European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 09, Issue 02, 2022

Management of pediatric femoral shaft fractures with elastic stable intramedullary nailing (ESIN)

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Abstract

Diaphyseal femur fractures in children account for 1.4-1.7% of all fractures, and 7.6% of those involving the long bones. Diaphyseal femur fractures ratio between males and females is 2.6:1.Non-operative treatments such as Pavlik harness, traction, and Spica casting, and operative treatments such as sub muscular plating, elastic nails, rigid nails, as well as internal and external fixation. Elastic stable intramedullary nailing is getting popular for management of femoral fractures for children 5 years and older.
In this study, 35 children aged between 6-15 years with diaphyseal femur shaft fractures were treated with elastic stable intramedullary nailing (ES1N). All patients successfully completed one-year follow-up and were included in the analysis. All the patients were managed with titanium nails. We based on our experience and results thus conclude that Titanium elastic nails can be considered better method of treatment regarding lesser rate of surgical wound complications.

Keywords: Diaphyseal femoral fractures, pediatrics, elastic stable intramedullary nailing system

Introduction

Most common fractures of long are femoral fractures [1]. Diaphyseal femur fractures in children account for 1.4-1.7% of all fractures, and 7.6% of those involving the long bones. Diaphyseal femur fractures ratio between males and females is 2.6:1 [2].
Paediatric femoral fractures handling firstly counts on the age of the child in spite of the fact that the bone age and size of a child may determine the choice of treatment. Surgical experience and local practice can also be decisive factors for the possibility of management of the treatment. Some cases can be resolved by non-operative management still though there is inclination towards operative fixation as it permits untimely mobilisation and minimum hospitalization [1].

ISSN 2515-8260 Volume 09, Issue 02, 2022

Non-operative treatments such as Pavlik harness, traction, and spica casting and operative treatments such as sub muscular plating, elastic nails, rigid nails, as well as internal and external fixation. Parameters such as weight, fracture pattern, and presence of polytrauma are also considered with age [3].

Epiphysis and metaphysis of the paediatric femur get separated by proximal and distal physes. Intramedullary devices should be placed discreetly because both epiphysis and metaphysis are important for proper development of femur [3].

Elastic stable intramedullary nailing is getting popular for management of femoral fractures for children 5 years and older. ESIN is extensively relevant for many types of fractures, but it is exceptionally fit for length-stable transverse or short-oblique fractures. ESIN facilitates with minimal surgical exposures and provides a shorter healing period. It has lesser major complications as compared to traction, early Spica casting, external fixation, and plating. Titanium elastic nails (TEN) and stainless-steel nails are mainly two types of elastic nails. There is a slight variance in method of application [2].

TEN nails are more elastic, and are able to limit stress-shielding of the fracture site from forces necessary for rapid callus formation. Studies have shown that patients weighing more than 49 kg or with age greater than 11 years have greater tendency for deformation of nails in femoral fractures treated with the more flexible TEN. Stainless-steel nails are more rigid and are often stacked to enhance canal filling. Hence, the use of the more rigid stainless-steel nails is recommended for the treatment of fractures in heavier patients. In such patients, for optimal rotational, axial, and translational stability proper surgical technique is also required [3].

This study was carried out to interpret the role of Titanium Elastic Nailing System (TENS) in children aged 6-15 years with femur shaft fracture.

Material and Methods

A total of 35 patients between the ages of 6 to 15 years were included in the study. All the patients were presented with the closed fractures of the diaphyseal femoral shaft. Orthopaedic emergency was included in this study. We had taken written informed consent from the parents of study participants or guardians and obtained base line information. All patients successfully completed one-year follow-up and were included in the analysis. All the patients were managed with titanium nails.

The inclusion criteria were as follows

- Patients 6-15 years of age
- Patients with diaphyseal femur fracture
- Patients with closed fractures
- Patients whose weight is less than 50 kilograms.

The exclusion criteria

- Patients with head trauma
- Patients with open fractures, pathologic fractures, fracture line that extend either to the
- Proximal or distal femur.
- Patients with active infections
- Non-ambulatory patients
- Patients with presence of any comorbid illness
- Patients whose weight is more than 50 kilograms.

Patients were placed in Thomas Knee splint with below knee skin traction prior to procedure.

ISSN 2515-8260 Volume 09, Issue 02, 2022

Elastic nails of standard length that is 440 mm and 2.0-4.0 mm in diameters were used. The diameter of every single nail was chosen based on Flynn *et al*. formula [4] (Diameter of nail 40% of the width of the narrowest point of the medullary canal on AP and lateral views (0.4 mm). The length of the nail was determined intraoperatively by fluoroscopy. Two nails of the same diameter were used. The patients were positioned on an orthopaedic fracture table and a reduction of the fracture by traction guided by fluoroscopy was done.

Technique

Pre-angled nails which were angled at 45° about 2 cm from one end were used. An entry point was made with the help of bone awl approximately 2 cm above the physics on lateral side. A nail loaded onto a T handle was then inserted through the entry point into the medullary canal by rotator movements of the wrist and advanced upto fracture site. Another nail was introduced using the same technique from the medial side and advanced upto fracture site. The nails were then crossed across the already reduced fracture site one by one. It was ensured that both nails were in the canal across the fracture site by fluoroscopy [5].
Traction was released when the nails crossed the fracture site and then they were advanced further. Medial nail was advanced till it was within 2 cm of proximal femoral capital physics whereas lateral nail was inserted till it was about 1 cm from greater trochanteric physics. Nails were left protruding about 0.5 to 1.0 cm at the distal end for easy removal later on. In the postoperative period limbs were simply rested on the pillow or placed in a T-K splint based on postoperative reduction and preoperative fracture pattern. Sutures were removed on the 12th postoperative day.
Patients were instructed for isometric straight leg raises, quadriceps and hamstrings strengthening exercises with active, active-assisted and passive knee range of motion. Axillary crutches were started immediately after operation in non-weight bearing patients, when tolerated. Weight bearing status depends on fracture configuration after reduction. Generally partial weight bearing was started at around 4 weeks and advanced to full weight bearing when bridging callus developed and fracture line was not visible on X-rays.
Patients were followed up at scheduled intervals of one month, three months and six months postoperatively. At each investigation patients were evaluated clinically, radiologically and the complications were noted. The nails were removed when complete healing of the fracture occurred (usually between 10 and 12 months). The final results were calculated using the criteria of Flynn *et al*. [4].

Results

In present study, majority of patients were in the age group 6-14 years. We analysed 35 patients in total, 32 males and 3 females. The right femur was involved in 65.71% patients and in rest 34.28% left femur was under examination.
Fracture location was upper third in 51.42% patients, mid third in 37.14% and distal third of femur in 11.42% patients.
Type of fracture was transverse in 16 patients out of 35. It was oblique for 5 patients and spiral for 14 patients.

Table 1: Patient profile

Variable	Value
a) Gender	
Male	32(91.42%)
Female	3 (8.5%)
b) Side involved	
Right	23(65.71%)

Left	12(34.28%)
c) Fracture location	
Upper third	18(51.42%)
Mid third	13 (37.14%)
Distal third	4 (11.42%)
d) Type of fracture	
Transverse	16 (45.71%)
Oblique	5 (14.28%)
Spiral	14 (40%)

Investigation of all the patients was done regularly till union and were looked over clinically and radiologically. The results were evaluated according to the TENS SCORING SYSTEM used by FLYNN *et al* [4].

Table 2: The Scoring Criteria for Tens

	Excellent	**Successful**	**Poor**
Limb length discrepancy	< 1.0cm	< 2cm	> 2cm
Malalignment	5º	10º	>10º
Pain	Absent	Absent	Present
Complication	Absent	Mild	Major complication or increased morbidity

Time of union is defined as the period between surgery and full weight bearing without external support and a radio graphically healed fracture. 29 patients were healed less than 12 weeks and 6 of them took more than 12 weeks to heal.

Table 3: Time of full weight bearing and union

Time to full weight bearing and union	**Number of patients**
≤ 12 weeks	29
>12 weeks	6

Full range of motion of the hip joint was found in all the patients, two patient who had a nail protrusion and bursa had little knee stiffness and soon recovered with physiotherapy. Following complications were seen in our study.

Table 4: Different complications after the ESIN

Complication	**No. of cases**
Pain at the site of insertion	20
Minor angulation	1
Limb lengthening discrepancy	6
Inflammatory bursa	2
Puncture of the opposite cortex	1

Out of 35, 20 patients had pain at site of insertion. Oral painkillers were given them to subdue the pain. Minor angulation was found only in one patient. Six patients had limb lengthening discrepancy. Out of them, four had less than 5 mm, and two had nearly 1cm limb length discrepancy. No patient in our series had significant limb length discrepancy (i.e.,> - 2 to + 2cm). Superficial infection was seen in two patients and was controlled by antibiotics. No cases of delayed union and non-union were seen in our series. No cases of valgus, anteroposterior or rotational malalignment were observed.

We analysed our final results with tens evaluation score given by flynn *et al*. Results were excellent in 23(65.71%), successful in 12(34.28%) patients.

ISSN 2515-8260 Volume 09, Issue 02, 2022

Table 5: Results

Results	No. of cases
Excellent	23 (65.71%)
Successful	12 (34.28%)

Discussion

For a better alignment anatomically, untimely union and early mobilization in paediatric femur fractures surgical procedures are preferred now a days. Surgical procedures reduce complications like joint stiffness, wound complications, malunion and also facilitates less morbidity and mortality.

In the present study, 35 patients shaft femur fracture were treated with titanium elastic nailing system. The age of children varied from 6 to 14 years. Various studies have supported that it is easier to use elastic nails in this age. Male predominance was found in our patient profiles which is 32(91.42%) over female 3(8.5%). Reason may be the more outdoor activity of the male child, more susceptible to trauma. Hassan *et al*. (2006) reported 88% male child was having femur fracture out of 25 children [6].

Subjects had 65.71% right side injury and 34.28% had left side injury. Saikia (2007) reported 54.5% right sided fracture femur in children [7]. it may be due to right side is the dominant side in most of the children. Transverse pattern was most common pattern in our study i.e., 45.71% patients.

Full range of motion of the hip joint was found in all the patients. Similar findings were obtained by the studies of Khazzam *et al*. [8] and Lohiya *et al*. [9] where clinical evaluation revealed full range of motion of the hip and knee in all patients at final follow-up. The average duration of progressing to full weight bearing in our study was 11.4 weeks.

Minor complications were also found like pain at insertion site and Angulation. Rajesh *et al*. also found malunion in 2 patients by using TENS and in the final follow up, and they had excellent improvement in angulation deformity [10].

Limb lengthening discrepancy was also found it was non-significant. It didn't give any problem to the patients. Rajesh *et al*. also reported the similar findings.

Conclusion

We based on our experience and results thus conclude that Titanium elastic nails can be considered better method of treatment regarding lesser rate of surgical wound complications. It is an effective and minimally invasive method of treatment for femur fracture in children. We cannot declare titanium elastic nailing system as a superior method as compared to other plating systems because our study was not comparative.

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