### 2.1 Inclusion and exclusion criteria

Male and female patients more than 18years of age with supracondylar fracture femur with an indication for surgical management even patients with multiple fractures were

included in the study. Whereas, Patients less than 18 years of age, Patients who were non ambulatory or bedridden patients with knee sepsis or Severe infection present somewhere in body, Type IIIB, IIIC compound injuries were excluded from the study.

On admission all patients were evaluated clinically and radiologically and were stabilized haemodynamically. Radiographs of knee with thigh, AP & Lateral were taken. Skin traction was applied to the fractured limb as a preliminary measure. Routine lab surgical profile was done for all patients and were obtained fitness for anesthesia and surgery. patients were operated as early as possible using standard midline incision over the knee.

### 2.2 Surgical procedure

Patients were operated under epidural/spinal/ general anaesthesia. Patient was placed in supine position over a radiolucent operating table. Tourniquet was applied, parts scrubbed, painted, draped. Fluoroscopic control was used throughout the procedure. Fracture was reduced either with a tibial traction pin or with manual traction. Rotational alignment was obtained by aligning the iliac crest, patella, and first web space of the foot in comparison with the uninjured leg. The nail was inserted with either an open or percutaneous technique. An open technique is necessary for accurate reduction of displaced intercondylar fractures. The knee joint was entered through a standard midline incision or medial parapatellar capsular incision. For the percutaneous technique, a five cm vertical incision was centered over the patellar tendon, extending from the inferior pole of the patella to 1 cm above the tibial tubercle, incising the center of the patellar tendon vertically in the direction of the longitudinal fibers, Intercondylar fractures were anatomically reduced and stabilized With Kirschner wires. A large pointed clamp aids in maintaining reduction. The medial and lateral femoral condyles are lagged together with 6.5 mm partially threaded cancellous screws placed in a lateral to medial direction in the anterior and posterior segments of the condyles at least 1.5 mm apart. Preoperative radiographs and CT scans should be scrutinized for tangential posterior fractures of the condyles. These fractures (Hoffa's fracture) require screw osteosynthesis in an anteroposterior direction.

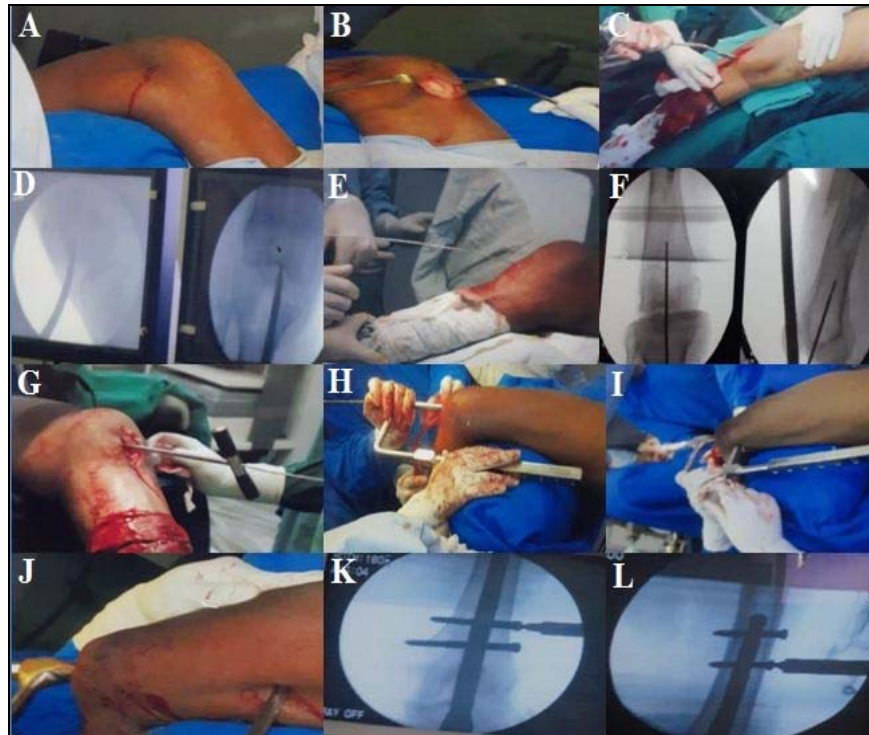
Entry point was made in the center of the intercondylar notch, just anterior to the origin of the posterior cruciate ligament or approximately five mm anterior to the posterior cortex. Either an awl or a cannulated step reamer over a guide pin was used to make the entry portal. The portal was aligned with reference to the condyles, not the femoral shaft. After creation of the entry portal, awl was removed and replaced with a ball-tipped guide wire & centered in the middle of the medullary canal both in AP & Lateral views. This guide wire was advanced across the fracture into the diaphysis under fluoroscopic control. There are several ways to achieve reduction. The most Simple is manual traction and the reduction, drill sleeve which can be used to "joystick" the distal fragment into place with this maneuver, a femoral distractor may be used. It is important to remember the anatomic relationships of the supra condylar region and the femoral shaft when reaming. If the distal fragment is reamed exactly perpendicular to the joint line and not at 5° to 7° valgus to the femoral shaft, then the distal fragment will be fixed in varus. An eight mm end-cutting reamer was used to enlarge the condylar portal and then progressively reamed in 0.5 mm increments to one to 1.5 mm larger than the diameter of the selected nail. The shaft was reamed to a point slightly

proximal to the expected tip of the nail. The entry point was reamed 1.5 mm larger than the selected nail to avoid displacing the condyle when the nail is inserted.

**Nail Selection:** The size of the implant was based on the location and extent of the fracture. It was ensured that the size chosen will enable the nail to be locked securely into the proximal non-fractured zone, in fractures with diaphyseal extension long nail upto just below the lesser trochanter was used.

**Nail Insertion:** A nail of the proper length and diameter was connected with the alignment rod placed through the guide bar. The apex at the distal end of the nail usually was directed

dorsally and guide bar positioned laterally. The nail was advanced over the guide wire into the distal condyles and then across the fracture site, into the diaphysis. The nail was advanced until the distal end was countersunk two to five mm below the surface of the intercondylar notch and guide wire was removed. Failure to countersink the nail may adequately lead to patellar impingement. Anterior to posterior or lateral to medial blocking screws can be used to help align the nail and prevent malreduction at this point. These supracondylar nails should be statically locked with at least two distal and two proximal screws. The distal interlocking screws usually were placed first. The wounds were irrigated copiously and closed in layers with a drain in situ.



**Fig 1:** (A) Positioning, (B) Incision, (C & D) Making the entry point, (E & F) Passing the guide wire, (G) Reaming, (H) Passing the nail, (I, J, K & L) Locking

### 2.3 Post-operative protocol

Post operatively patients are advised non weight bearing. Static quadriceps exercise was started from 2nd post op day. Continuous passive motion of knee was initiated on 3<sup>rd</sup> post operative day. Active knee range of motion was started as early as possible. Weight bearing advised depending on the fracture type and stability of fixation and evidence of fracture union radiologically and clinically.

### 2.4 Follow-up

Fracture was considered united when bridging callus was evident on one or more radiographs and patients were able to walk without crutches. Patients were followed at 6wks, 3 months, 6months, 12 months, 18 months. For each fracture type, the long term results were evaluated using Sanders 40 point functional evaluation scale, which assigns points for pain, working and walking capacity, knee range of movement, radiological appearance, etc.

### 3. Results and analysis

Observation and analysis of results was done in relationship

to age, sex, laterality of fracture, type of fracture, mode of violence, duration of surgery, amount of blood loss, time for radiological union, complications and the functional outcome. In our Series, the majority of the patients are found to be between the age group of 40-59 years 15 patients (45%) and 60-79 years 10 patients (30%). The youngest being 21 years and the eldest being 77years (TABLE 1). Among 33 cases total number of male cases were 22 (66.7%) and total number of female cases were 11 (33.3%). This incidence of sex in supracondylar femur fractures can be attributed to an overwhelming large proportion of male patients, because in Our indian setup, the female population largely working indoors or in agricultural fields and do not indulge themselves in travelling or outdoor activities (TABLE 2).

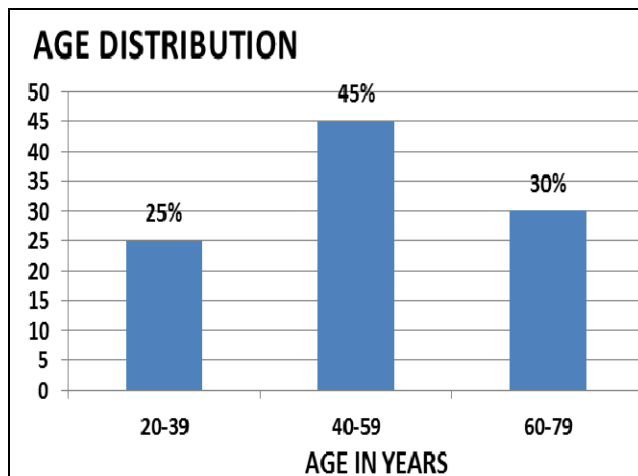
In this series, the majority of the patients with distal femur fractures were due to road or automobile accidents upto the extent of 54.6% (TABLE 3), with right side predominance about 20 cases (60.6%) and left side distal femur fractures are about 13 (39.4%) (TABLE 4). In our series, the majority of the fractures were found to be of AO type A-1 (36.4%) and A-2 and A-3 types are next to that 8 (24.3%) (TABLE 5).

The operative time for 6 cases (18.3%) took 30 to 60 minutes, 14 cases (42.4%) took 1 to 1 and 1/2 hr, 11 cases (33.3%) took 1 1/2 - 2 hrs, 2 cases (6%) took 2 to 2 and half hours. (TABLE 6). Time taken for fracture to unite for 16 cases (48.7%) it took 10 to 12 wks, 13 cases (39.3%) took 13 to 14 wks, 2 cases (6%) took 15 to 16 weeks, and 2 cases (6%) took 17 to 18 wks. (TABLE 7).

Among 33 cases complications are seen in 12 cases. 2 cases (6%) had anterior knee pain due to nail impingement, 1 patient (3%) had superficial infection, 1 patient (3%) had delayed union, 4 cases had knee stiffness (12%), 1 case had shortening (3%). 1 case had (3%) screw loosening (TABLE 8). Functional evaluation was done using Sanders 40 point functional evaluation scale, which assigns points for pain, working and walking capacity, knee range of movement, radiological appearance, etc. At the end of study, 29 cases (87.9%) had good to excellent results and 4 cases (12.1%) had fair results and no patient had poor results (TABLE 9).

**Table 1: Age Distribution**

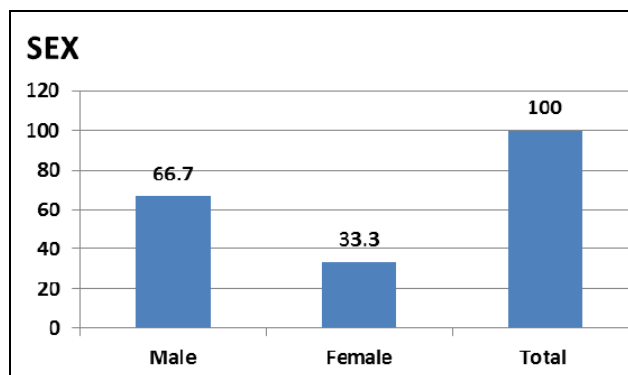
Age in years	No. of cases	percentage
20-39	8	25
40-59	15	45
60-79	10	30
Total	33	100



**Fig 1: Age distribution**

**Table 2: Sex Distribution**

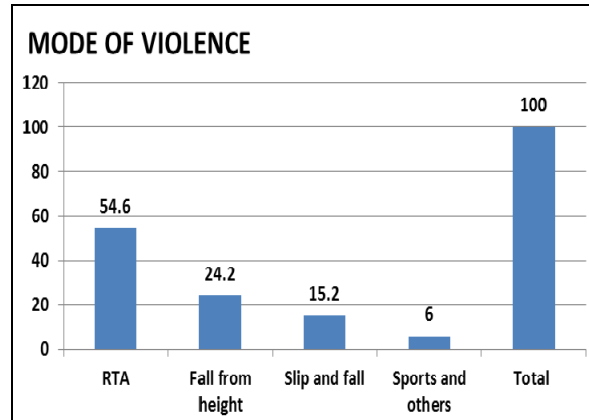
Sex	No. of cases	Percentage
Male	22	66.7
Female	11	33.3
Total	33	100



**Fig 2: Sex Distribution**

**Table 3: Mode of violence**

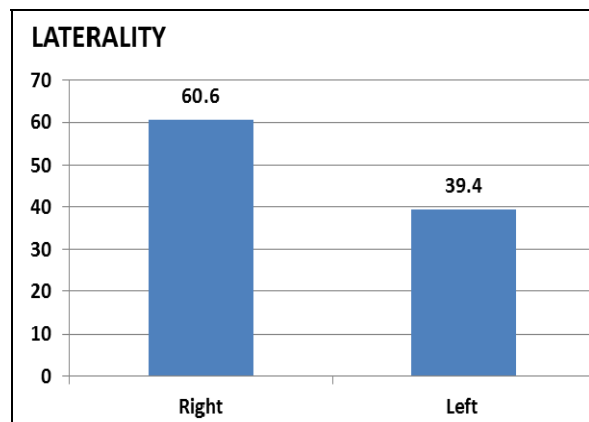
Mode of violence	No. of cases	Percentage
RTA	18	54.6
Fall from height	8	24.2
Slip and fall	5	15.2
Sports and others	2	6.00
Total	33	100



**Fig 3: Mode of violence**

**Table 4: Laterality of Fractures**

Laterality of fractures	No. of cases	Percentage
Right	20	60.6
Left	13	39.4



**Fig 4: Laterality**

**Table 5: Type of Fracture**

Type of fractures	No. of cases	Percentage
A1	12	36.4
A2	8	24.3
A3	8	24.3
B2	1	3.0
C1	2	6.0
C2	2	6.0

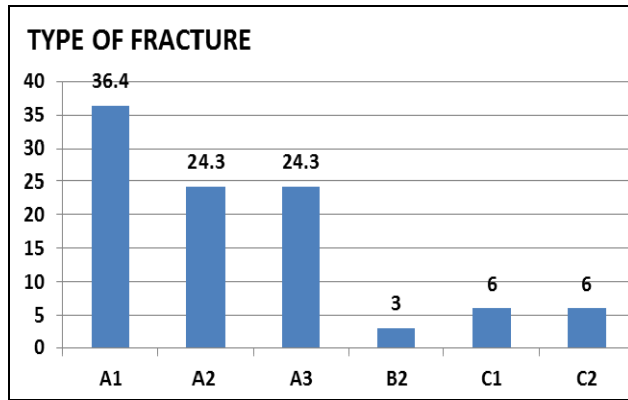


Fig 5: Type of Fracture

Table 6: Duration of surgery

Duration	No. of cases	Percentage
½-1 hr	6	18.3
1-1½ hrs	14	42.4
1½-2 hrs	11	33.3
2-2½ hrs	2	6

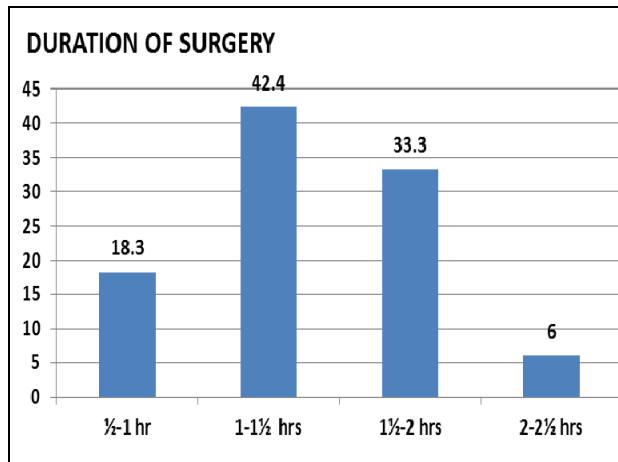


Fig 6: Duration of surgery

Table 7: Time for radiological union

Time	No. of cases	Percentage
10-12 wks	16	48.7
13-14 wks	13	39.3
15-16 wks	2	6
17-18 wks	2	6

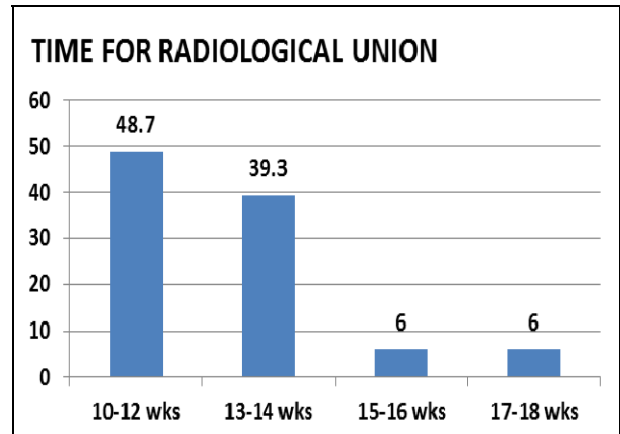


Fig 7: Time for radiological union

Table 8: Complications

Complications	No. of cases	Percentage
Anterior knee pain	2	6
Knee stiffness	4	12
Superficial infection	1	3
Delayed union	1	3
Shortening	1	3
Screw loosening	1	3

Table 9: Clinical Results

Clinical results	No. of cases	Percentage
Good to Excellent	29	87.9
Fair	4	12.1
Poor	0	0

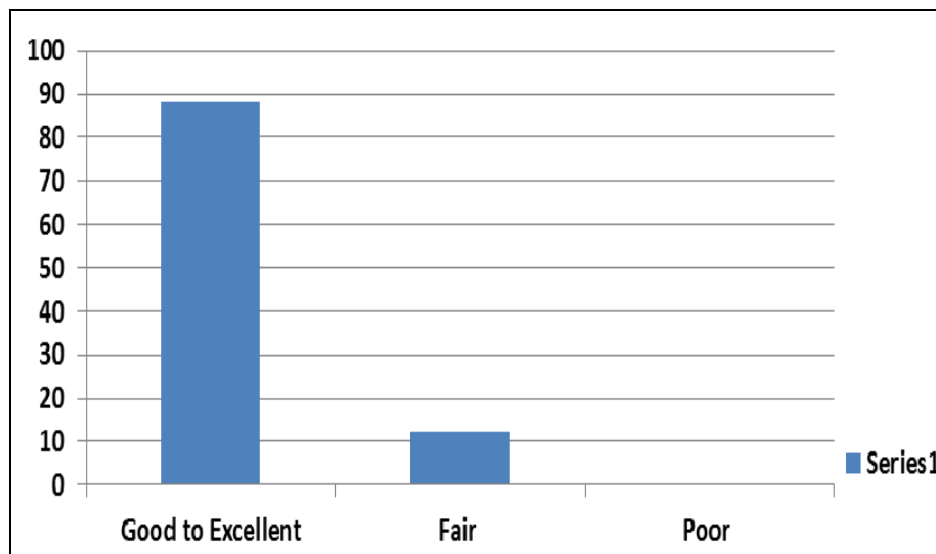


Fig 8: Clinical Results



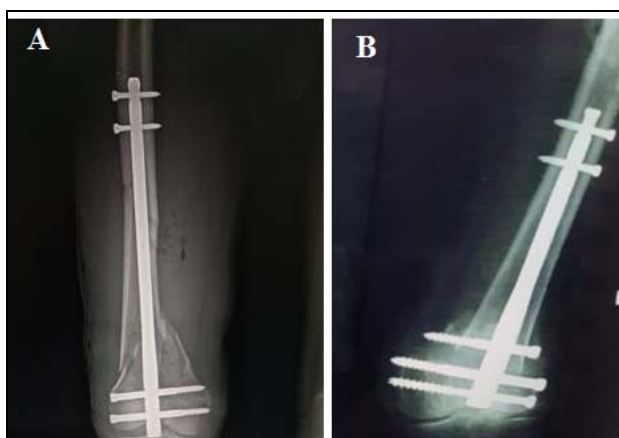


**Fig 2:** Normally healed distal femur fracture (case 1)

A) At the time of fracture, B) postoperative image C) at 18 months follow up with normally healed fracture site.



**Fig 3:** Normally healed distal femur fracture (Case 2) A) At the time of fracture, b) postoperative image c) at 18 months follow up with normally healed fracture site



**Fig 4:** Complications A) Nail Impingement B) Screw Backout

**4. Discussion**

There has been no uniform reporting of the results of treatment of supracondylar femur fractures. It is difficult to compare the results of different reported series in literature, because of differences in demographic characteristics and differing fracture characteristics and is further complicated by the use of different classification systems and functional

rating systems. The results for different fracture groups should be separately analyzed, otherwise "mix" of fractures may alter results.

Lucas SE [9] (1993) observed 39 as mean age group and sex incidence was 13 males and 11 females, Gellmann RE [10] (1996) observed that, there were 10 males (mean age 39 years) and 12 females (mean age 60 years) with overall mean age of 50 years, Watanabe Y [11] (2002) study, whose mean age was 64 years, there were 4 male and 20 female patients. In our series, there were 23 male patients with age group 34.89 years, and 10 female with average age of 47.5 years. Overall mean age was 50.9 years. Out of 33 patients, 18 were below 59 years and of them, 8 were below 39 years age.

Studies conducted by Schatzker *et al.* [12] (1974), (1990) and Leung KS *et al.* [13] (1991), demonstrated road traffic accidents as the major causal factor, Lucas SE [9] (1993) reported 79% road traffic accident, 17% fall and 4% gun shot wound. Gellmann RE [10] (1996) stated that high energy fractures occurred more in young, male patients and low energy falls caused fracture in older women and men. In the present series, road traffic accidents accounted for 54.6% of cases and 24.2% resulting from fall.

In the present series, 7 patients had associated injuries. Of the 7 injured patients, 1 with ipsilateral proximal tibial fracture

had knee flexion of average 80 degrees, 2 Patients with patellar fracture had knee flexion of 100<sup>0</sup>, 2 patients with contra lateral shaft femur fracture had average knee flexion of 115<sup>0</sup>. One with ipsilateral intracapsular fracture and one with ipsilateral distal radius fracture had knee flexion of 115<sup>0</sup>. Thus, it appears that though significantly less number of patients in the present series had associated trauma, it seems to affect the final outcome. This can be attributed to delayed mobilization and delayed weight bearing in these patients.

Average operative time in this series was 86.8 minutes (75-140minutes). A Kumar A <sup>[14]</sup> (2000) reported average operative time as 58 minutes. Watanabe Y <sup>[11]</sup> (2002) reported average operative time as 108 minutes. Gellman GE <sup>[10]</sup> (1996) reported operative time for Type-A 113 minutes. Watanabe Y <sup>[11]</sup> (2002) reported operative time for Type-A 90minute. Christodoulou A <sup>[15]</sup> (2005) reported average operative time of 92 minutes. Majority of the fracture of A1, A2 required operative time of less than 90 minutes ie., 85 minutes and 86.42 minutes respectively, while the average operative time was 114 minutes in type-A3 fractures.

In the present study fractures united at an average of 12.5 weeks. Danziger MB <sup>[16]</sup> (1995) reported average radiological union time of 12.4 weeks. Gellmann GE <sup>[10]</sup> (1996) reported average radiological union time of 12 weeks. Kumar A <sup>[14]</sup> (2000) reported average radiological union time of 14 weeks. The patients who required more time for union had some associated injuries, which delayed the period of mobilization and partial weight bearing.

In the present study, the average knee flexion was 103 degrees. Gellmanna GE <sup>[10]</sup> (1996) obtained an average knee flexion of 106 degrees. Kumar A <sup>[14]</sup> (2000) obtained an average knee flexion of 100 degrees. Watanabe Y <sup>[11]</sup> (2002) obtained an average knee flexion of 102 degrees. Ingman AM <sup>[17]</sup> (2002) obtained an average knee flexion of 101<sup>0</sup>. In the present study, 10 out of 12 patients with A1-type had >115 degree knee flexion (80%), 3 of 8 patients with A2 type had >115 degrees flexion (42.86%) while none of the 8 patients of type A3 had >115<sup>0</sup> knee flexion.

Fractures which were managed with closed reduction and internal fixation had better flexion than fractures which had to be opened for reduction. This could be explained on the basis of surgical trauma to quadriceps mechanism with open reduction and subsequent soft tissue healing with fibrosis as mentioned earlier. Also, it was found that, injury-surgery interval was inversely proportional to knee flexion. The lesser the injury-surgery interval, better the knee flexion. Lucas SE<sup>9</sup> (1993) noted that, "the consistently patients showed a continued increasing range of motion for 12 months and frequently for 15 months post-operative. Of the patients who had less than arc average of 100<sup>0</sup> motion, 5 of 7 patients had less than 12 months follow-up evaluation and 9 of 12 had <15 months.

Complications: There has been no report of infection by any authors except for Lucas SE <sup>[9]</sup> (1993) who reported one case of septic knee nine months after nail insertion in a patient who had multiple bouts of intra-abdominal sepsis and multiple abdominal surgeries. The infection resolved after removal of nail and irrigation and debridement of knee. In the present series, there was one case of superficial infection in the immediate postoperative period which was controlled with debridement and antibiotics. Four cases of non-union were reported by Iannacone WM <sup>[18]</sup> (1994), which were treated with bone grafting and revision fixation. Kumar A <sup>[14]</sup> (2000) reported one case of non-union but attributed it to technical error, rather than implant. Christodoulou A *et al.* <sup>[15]</sup> (2009)

reported 2 cases of non-union in their study. All other studies reported good and solid union. In the present series, also there was no case of non-union and all fractures united radiologically at an average of 12.5weeks. Iannacone WM <sup>[18]</sup> (1994) reported 5 delayed unions which were treated with screw removal and dynamization or revision internal fixation. Danziger MB <sup>[10]</sup> (1995) also reported a case of delayed union. In the present series, there was a case of A3 type of supracondylar fracture, associated with ipsilateral intracapsular fracture neck of femur and fixed with cancellous screws, after which patient was immobilized for 10 weeks and the supracondylar fracture showed bridging callus and clinical signs of union at 18 weeks. No secondary procedure was done in that patient except for delayed full weight bearing. Kumar A <sup>[14]</sup> (2000) reported a case of loosening of distal screw in 1 patient 4 weeks after surgery which was removed without affecting final Outcome. Watanabe Y <sup>[11]</sup> (2002) reported 2 cases of distal screw breakage in whom early weight bearing was permitted. In the present series, 1 patient had loosening of the distal screws due to osteoporosis, which required screw removal after fracture healing. High implant failure rate was reported by Danziger MB <sup>[16]</sup> (1995) and Iannacone <sup>[18]</sup> (1994) in their studies where nails with multiple holes were used along with 6.4 mm locking screws. With the modification of the nail to total 4 to 5 holes placed at both ends with screw size of 5.0 mm, no implants failure has been reported in newer studies. In our study also, there were no cases of implant failure. In the present series 2 nails showed impingement in the intercondylar notch, due to error in technique. They were removed after solid bone union. In Lucas SE <sup>[9]</sup> (1993) study 1 patient had shortening of >3 cm while Gellmann GE <sup>[10]</sup> (1996) reported 6 out of 24 patients having 2 cm shortening and Kumar A <sup>[14]</sup> (2000) reported as average shortening of 1.4 cm. In the present study, 1 patient had shortening of 2.5 cm due to gross comminution of fracture, which was managed by giving a shoe raise. Neer *et al.* <sup>[4]</sup> (1967) reported 52% satisfactory results with this operative method. Gellmann GE <sup>[10]</sup> *et al.* (1996), reported 84% good to Excellent results with Sander's 40 point evaluation scale in their study. In the present series, 87.9% had Sander's score of good to excellent.

Thus fractures of the distal femur present considerable challenges in management. Retrograde intramedullary nailing offers a kind of Biological osteosynthesis, and is a good fixation system for these fractures, particularly extra-articular type. It is in the line of load bearing axis, provides additional stability for active motion. The operative-time is lessened with decrease in blood loss. Obese patients can be operated more efficiently. Closed reduction can be achieved by not disturbing fracture hematoma and soft tissue, and there is no periosteal stripping. Even with open reduction, there is less soft tissue trauma and less post operative stiffness. There is no non-union, less delayed unions and rates of angular or Rotational malunions. Non-requirement of bone graft, decreases the morbidity associated with donor site. Early surgery, closed reduction, at least two screws in each fragment and early post-operative knee mobilization are essential for good union and good knee range of motion. Distal screw related local symptoms is a common problem and is related to implant and technique; and has a definite learning curve. Utmost great care require to avoid infection. Disadvantages are opening of the Knee joint, Damage to the cartilage, lack of appropriate fracture reduction, chances of mal- alignment, cruciate ligament injury, nail migration into the joint, knee stiffness, patello- femoral arthrosis. These

complications can be prevented or minimised with strict adherence to proper decision making, meticulous surgical technique and diligent postoperative management.

### 5. Conclusion

From this study, it is concluded that, supracondylar nail is the optimal tool for many supracondylar fractures of femur (especially Extraarticular and simple intraarticular fractures). It provides rigid fixation in a region of femur, where a widening canal, thin cortices and frequently poor bone stock make fixation difficult. Surgical exposure for nail placement requires significantly less periosteal stripping and soft tissue exposure than that of lateral fixation devices. Orthopaedic surgeons experienced with intramedullary nailing will find the supracondylar nail a useful technique, but requires meticulous attention to the technical details to prevent complications.

**Limitation of study:** Less sample and follow up period is suboptimal.

**Conflicts of Interest:** nil

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