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Outcomes of fracture shaft femur in pediatric population managed at emergency

Sourabh Kumar Sinha, Vineet Kumar, Ajai Singh*

Department of Orthopaedic Surgery, King George's Medical University, Lucknow, Uttar Pradesh 226018, India

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ABSTRACT

Background: Fracture shaft of femur is amongst one of the commonest major diaphyseal injuries in school going children presenting to us at emergency rooms of our hospitals. The presence of a growing proximal and distal physes imposes a real challenge in management of these fractures. The use of titanium elastic nails has gained wide acceptance for stabilizing these fractures.

Materials and methods: A sample of 53 children of age group 6 to 12 years were included in the study according to the inclusion and exclusion criteria. The mean age of subjects was 8.87 ± 1.64 years of which 39 were males and 14 were females. The femoral shaft fractures were stabilized using titanium elastic nails and followed up for a mean duration of six months. The outcomes were evaluated based on Flynn's criteria.

Results: We obtained excellent outcome in 75.5% of our cases, satisfactory outcome in 17% and poor outcome in 7.5% of cases. We found no statistically significant difference in outcome in patients of age 9 years or less compared to 10 years or older.

Conclusion: Patient selection is important to obtain good results using titanium elastic nails. Mid diaphyseal femoral shaft fractures with minimal comminution are ideal fractures for treatment using titanium elastic nails.

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1. Introduction

Femoral shaft fractures are amongst one of the commonest major injuries occurring in the diaphysis of long bones in school going children presenting to us in the emergency rooms of our hospital.¹ The etiology has mainly been attributed to high velocity injuries, like road traffic accidents and fall from height.²

Though the treatment in toddlers and adults is standard protocol in form of spica casting and medullary interlocking nailing respectively, the management in school age children has always presented a challenge and dilemma situation as to what can be the better option. The presence of a growing proximal and distal physes has presented a challenge in treating these injuries and hence the use of elastic intramedullary nails has gained popularity worldwide.³ Various authors have evaluated the use of titanium elastic nails and proposed guidelines regarding the operative procedure to minimize the inherent complications associated with their use. We in this study have treated and observed treatment outcome of 6–12 years age group population considering various

criteria which share a major burden of these fractures and frequently present to us in our emergency room.

2. Material and methods

The study population comprised of school going children (between 6–12 years)⁴ with traumatic fracture shaft of femur who presented to us within 72 hours of injury satisfying our inclusion and exclusion criteria and admitted to our hospital between January 2013 and 2015. Subjects included were with Winquist type-1 fractures, short oblique and transverse fractures having either closed or Gustillo Anderson grade-1 injury. The subjects having multiple fractures of ipsilateral lower limb, polytrauma, subtrochanteric and supracondylar fractures, Winquist type 2 and type 3 fractures, open fractures of Gustillo Anderson grade 2 and above, pathological fractures, subject with congenital musculoskeletal disorders or dysplasia, local entry site skin infection, those not fit for surgery and attendants not willing to give written consent for surgery as well as study were excluded from the study.

A total of sixty subjects were included in our study. All the cases were operated within 24 hours of their admission in emergency. Routine pre anesthetic work up was performed for all patients. Written informed consent for anesthesia and surgery was obtained

* Corresponding author.

E-mail address: as29762@gmail.com (A. Singh).

as per hospital protocol. Preoperative planning was done as per standard guidelines which included classification of fracture according to Winquist classification and measuring the diameter of the medullary canal at the isthmus in order to calculate probable diameter of the elastic nail. This was obtained using the formula (diameter in mm $\times$ 0.4) i.e 40% of canal diameter. Standard aseptic precautions were followed in the operation theatre. Surgeries were performed on traction table and fluoroscopy used to guide fracture reduction and implant placement. Two titanium elastic nails were used for each fracture. The nails were pre-bent before insertion. Insertion was done in retrograde direction. Closed stable reduction of the fracture was attempted prior to incision. Skin incision of about 2 cm size was given over medial and lateral aspect of lower thigh at the level of the upper pole of patella. Using a 4.5 mm bone awl or Steinman pin entry was made about 2–3 cm proximal to the physis at an angle directed into the canal. Titanium elastic nails of appropriate size was inserted and gently hammered across the fracture site and rotated appropriately to engage in the proximal femoral metaphyses in a divergent fashion. Approximately 2–3 cm of nail was left outside the entry site and cut to allow for extraction. End of the nail were not bent and allowed to lie flush with the bone to prevent skin irritation. Postoperatively, secondary stabilization was done by application of a pop thigh corset. Knee mobilization and quadriceps exercises were begun from 3rd post op day. Patients were discharged when patient and attendants are well versed with physiotherapy schedule. Patients were encouraged to perform wall pushing exercises to prevent distraction at fracture site. Patients were called for first follow up at 6 weeks and allowed partial weight bearing if the X- ray showed bridging callus formation in at least three cortices in both AP and Lateral views. Full weight bearing was allowed in subsequent 2 weeks. Subsequent follow up was done at 3rd and 6th month post-operatively. In follow up visits patients were evaluated for functional outcome by Flynn's criteria and were looked in for complications like malunion, delayed union, knee stiffness, pain at entry site and evidence of infection.

2.1. Statistical analysis

The data summaries were presented as absolute and relative frequencies for quantitative measures and are presented as means, frequencies (%), and standard deviations. Statistical analysis was performed using the chi square test and ANOVA (Analysis of Variance) test on SPSS version 18 for Windows. p -values < 0.05

Table 1

Distribution of Types of fractures and their causes.

Parameter	Type	No. of Subjects	Percent
Mode of Injury	Fall from height	18	34
	Fall of weight	4	7.5
	Hit by car	16	30.2
	Hit by motorcycle	15	28.3
Type of Injury	Comminuted	5	9.4
	Oblique	22	41.5
	Transverse	26	49.1
Total		53	100

were considered significant. A power test was completed using overall patient satisfaction as the primary outcome measure once 53 patients were selected, which determined a significant power of 80% and a significance level of 0.95.

3. Observation and results

A total of sixty subjects of school going age satisfying our inclusion and exclusion criteria were included in the study. Seven out of sixty patients could not be traced for follow up. Fifty three patients who came for regular follow up were included for statistical analysis. Study population comprised of thirty nine (73.6%) male and fourteen (26.4%) female subjects. The average age of patients was 8.87 ± 1.64 years (Fig. 1). Road Traffic Accidents were the most common mode of injury in this population sub group with short oblique fracture being the commonest radiological presentation (Table 1). Perioperative details of study population are shown in Tables 2 and 3. The mean duration of surgery was 59.43 ± 16.63 minutes and the mean duration of hospital stay was 6.6 days. All patients had union at the fracture site with evidence of bridging callus formation at 6 months follow up. On evaluation as per Flynn's criteria 75.5% patients had excellent outcome, whereas 17% had satisfactory and 7.5% had poor outcome. Tenderness at fracture site was present in 13.2% cases at 1st follow up (6 weeks) and only in 7.5% cases at 3rd follow up (6 months). Results are shown in Table 4.

The final outcome as analyzed by Flynn's criteria in our study was better in short oblique radiological variety (Fig. 3), and also in children aged ten years & older as compared to those aged 9 years and younger, although the difference was not significant. ($p = 0.631$) (Fig. 2). Nail insertion site pain/knee pain was the most common complication noted in our study group (Table 5, Figs. 4 and 5).

Fig. 1. Distribution of ages of patients at the time of treatment.

Table 2

Peri-operative details of operated subject.

	Day of Surgery	Nail diameter	Duration of surgery (in min)	Duration of stay (in days)
N	53	53	53	53
Mean	2.2 ± 0.7	3.6 ± 0.3	59.4 ± 16.6	6.6 ± 1.3

Table 3

Peri-operative details for various fracture patterns.

Type of Injury		Day of Surgery	Nail diameter	Duration of surgery	Duration of stay
Comminuted	N	5	5	5	5
	Mean	2.20 ± 1.09	3.80 ± 0.27	54.00 ± 8.22	7.20 ± 1.10
Short oblique	N	22	22	22	22
	Mean	2.04 ± 0.57	3.59 ± 0.33	60.00 ± 18.52	6.64 ± 1.33
Transverse	N	26	26	26	26
	Mean	2.30 ± 0.73	3.60 ± 0.35	60.00 ± 16.63	6.46 ± 1.30
p value (using F-Test)		0.45	0.431	0.752	0.506

Table 4

Outcomes in children operated for femur fractures.

Outcome	Status	Frequency	Percent
Flynn outcome	Excellent	40	75.5
	Poor	4	7.5
	Satisfactory	9	17.0
Tenderness-6 weeks	Absent	46	86.8
	Present	7	13.2
Tenderness-3 months	Absent	49	92.5
	Present	4	7.5
Tenderness-6 months	Absent	49	92.5
	Present	4	7.5
Total		53	100.0

4. Discussion

The management for fracture shaft of femur in children has always been controversial and debatable, as till date there is no consensus in the treatment for this fracture in pediatric age group. On considering school going age group (6yrs. to 12 yrs.) there are

numerous options available to treat this fracture pattern which we have included in our study. Treatment options range from conservative spica casting to operative i.e elastic intramedullary nailing, dynamic and locking compression plates and use of external fixators. Plaster of paris spica casting in school age children is associated with complications like cast breakage, loss of reduction, malunion, skin complications, prolonged immobilization, quadriceps weakness, loss of education and associated psychological burden. Due to these complications the trend has shifted towards operative stabilization of these fractures. Out of all available options (hip spica casting, traction on thomas splint, dynamic compression plate, external fixator, trochanteric femoral interlocking nail and intramedullary elastic nail), we in this study have used TENs for fixation of Winquist type-1 closed/Gustillo type-1 fracture shaft of femur presenting to us in emergency department within 72 hours of injury. Titanium elastic nails have been showed to be superior to external fixation and hip spica casting for femoral shaft fractures in children.^{5,6} Titanium elastic nails provide intramedullary stabilization of the fracture site, helps

Fig. 2. Proportion of excellent, satisfactory and poor outcomes for patients aged 9 years and younger compared with patients aged 10 years and older.

Fig. 3. Proportion of excellent, satisfactory and poor outcomes for patients of various types of fractures.

Table 5

Complications seen among children operated for femur fractures.

Complication	Frequency (N = 53)	Percent
Knee Stiffness	4	7.5
Infection	3	5.7
Non Union	–	–
Mal Union	2	3.8
Any Complication	4	7.5

in maintaining limb length and providing rotational stability at the fracture site. It acts as a load sharing implant, providing biological fixation and thus promotes healing at the fracture site. The procedure involves negligible blood loss, has low chances of distal femoral physeal injury and is less demanding requiring a simple learning curve. The recommended age group for the use of elastic nails is 6–12 years as recommended by various studies.^{7–9}

This surgery is less demanding and requires a shorter operative time as shown by Basant et al. in their study which reported a duration ranging from 20 to 45 minutes (mean 30 minutes).¹⁰ Although in our study we took an average operating time of 59 minutes (range 30 to 90 minutes) as our cases were operated on in emergency itself by an orthopedic resident who had lesser experience (under the guidance of a senior surgeon). Thus even in inexperienced hands this surgery does not last for more than an hour.

As all our subjects were operated within 24 hours of injury and were discharged as soon as they were comfortable with their physiotherapy schedule so the mean duration of hospital stay in our subjects in study was 6.6 days. Newton and Mubarak¹¹ reported mean hospitalization periods of 20.6 days before casting. Ligier and Heinrich^{7,12} reported hospitalization periods of 4.5 to 8 days with the use of titanium elastic nails whereas Fabiano et al. reported mean hospitalization period of 9.4 days.¹³ Basant et al. also reported a mean hospitalization period of 8.1 days.¹⁰ The hospital stay was at par with other studies searched in literature, more towards lower side probably due to early operative intervention and rigorous rehabilitation.

Existing literature shows that almost all fractures heal well with TENS.⁷ Functional outcome in our study population as evaluated by Flynn's scoring system shows excellent outcome in 75.5% of our cases, satisfactory outcome in 17% and poor outcome in 7.5% of cases. This was in contrast to outcomes showed by Moroz et al. who studied efficacy of TENS in 234 femoral fractures and found the results to be excellent in 65% cases, satisfactory in 25% of cases and poor in 10% cases.¹⁴ We had better outcomes due to the fact that we had more stringent inclusion criteria which led us to better outcome. Nishant kumar¹⁵ reported excellent outcome in all 20 cases of pediatric femoral shaft fractures treated with TENS.

Flynn et al. reported age as a strong predictor of poor outcome. Odds ratio for poor outcome was 3.86 for children aged greater than 10 years as compared to those younger.¹⁴ In contrast to this, in our study we found no statistically significant difference in outcome of patients with age 9 years or less compared to 10 years or older. This is probably due to the fact that we had a strict inclusion criteria of mid diaphyseal fractures in our study whereas the study conducted by Flynn also included fractures of proximal and distal femur, in which the fracture stability is more compromised owing to wider intramedullary canal diameter.

We did not find statistically significant difference in outcomes with different fracture patterns (transverse, short oblique, and comminuted) which were included in criteria of subject selection. The use of pop thigh corset extending from the iliac crest to the femoral condyles was used in our setup in post-operative phase till callus is radiologically visible. This probably has a role in preventing angulation at the fracture site and in the maintenance of limb length and alignment across fracture patterns. The problem of significant shortening was also not observed because of the fact that we took only Winquist type-1 fractures.

Higher complication rates were initially observed with the use of these nails due to improper use in bigger, older and heavier children.^{16,17}

We had two patients with malunion beyond acceptable criteria. Both the patients came to us with a broken POP thigh brace. Malunion observed in both the cases was angular deformity. Probably this can be attributed to non-compliant attitude of the patient. However follow up till skeletal maturity is needed to

Fig. 4. 12 yrs old patient (a) PreOP X-ray (b) Post OP X-ray (c) X-ray at 12 week of follow-up (d) Clinical picture showing nail ends hurting the skin (e) Full weight bearing of the patient.

reaffirm this finding. Children have good remodeling ability and most of the minor mal-alignment gets corrected as age progresses.

We too confronted four cases of knee stiffness and the same set of subjects was also having persistent tenderness at site of nail insertion even at 6 months follow up. Three of the above had superficial infection and ulceration at site of nail insertion initially

which was taken care of by oral antibiotics and local care of the site. Flynn et al. reported 8 cases of nail-tip irritation near the insertion site, 1 re-fracture caused by premature nail removal, and 1 case of nail bending after a fall.⁹

Moroz et al. reported major complications in 17.5% and minor complication in 30% of patients.¹⁴ Beatty et al. reported

Fig. 5. 6 yrs old patient (a) PreOP X-ray (b) Post OP X-ray (c) X-ray at 6 month of follow-up (d) Clinical picture of patient squatting and showing full range of knee motion (e) Full weight bearing of the patient.

malalignment as the most common complication.¹⁸ So, complications are not common. Narayanan et al.¹⁹ studied 79 femoral fractures with titanium elastic stable intramedullary nailing over 5-years and specifically reported the complications associated

with this technique to provide recommendations to avoid these complications. Complications included pain/irritation at the insertion site in 41 cases, radiographic malunion in 8, refracture

in 2, transient neurologic deficit in 2 and superficial wound infection in 2. Ten patients required re-operation prior to union.

We in our study did not encountered deep infection, limb length discrepancy greater than 1 cm, physeal injury or nonunion in any of our patients.

Thus to have best results with TENs one has to be very specific with patient selection as too young or too old a patient can pose problems. We do have better options available for these age group population. Our study findings are limited by its small sample size and lesser follow up (as we could not comment upon long term outcomes). On radiological consideration, TENs is best suited for diaphyseal fractures having Winquist type-1 pattern.

Conflict of interest

The authors have none to declare.

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