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Functional outcome following fixation of diaphyseal fracture of femur with closed intramedullary interlocking nail in adults: A prospective study

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Abstract
Background: Diaphyseal fracture of the femur in adults is one of the most commonly faced fractures in the orthopaedic practice. It is a major cause of morbidity and mortality in patients who sustain high-energy trauma, as the femur is the largest bone of the body and is covered with extensive soft tissue cover. There are multiple techniques available at present for their management. The technique chosen should cause minimal soft tissue and bone damage. We planned to study the functional outcome of the closed intramedullary interlocking nail in diaphyseal fracture of the femur in adults.
Materials and Methods: A prospective observational study on 60 patients with femur shaft fractures managed by intramedullary interlock nails was done at a tertiary care centre between April 2018 to March 2019. The patients were followed up at regular intervals at 2 weeks, 6 weeks, 3 months, 6 months and one year. The clinical, radiological evaluation was done for each patient and the final observation was made according to the criteria by Thorsen *et al.*
Results: The clinical, radiological evaluation was done for each patient and the final observation were made according to the criteria by Thorsen *et al.*, There was excellent results in 70% of cases, good results in 23% and fair to poor results in 7% cases.
Conclusion: Earlier the patients were taken up for surgery, easier the reduction and nailing by the closed method. Static locking is advisable in severely comminuted fractures to avoid shortening. We conclude that closed reamed interlocking intramedullary nail in femoral shaft fracture is the treatment of choice.

Keywords: Femur shaft fractures, intramedullary interlock nail, Thorsen classification reamed nail

Introduction
Diaphyseal fracture of the femur in adults is one of the most commonly faced fractures in the orthopaedic practice [1]. It is a major cause of morbidity and mortality in patients who sustain high-energy trauma, as the femur is the largest bone of the body and covered with extensive soft tissue cover [2]. As the femur is the principal weight-bearing bone in the human body, fracture of the shaft femur results into limb shortening, malalignment, knee contracture, non-union and complications of fracture care unless treatment is appropriate. Fat embolism, vascular injury, haemorrhagic shock, adult respiratory distress syndrome or multi-organ injuries associated will lead to mortality in patients with femur shaft fracture [3]. Both morbidity and mortality can be reduced by prompt reduction and internal fixation of the fracture.
There are multiple techniques available at present for their management. The technique chosen should cause minimal soft tissue and bone damage. The type and location of the fracture, the degree of comminution, the age of the patient, the patient's socio-economic status and other factors may influence the method of treatment [4]. The goal of treatment is the restoration of alignment, rotation and length, preservation of the blood supply to aid union and early rehabilitation of the patient by achieving a good union at the fracture site [5].
The femur has a rich vascular supply, mainly derived from the profunda femoris artery. The nutrient artery to the femur arises from the second perforating artery and enters the femur proximally and posteriorly along the linea aspera [6]. They align themselves perpendicular to the cortical surface, while a few align longitudinally along the periosteum.

These vessels supply the outer 1/3 to 1/4 of the cortex. Inside the cortex, there are direct communications between periosteal vessels and endosteal vessels. The normal flow is centrifugal, although some blood returns to the large venous sinusoids of the medullary canal [7]. After a diaphyseal fracture, the circulatory pattern is radically altered. In fracture displacement, endosteal flow is interrupted and periosteal vessels assume a dominant role till fracture healing [8]. We planned to study the functional outcome of the closed intramedullary interlocking nail in diaphyseal fracture of the femur in adults.

Materials and Methods

Patient with Fracture shaft of the femur is mostly a result of a high-velocity injury. After the patient had been stabilized, radiographic evaluation included anteroposterior and lateral radiographs of the entire femur, including the hip joint and the knee joint. The injured limb was Immobilized in a Thomas splint with skin traction. In skeletal traction in the form of upper tibial pin traction on a Bohler– Braun splint with a weight of 10% of patient body weight was added with an elevation of the foot end of the bed. This traction reduced the unnecessary intra- operative stripping of fragments to reduce the fracture, to prevent soft tissue contracture and maintain the limb length.

In our study, we have used a conventional interlocking nail. The proper length of the nail used was determined by measuring on the normal side from the tip of the greater trochanter to the superior pole of the patella. The diameter of the nail was measured at the isthmic level on the x-ray. A nail of known length was strapped to the lateral side of the normal thigh. The patient was positioned supine on a fracture table with the patient in supine position with the traction of the involved limb and abduction of the normal limb to allow navigation of the image intensifier.

The patient was mobilized, the next day after surgery. The patients were followed up at regular interval at 2 weeks, 6 weeks, 3 months, 6 months and one year. The clinical, radiological evaluation was done for each patient and the final observation were made according to the criteria by Thorsen *et al.*

Statistical analysis

Functional outcomes for pain, range of motion, function and anatomy are evaluated by the percentage method. Thoresen B.O. *et al.* [32] scoring system was used to determine the functional capacity of the patients. Quantitative data is presented with the help of Mean, Mode, Median and Standard deviation. Results were graphically represented where deemed necessary. Appropriate statistical software, including but not restricted to MS Excel, SPSS ver. 18 will be used for statistical analysis. Graphical representation done in MS Excel 2016.

Results

In our study, the male-to-female ratio was 3.2:1 and 67% of patients were in the 3rd and 5th decades. The mode of injury in 96% of cases was a road traffic accident. Two cases were open fractures. The average union time in this study after closed intramedullary interlocking nailing is 5.86 months (3-9 months). The average time duration between injury and surgery was 6.75 days in the age group less then 25 years, 13.45 days in the 25-50 age group and 15.25 days in the age group more than 50 years. With an average duration between injury and surgery was 11.81 days.

The average union time was 4.32 months in the less than 25 years age group, 5.85 months in the 25-50 years group and 7.42 months in the age group more than 50 years. The average union time was 4.1 months in type I, 4.8 months in type II, 6.7 months in type III and 7.8 months in type IV of Winquist and Hansen classification. Delayed intervention was done in 4 cases who had delayed union. Dynamization was done in 3 cases and bone grafting was done in one case. In one case nail was broken with fracture nonunion in which exchange nailing with bone grafting done later on. Most of our patients had full range of knee and hip movements. Four patients having knee stiffness are now on physiotherapy. Two patients had deep infection. Exploration, debridement and irrigation done, infection was controlled with IV antibiotics. The clinical, radiological evaluation done for each patient and the final observation were made according to the criteria by Thorsen *et al.* There was excellent results in 70% cases, good results in 23% and fair to poor results in 7% cases.

Table 1: Scoring system for the result of treatment (Thoresen b.o. *et al.*)

	Results			
	Excellent	**Good**	**Fair**	**Poor**
Malalignment of femur				
Varus\ Valgus	50	50	10	$>10^0$
Antecurvatum\Recurvatum	50	10^0	15^0	$>15^0$
Internal rotation	50	10^0	15^0	$>15^0$
External rotation	10^0	15^0	20^0	$>20^0$
Shortening of femur in cm	1	2	3	>3
Range of Movements of Knee				
Flexion	$>120^0$	120^0	$90\text{-}120^0$	$<90^0$
Extension deficit	50	10^0	15^0	$>15^0$
Pain or swelling	None	Sporadic	Significant	Severe

Table 2: Average union time age group wise

Age	Average Union Time
< 25	4.32 Months
25-50	5.85 Months
> 50	7.42 Months

Table 3: Average Union Time as per fracture Type

Type of Fracture	Average union time
Type I	4.1 Months
Type II	4.8 Months
Type III	6.7 Months
Type IV	7.8 Months

Table 4: Final Outcome

Final Results	In our series
Excellent	42
Good	14
Fair	2
Poor	2

Discussion

The treatment of fracture diaphysis of femur has evolved from the old conservative management to the most recent methods of interlocking nails. This is the era of biological fixation. Interlocking nails have greatly expanded the indications for closed IM nailing of femoral fractures. The rationale for internal fixation is that it restores the anatomical alignment and allows early mobilization of the patient and limb [9]. The use of a plate to achieve osteosynthesis necessitates wide operative exposure and excessive soft tissue stripping, resulting in increased blood loss and operating time. The risk

of infection is increased. Failure of the plate is common and the need for primary bone grafts adds additional morbidity to the procedure [10]. Early mobilization following fractures of the femoral diaphysis has been shown to have a significant advantage in terms of both joint mobility and economic impact which has very well attained by the use of intramedullary interlocking nails.

In our study majority of patients were in age group of 26-50 years with mean age of 31 years. Wiss *et al.* in their study mean age was 29 years [11]. White *et al.* observed mean age of 28 years. Series of Thoresen of 48 cases of femoral shaft fractures stated a mean age of 28 years [12]. In most of the studies and in ours too the incidence was significantly higher in males (46 males and 14 Females). Wiss-Fleming *et al.* male predominance (83.7%) found in his 111 patients series. Winquest R.A., Clawson DK, concluded in their study that intramedullary interlocking nail acts as a load sharing implant, and has great torsional rigidity and rotational stability [13].

Robert J. Brumback, Walter Virkus concluded in their study that femoral shaft fractures treated with unreamed nailing have been shown to have slightly higher rate of delayed union and non-union compared with those of reamed nail [14]. Reamed interlocking nail remains the treatment of choice for femoral shaft fracture in adults, since femoral shaft has rich periosteal blood supply reaming does not impede fracture healing. In our study we routinely perform reamed interlocking nailing except in two cases. Brumback *et al.* in his series, reported 92% union rate with an average union time of 4.8 months in 100 case of closed interlocking nailing. In our series union rate was 93% with average union time of 5.86 months. Pati and Bansal *et al.* reported 85.87% union rate with average union time of 5.7 months in a study of 90 patient with open interlocking nailing [15]. The poor result in open interlocking nailing attributed to disturbance of fracture hematoma and periosteal stripping. In our study mean duration between injury and surgery was 12 days due to delay in patient reporting to hospital after native treatment, non-availability of theatre time, arrangement of fund for operation and associated co-morbid illness. This results in delay in taking up for surgery. Covey, Claiborne A, Christian in their study reported average union time of 3.97 months in < 25 age group 4.67 months in 25 to 50 age group 6.87 months in > 50 age group [16]. In our study in all age groups the average union time is more because of longer duration between injury and surgery. Kettek, Mattz W in their study reported the average union time of 3.72 months in type I fracture, 4.03 months in Type II fracture, 5.68 months in Type III and 6.2 months in Type IV. In our study the average union time is more because of longer duration between injury and surgery [17]. Donald A wiss, William, W Brien concluded in their series that closed interlocking nailing is treatment of choice for most segmental femoral fracture. Rinaldi *et al.* 1989 [18], Braten *et al.* in their study concluded that there will be substantial soft tissue injury in segmental femoral fracture and further open reduction decreases the union rate. In our study segmental femoral fracture were fixed with closed static interlocking nailing. The incidence of infection following open nailing was reported by Wiss *et al.* as 8.3% and by John *et al.* as 13%. The incidence of infection was drastically low in closed interlocking nail. The average duration of hospital stay in our study is 16 days, compared to 12 days in Wiss *et al.* study and 21 days in Gross kempf study [19]. Functional outcome is excellent to good in 93% cases in our study as compared to 92% in Wiss *et al.* Gross *et al.* advised dynamization in the 3rd-5th post-operative month if no radiological evidence of union present. In our study 3 patients with fracture gap were dynamized at 14-16 weeks. Union achieved after another 3-5 months (3 months to 6 months). Brumback *et al.* in his series advocated immediate weight bearing for allowing micro movements at fracture site which augments union [20]. In our study, In all stable fracture partial weight bearing started at the end of 3rd week and full weight bearing allowed at the end of 6th week. For all comminuted fracture and segmental fracture parietal and full weight bearing allowed at 6 week and 12 weeks respectively.

Conclusion

Reamed nailing does not impede fracture healing and helps in easy insertion. Earlier the patients were taken up for surgery, easier the reduction and nailing by closed method. Static locking is advisable in severely comminuted fracture to avoid shortening. If fracture gap is present, Dynamization should be performed at 14- 16 weeks of post-operative period. We conclude that closed reamed interlocking intra medullary nail in femoral shaft fracture is the treatment of choice.

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