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# Functional and Radiological Outcome in the Management of Segmental Femur Fractures By Intramedullary Interlocking Nailing

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**Abstract**

Fracture of the shaft of femur is a major cause morbidity and mortality in patients who sustain high energy trauma. Both mortality and morbidity can be diminished by prompt reduction and internal fixation of the fracture. Segmental femur fractures occur as a result of high energy trauma and they are usually accompanied by massive soft tissue damage. The purpose of this review is to analyze our results with interlocked nailing of segmental fractures of the femur. A prospective study was done from 2018-2020. A total of 14 patients who underwent intramedullary interlocking nailing for segmental femur fractures were included. Radiologic assessment was done using standard AP and lateral radiograph at 6 weeks, 3 months, 6 months, 9 months and 1 year. Functional outcome was assessed using Harris Hip Score (HHS). The mean duration of surgery was 127.5 minutes. The mean duration of radiological union was 24 weeks. There were two cases of delayed union which united subsequently without any further intervention and one case shortening more than 1.5 cm who required shoe heel raise. According to Harris hip score, we have got 7 excellent 6 good and 1 fair result in this series. Segmental fractures of femur are caused by high energy violence. Intramedullary interlocking nailing for segmental fractures of femur gives good to excellent results in 93% of patients. Segmental fractures treated by closed intramedullary interlocking nailing united at an average of 24 weeks. All fractures united without the need for secondary procedures

**Keywords**: NIL

## Introduction

Femur is the longest and strongest of the human bones and it possesses a well vascularized, thick envelope of muscles that predictably promotes rapid fracture healing in most patients.

Fracture of the shaft of femur is a major cause of morbidity and mortality in patients who sustain high energy trauma. Segmental femur fractures occur in approximately 5% of all femur fractures[1]. Segmental fracture femurs are the result of high energy trauma and they are usually accompanied by massive soft tissue damage [1] [2] and therefore can be both life threatening injuries and causes of severe permanent disability. Since patients who incur this type of fracture frequently have multiple injuries; stabilization of patients is the first objective in the treatment, but the two subsequent goals – bone union despite diminished vascularity and restoration of function despite extensive soft tissue trauma – present a great challenge [3].

Segmental fractures of the femur are difficult to treat. Plating of segmental femoral shaft fractures is also an option, but it has been associated with extensive

periosteal stripping, increased blood loss, increased operating room time and increased chance of infection [1].When electing intramedullary nailing, care must be taken for proper nail selection. Standard interlocking intramedullary nails may be used successfully for fractures that are distal to the lesser trochanter; however, this may require leaving the nail "proud" to ensure proximal fixation. Although technically difficult, interlocked intramedullary nailing has been recommended by several investigators and has demonstrated good results [1] [3].

Though union of fractures are achieved by intramedullary nailing, in various studies the delayed union rate was around 25% and non-union rate was around 5%. The purpose of this review is to analyze our results with interlocked nailing of segmental fractures of the femur.

## Materials and Methods

A Prospective study was done between the period of April 2018 – October 2020, in a tertiary care hospital. The period of follow up was upto 1 year or till the bone completely unites (whichever is earlier).

Inclusion criteria included all closed segmental fractures of femur operated by intramedullary interlocking nailing, Open segmental femoral fractures of Gustilo Anderson type 1, 2 and 3a operated by intramedullary interlocking nailing, age more than 18 years. Exclusion criteria includes open fractures of Gustilo Anderson type 3b and 3c, pathological fractures, previous chemotherapy and/or radiotherapy, rheumatic diseases, age less than 18 years. A total of 14 patients who underwent intramedullary interlocking nailing for segmental femur fractures and met the study criteria were studied prospectively, after obtaining institutional ethics committee approval.

All the patients underwent thorough pre operative assessment which includes history (mode of injury), Examination (To find associated injuries and neurovascular status), imaging (Antero-posterior and lateral radiograph of involved bone and other associated injuries). They were explained about the treatment plan, cost of operation, hospital stay after surgery and the possible complications. Initial treatment was at the emergency service, where the systemic condition was first stabilized. All patients with closed fractures were immobilized in a long leg splint. All Open fractures were adequately washed in the emergency room and were covered with a clean, dry dressing and were admitted with a long leg splint. The patients with significant wound contamination were taken to operative room and underwent thorough debridement and appropriate external fixator application. All the patients with open fractures were administered with IV broad spectrum antibiotics immediately on admission. On the day of surgery, prophylactic antibiotic (3rdgenration cephalosporin) is given 30 minutes prior to surgery, in the theater. Skin preparation was done using chlorhexidine solution.

Epidural and spinal anesthesia were used for all cases. Patients were then positioned spine. All the patients underwent intramedullary interlocking nailing under fluoroscopic control with the use of fracture table. Initially closed reduction was done in all the cases. If closed reduction failed after several attempts, then open reduction was done. Reduction devices commonly are required to obtain and maintain reductions. Mallets, spiked pushers, hooks and shank pins are frequently beneficial in aligning the fractured fragments. The criteria used for acceptable fracture reduction and alignment includes More than 75% of cortical contact, less than 5 degrees of varus / valgus angulation, less than 10 degrees of anterior/posterior angulation on lateral film, no internal or external rotation deformity was accepted.

Serial wound inspections were done on POD 2, 5, 8, 12 and 15. Staplers were removed on POD 15. Patient was started on non weight bearing mobilization, active quadriceps and hamstring muscle exercise on POD 2. Partial weight bearing mobilization was started only after the evidence of bridging callus formation on both the AP and lateral radiograph which was mostly around 4-6 weeks and Full weight bearing mobilization was then started gradually. Patients were followed at the Outpatient clinic every 6 weeks during the initial 6 months and then every 3 months till 1 year.

Radiologic assessment was done using standard AP and lateral radiograph at 6 weeks, 3 months, 6 months, 9 months and 1 year. Union was said to have occurred when there is callus bridging at least three cortices on two different views of the fracture



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radiologically. Delayed union is defined as no fracture healing after 6 months. Nonunion is defined as no fracture healing after 9 months. Malunion is defined as 10 degrees or more of angulation in any plane, or rotational malalignment of more than 15 degrees. Functional outcome was assessed using Harris Hip Score (HHS)

**Results**

Out of the total 14 participants, 6 participants were in 18 – 30 years, 6 participants belonged to 30 – 45 years. There was 1 participant each in 45 – 60 years and > 60 years. The mean age of the participant is 33 years and age group ranged between 18 – 67 years (Table 1). 1 participant was female remaining 13 were male.

28.6% had left sided fracture and 71.4% had Right sided fracture. 78.6% (11 participants) had closed fracture and 21.4% (3 participants) had open fracture. 93% (13 participants) had no comorbidity and 7% (1 participant) had comorbidity as diabetes and Hypertension. 50% (7 participants) had associated injuries and 50% (7 participants) had no associated injuries.

The mean duration of surgery was 127.5 minutes and ranged between 100 – 180 minutes. The mean delay in surgery was 4 days with range between 1 to 12 days. The mean blood loss during surgery was 268ml with range from 180-500ml.The mean hospital stay for the patients was 15 days which ranged from 4-26 days.

The mean duration of radiological union was 24 weeks, with range from 20 to 32 weeks.

The mean Hip flexion (degrees) was 114.3 degrees. The Hip flexion (degrees) ranged between 110 – 120 degrees. The mean Hip abduction was 33.57 degrees. The hip abduction ranged between 30 – 50 degrees. The mean Knee flexion (degrees) was 124.3 degrees. The Knee flexion (degrees) ranged between 110 – 130 degrees (Table 2).

14.3% (2 participants) had delayed union, 7.1% (1 participants) had shortening > 1.5cm and 78.6% (11 participants) had no complications (Table 3). 14.3% (2 participants) had 1cm limb length discrepancy, 7.1% (1 participant) had 2cm limb length discrepancy and 78.6% (11 participants) had no limb length discrepancy (Table 4). 50% (7 participants) had excellent harris hip score, 43% (6 participants) had good harris hip score and 7% (1 participant) had fair harris hip score (Table 5).

**Discussion**

Internal fixation of segmental fractures of femur has gained wide spread acceptance in the past decade as implants and technology have improved. The rationale for internal fixation is that it restores anatomical alignment and allows early mobilization of the patient.

The use of a plate to achieve osteosynthesis of segmental fractures necessitates a wide surgical exposure and extensive stripping of soft tissues, resulting in increased loss of blood and longer operative duration, which in turn increases the risk of infection and delayed healing. The plate also functions as a load-bearing device that will be subjected to fatigue. Intramedullary fixation, on the other hand, provides a load-sharing system in which impaction of the bone ends occurs and minimum stress is applied through the implant [3]. Thus fatigue of this implant would be expected to be rare. Because healing is prolonged in these severe injuries, a load-sharing rather than a load-bearing implant is desirable.

The success of intramedullary interlocking nailing for simple femoral shaft fractures has promoted the surgeons to extend its indications for segmental fractures of femur. Locking the nail into the bone with screws proximal and distal to the fracture affords immediate stability. However, intramedullary nailing of segmental fractures of the femoral shaft is a technically difficult procedure. Several authors have discussed the theoretical risk of spinning of central fragment during reaming, thereby damaging the blood supply and delaying healing. In their experience, the strong attachment of soft tissues along the lineaaspra prevents spinng in most patients [3]. However, when the intermediate fragment is less than 10 cms in length, spinning is a risk and reaming should be performed slowly and carefully.

Chi-Chuan-Wu [4] et al reported 35 segmental femoral shaft fractures treated with closed intramedullary nails. 82.9% union and union period of 6 months. 9 patients had complications with shortening of more than 2cms or angulation >10° and malrotation >10°. Wiss, D [1] et al have analysed 33



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segmental fractures of the shaft of the femur and were treated with the Grosse-Kempf interlocking nail. 28 of the fractures had been caused by high-energy trauma. There were 26 closed and 7 open fractures. 32 of the 33 fractures united, at an average of 32 weeks, without additional intervention other than dynamisation of the nail. There were one non-union, one delayed union and two malunions. Winquist and Hansen [3] et al reported closed nailing of segmental fractures of the femoral shaft with a Kuntscher nail. Of their twenty patients, six had more than one centimeter of shortening, and seven needed supplemental external support after nailing to prevent deformity.

Winquist [3] et al reported 30% of open fractures. Wiss [1] et al reported 21% of open fractures. In our series, the percentage of open fracture is 21% which is comparable with the other two studies.

Wiss [1] et al reported 60% cases with associated injuries. Winquist [3] et al reported 48% cases with associated injuries. In our series, the percentage of associated injuries is 50% which is comparable with the other two studies. It is important to depict the magnitude of these associated injuries. These patients usually sustain serious injuries to head, chest, abdomen or a combination of these. Presence of associated injuries like head injury will delay the waiting time for surgery. While all of the associated injuries need not be listed, this gives an idea about the multiple injuries in the patients under study.

In our series, the average time of nailing from injury was 4 days (range 1-12 days). The delay in surgery in some cases were due to associated injuries like liver laceration, head injury etc., making the patient haemodynamically unstable. In such cases, there was a delay in performing the index procedure. Wiss [1] et al stated that the average time between the day of trauma and nailing was 9 days.

Wiss [1] et al reported the average operating time was 157 minutes. In our series, the average operating time was less i.e.128 minutes. The decrease in operating time was due to improved surgical techniques and advancement of instruments and implants in our study.

In our experience, the volume of blood loss is less. It ranged between 180 and 500 ml and the average was 268 ml. In the patients who underwent closed reduction, the blood loss was around 180-240 ml and in patients who underwent open reduction, the blood loss was around 450-500 ml. Wiss [1] et al reported that the average blood loss was 470 ml.

Winquist [3] et al, in his study, which included 20 cases of segmental femur fracture observed an average fracture union time of 30 weeks. Wiss [1] et al, in his study, which included 33 cases of segmental femur fracture observed an average fracture union time of 32 weeks (range 16-44 weeks). In our series, average fracture union time was 24 weeks (20-32 weeks). In our study which was conducted 30-40 years after the other two comparative studies, we were able to use better surgical instruments which were not available during those days. This has decreased the duration of fracture union to this extent.

In the study conducted by Wiss [1] et al, in one patient, 4mm of shortening occurred after dynamization, but it was not associated with any functional impairment. Winquist [3] et al recorded that in 6 patients, shortening between 1.0 and 1.5 cm occurred. This degree of shortening did not prove symptomatic for any of these patients. In our series, 2 patients had shortening of 1 cm and one patient had shortening of 2 cm. Patients who had shortening of 1 cm did not have any functional impairment. The patient with 2 cm shortening had a comminuted segmental fracture of femur which was grossly displaced and it was treated by antegrade nailing. Shortening occurred due to the technical error of not restoring the length of the femur intraoperatively. Fracture united 6 months post operatively and he was given a shoe heel raise. From this, we were able to derive that, in comminuted segmental fracture of femur, careful pre-operative planning is required and all efforts should be made to restore the length.

The average flexion of knee was 110° (range 40°-140°) and the average flexion of hip was 115° (range 90°-135°) in the study conducted by Wiss [1] et al. Winquist [3] et al, noted that, among the 20 patients, the average knee flexion was 135° (120°-140°). In our series the average knee flexion was 125° (range 110°-130°); the average hip flexion was 110° (range 100°-110°) and average hip abduction was 45° (range 30°-50°). Flexion of hip and knee were assessed in the other two comparative articles but we have also assessed hip abduction because there might be



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abductor weakness following antegrade nailing due to injury to abductors, but here none of the 14 patients had decreased abduction. Iatrogenic injuries to abductors, external rotators, Superior Gluteal Nerve and Medial circumflex femoral artery are common in antegrade femoral nailing. This complication can be avoided by choosing a nail which enters through the trochanteric tip.

Figure 1 shows the example of one case with preoperative and post-operative Xrays.

There were no cases of malunion in our series. Wiss [1] et al reported that there were two malunion, one in a patient who had a varus angulation of 15° and the other in a patient who had a lengthening of 18 mm. Winquist [3] et al observed valgus deformity in 4 patients, measuring 3, 5, 6 and 11 degrees. None of these valgus deformities were symptomatic. 3° of varus angulation was noted in one patient and 5° of genu recurvatum in another. Although these complications were recorded, all were asymptomatic for the patients.

In our series, 2 cases had delayed union. But both the cases subsequently united completely without any further intervention by 32 weeks. One case had a double segmental femur fracture and there was delayed union at distal fracture site. Figure 2 shows the pre op and post operative Xrays of one of those patients. Harris hip score was 92 for this patient. The other case, a 50 year male had a closed segmental fracture at middle one third and distal one third of shaft of femur. He underwent retrograde nailing. The proximal fracture site healed by 24 weeks, whereas there was delayed union at distal fracture site. This delayed union has occurred due to loss of compression at fracture site. The cut-off for delayed union was 9 months in the previous 2 articles, whereas now the cut-off for delayed union is 6 months [5]. Wiss [1] et al reported 9 cases of delayed union for which dynamization was performed. Winquist [3] et al reported no case of delayed union.

Wiss [1] et al reported one non-union in his series in a patient who had an open fracture where closed distal segment healed, but the open proximal portion failed to unite. At 9 months, the nail broke at the site of non-union. The implant was removed through the entrance portal of the greater trochanter, and the fracture was nailed again. It healed uneventfully within 4 months. Winquist [3] et al reported no case of non-union. In our series, there was no case of non-union.

According to Harris Hip Score, we have got 7 excellent, 6 good and 1 fair result in our series. A 50 year old male who had delayed union had fair outcome. The other case of delayed union and shortening had excellent outcome and was not associated with any functional impairment. There was no significant association between Harris hip score and age, gender, side of fracture, type of fracture, presence or absence of associated injuries.

## Conclusion

Based on our study Segmental fractures of femur are caused by high energy violence. Intramedullary interlocking nailing for segmental fractures of femur gives good to excellent results in 93% of patients. Segmental fractures treated by closed intramedullary interlocking nailing united at an average of 24 weeks. All fractures united without the need for secondary procedures. Proximal fracture site in segmental femoral fracture united significantly earlier than the distal fracture site. The delayed union rate was 14%. Delayed union when present, was mostly encountered in the distal fracture site, but healed without the need for any secondary procedures.

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**Table 1: Age group distribution of the study participants:**

| Age group | Frequency | Percentage |
|---|---|---|
| 18 – 30 years | 6 | 43% |
| 31 – 45 years | 6 | 43% |
| 45 – 60 years | 1 | 7% |
| >60 years | 1 | 7% |

**Table 2: Descriptive statistics of Hip and knee range of movements among study participants:**

| | Mean | Standard deviation | Minimum - Maximum | Variance |
|---|---|---|---|---|
| Hip flexion (degrees) | 114.3 | 7.5 | 100 – 120 degrees | 57.1 |
| Hip abduction (degrees) | 33.57 | 7.67 | 30 – 50 degrees | 58.1 |
| Knee flexion (degrees) | 124.3 | 6.5 | 110 -130 degrees | 41.7 |

**Table 3: Complications distribution of study participants:**

| Complications | Frequency | Percentage |
|---|---|---|
| Delayed union | 2 | 14.3% |
| Shortening >1.5cm | 1 | 7.1% |
| Nil | 11 | 78.6% |
| Total | 14 | 100 |



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**Table 4: Limb length discrepancy distribution of study participants:**

| Limb length discrepancy | Frequency | Percentage |
|---|---|---|
| 1 cm | 2 | 14.3% |
| 2 cm | 1 | 7.1% |
| Nil | 11 | 78.6% |
| Total | 14 | 100 |

**Table 5: Harris Hip score distribution of the study participants:**

| Harris Hip score | Frequency | Percentage |
|---|---|---|
| Excellent (90-100) | 7 | 50% |
| Good (80 – 89) | 6 | 43% |
| Fair (70 – 79) | 1 | 7% |
| Poor (<70) | 0 | 0% |


**Figure 1: (a) Pre op, (b) immediate post op, (c) 6 month post op and (d) 1 year post op Femur Xrays (AP and Lateral view) of a participant**



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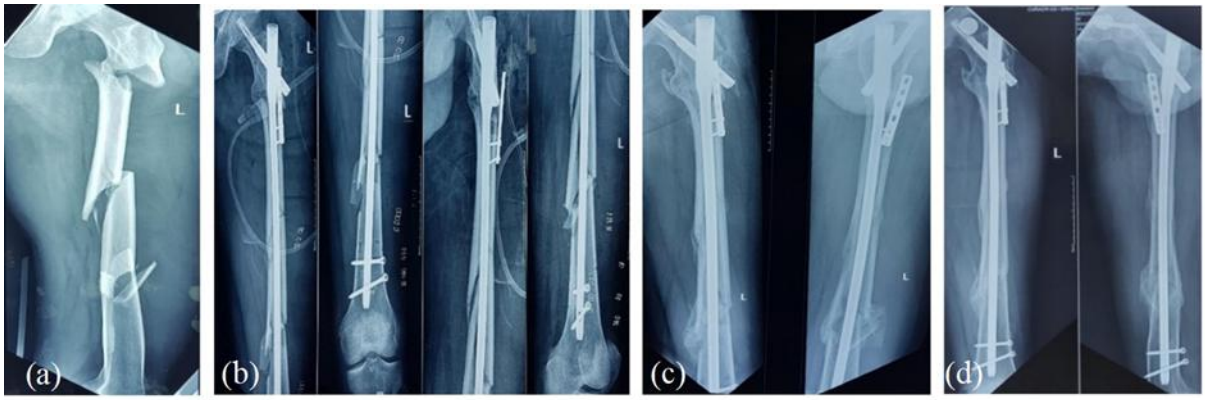


**Figure 2: (a) Pre op, (b) immediate post op, (c) 6 month post op and (d) 1 year post op Femur Xrays (AP and Lateral view) of a participant who had delayed union**



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