

Clinical and radiological evaluation of diaphyseal femoral fractures treated with titanium elastic nail in paediatric age group

Rajendra Kumar Pipal¹, Naveen Kumawat^{2*}, Seema Yadav³, Dharmendra Kumar Pipal⁴

¹Assistant Professor, Department of Orthopaedics, Geetanjali Medical College, Udaipur, Rajasthan, INDIA.

²Senior Resident, Department of Orthopaedics, S N Medical College, Jodhpur, Rajasthan, INDIA.

³Assistant Professor, Department of Anaesthesia, RVRS, Medical College, Bhilwara, Rajasthan, INDIA.

⁴Assistant Professor, Department of General Surgery, AIIMS, Gorakhpur, Uttar Pradesh, INDIA.

Email: dr.dharmendrapipal2007@gmail.com

Abstract

Background: Management of femoral diaphyseal fracture in the paediatric age group ranging from 5 to 16 years is debatable. Present study aimed to define the usefulness of intramedullary fixation of femoral shaft fractures by using titanium elastic nailing system (TENS). **Materials and methods:** This prospective study was carried out between July 2016 and December 2018. 30 paediatric patients (22 boys, 8 girls) aged 5 to 15 years with diaphyseal femoral fractures were treated by TENS fixation. Winquest and Hansen system was used to classify the diaphyseal femoral fracture as Grade-I, Grade-II, Grade-III. **Results:** The average follow-up duration was 9.86 months with minimum of 6 months and maximum of 12 months. Time of union ranged from 6-8 weeks with an average duration of 6.33 weeks. Majority of patients (86.67%) had full range of knee movement up to 6 weeks. The commonest complication encountered in this series was granuloma at nail insertion site in 2 cases (6.67%), followed by superficial infection in 1 (3.33%) case. The final result as evaluated by Flynn criteria showed that among a total of 30 cases, 27 (90%) had excellent results and 3 (10%) has satisfactory results. No patient showed poor results. **Conclusion:** TENS is not only minimally invasive and relatively easy method for the treatment of paediatric femoral shaft fractures but also safe and provide early resumption of work to school going children. Additionally, it has very good functional and cosmetic results.

*Address for Correspondence:

Dr Naveen Kumawat, Senior Resident, Department of Orthopaedics, S N Medical College, Jodhpur, Rajasthan, INDIA.

Email: dr.dharmendrapipal2007@gmail.com

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INTRODUCTION

Femoral shaft fracture is a crippling pediatric injury.¹⁻² The treatment has generally been age-related, affected by the kind of injury, related wounds and the area and sort of the crack. Generally, the treatment choices change as per the specialist's preference.³ Because of quick recuperating and unconstrained revision of angulation the vast majority of the femoral shaft cracks in youngsters more youthful

than six years old can be dealt with conservatively.⁴⁻⁵ Above six years old every such break, when treated nonoperatively could have, loss of decrease, malunion, bigotry and complexities related with mortar. Close to the furthest limit of skeletal development precise decrease is vital as rakish disfigurement is not, at this point correctable by growth.⁶ Availability of bolted intramedullary nail has made the treatment of femoral shaft cracks in skeletally developed youngsters settled. Be that as it may, the best treatment somewhere in the range of six and 16 years old involves debate.⁷ Since the most recent two decades, there has been a developing propensity towards a more employable methodology in licenses more than six years of age.^{3, 6, 8} Titanium Elastic Nailing, which is differently known as Elastic Stable Intramedullary Nailing, has become the decision of adjustment in pediatric long bone cracks, especially the femoral shaft fractures.⁹⁻¹⁰ The apparent favorable position of this strategy incorporates early association because of rehashed micromotion at

break site, regard for the physis, early assembly, early weight bearing, scar acknowledgment, simple embed expulsion and high patient fulfillment rate.^{1,3,9,11} We report an imminent report with the goal of assessing the job and adequacy of Titanium Elastic Nail in chosen instances of femoral diaphyseal breaks in the 6-16 years age gathering. We report a planned report with the goal of assessing the job and adequacy of Titanium Elastic Nail in chosen instances of femoral diaphyseal breaks in the 6-16 years age gathering.

MATERIALS AND METHODS

Thirty children (22 boys, 8 girls) in the age range of 5-15 years (average 9.13 years) with recent (> 3 days) femoral shaft fractures were treated with Titanium Elastic Nailing and followed up in the Department of Orthopedics, Dr. S. N. Medical College and Associated group of Hospitals, Jodhpur during the period of July 2016 to June 2018. The surgery was performed under general anesthesia with the patient on the fracture table in supine position. Two

Titanium Elastic Nails of identical diameter were used .The diameter of the individual nail was selected as per Flynn *et al.*'s formula¹ (Diameter of nail = Width of the narrowest point of the medullary canal on Anteroposterior and Lateral view × 0.4 mm) and intraoperative assessment. Fractures were reduced using fluoroscopic guidance. Postoperatively patients operated limb was kept elevated and nursed in supine position. Mobilization without weight bearing started on the fifth to seventh day postoperatively. Depending on the fracture configuration and callus response, partial weight bearing started at three weeks and full weight bearing by six to eight weeks. All patients were followed clinically and radiologically in terms of healing of fracture and the complication if any. Postoperatively optimal physiotherapy started for quadriceps strengthening s as soon as there was no pain and partial weight bearing allowed depending on the stability of fracture and callus formation. The final outcome based on the above observations was done as per Flynn’s criteria (Table 1).

Table 1: Criteria for Evaluation of Result (Flynn *et al.* 2001)

	Excellent	Satisfactory	Poor
Limb length discrepancy	Up to 1 cm	1-2 cm	>2cm
Malalignment	Up to 5 degree	5-10 degree	>10 degrees
Pain	None	None	Present
Complication	None	Minor and resolved	Major complication and/ or lasting morbidity

Excellent: Alignment- anatomical or near anatomical, length discrepancy-nil, preoperative problems-nil.

Satisfactory: Alignment- acceptable and leg length with resolution of preoperative problems.

Poor: Alignment- unacceptable alignment or leg length with unresolved preoperative problems.

Table 2: The demographic and clinical characteristics of subjects (n=30)

Clinical variables	Total number of patients (n=30)
Age in years	
5-6	6(20%)
7-8	7(23.33%)
9-10	11(36.67%)
11-12	2(6.67%)
13-15	4 (3.33%)
Gender	
Male	22(73.33%)
Female	8 (26.67%)
Mode of Injury	
RTA	19(63.33%)
Fall from height	9(30.00%)
Others	2(6.67%)
Pattern of fracture	
As per Shape	As per Winquest and Hansen
• Transverse	16(53.3%)
• Oblique	9(30%)
• Spiral	3(10%)
	Grade-1 3(10%)
	Grade-2 1(3.33%)
	Grade-3 1(3.33%)
	Grade-4 0 (0.00%)
Time interval between trauma and surgery	
	• 2days 24(80%)
	• 3 days 6(20%)

Table 3: Operative Parameters

Reduction	No of patients (%)
Closed	29 (96.67%)
Open	1 (3.33%)
Number of nails	
One	0 (0%)
Two	30 (30%)
Nail entry portal	
Both from medial and lateral side	30 (100%)
Both from medial side	0 (0%)
Both from lateral side	0 (0%)
Duration of surgery	
28-35 mints	17(56.67%)
36-40 mints	9 (30%)
41-45 mints	4 (13.33%)

Table 4: Post-operative outcomes

Hospital stay	No. of patients (%)
3 weeks	2(6.67%)
4 weeks	26 (86.67%)
6 weeks	2 (6.67%)
Time of union	
6 weeks	25(83.33%)
8 weeks	5 (16.67%)
Time of full weight bearing	
6 weeks	6(20%)
8 weeks	23 (76.67%)
10 weeks	1 (3.33%)
Full range of knee movements	
6 weeks	26 (86.67%)
8 weeks	1 (3.33%)
9 weeks	2 (6.67%)
10 weeks	1 (3.33%)
Limb lengthening	
1 cm	2(66.66%)
1.5 cm	2 (66.66%)
Mal-alignment	
5° Angulation	2(6.67%)
10° Angulation	0 (0%)
Complications	
Granuloma	2(6.65%)
Entry site infection	1 (3.33%)
Nail bending/breakage	0 (0%)
Results	
Excellent	27 (90%)
Satisfactory	3 (10%)

RESULT

The study was done in the Department of Orthopedics, Dr. S. N. Medical College and Associated group of Hospitals, Jodhpur during the period of July 2016 to June 2018. A total of 30 patients were randomly selected. As per the Table no-2, 6 (20%) patients were 5-6 years, 7 (23.33%) were 7 to 8 years, 11(36.67%) were 9 to 10 years' age, 2 (96.67%) were 11-12 years and 4 (3.33%) were of 13-15 year of group with the average age being 9.13 years. There were 22 (73.33%) males and 8(26.67%) females in

the present study. In the present study RTA was the most common mode of injury (63.33%) and fall from height for 30%. The incidence of fracture was almost equal on Right (16 cases) and Left (14 cases) fracture shaft femur and the percentage of open fracture was 3.33%. In our study (Table-2), transverse fractures accounted for 12 (40%) cases, oblique fractures –15 (50%) and spiral fractures – 3 (10%). Fractures involving the middle 1/3rd accounted for 20 (66.67%) cases, proximal 1/3rd – 6 (20%) and distal 1/3rd – 4 (13.33%) of cases in our study. In the present

series, 24 (80%) patients underwent surgery within 2 days after trauma and 6 (20%) patients on 3rd days. Duration of surgery was 28-35 mins in 17(56.67%) case, 36- 40 mins in 9 (30%) cases and 41-45 mins in 4 (13.33%) cases (Table -3). In our series, the average interval between injury and definitive management was 2.2 days (Table-2). Delay in the definitive management was mainly due to late presentation of patient because most of them belongs to interior rural area and they were illiterate. The average hospitalization time noted in this series was 4.83 days. All cases were reduced by closed technique. The average duration of surgery was 35.76 min. The average follow-up duration was 9.86 months with minimum of 6 months and maximum of 12 months. The average time of union was 6.33 wks. and the average time of full weight bearing was 7.66 weeks. In the present study majority of patient 86.67% achieved full Range of knee movement up to 6 wks.

In our study lengthening was seen in 2 (3.37%) patients. In 1 patient lengthening was 1 cm while in 1 patient lengthening was 1.5 cm with an average lengthening of 1.25 mm (lengthening was seen in cases, all were having middle third fracture) and angulation was seen in 2 (6.67%) patients in this study (Table-4). One patient in this study was found to have infection at the entry portal of the nails, which subsided by 4 weeks after antibiotic therapy (Table-4). The final result as evaluated by Flynn criteria showed that among a total of 30 cases, 27 (90%) had excellent results and 3 (10%) has satisfactory results. No patient showed poor results.

DISCUSSION

The ideal choice for managing a femoral shaft fractures has always debatable issue remained a constant challenge in the field of orthopedic surgery. The classic treatment algorithm consists of Spica casting in children < 5 years; early skin/skeletal traction followed by casting, flexible intramedullary nail fixation, external fixation or compression plating in children age group of 6–11 years. Locked rigid intramedullary nail fixation, external fixation, compression plate or flexible intramedullary nail fixation is indicated in children of 12 years and older. Until recently, the conservative treatment for pediatric diaphysis femoral fractures was preferred in children and young adolescents. This conservative treatment requires prolonged immobilization along with better nursing care and of course the loss of school days of children so to avoid these problems, the management of such fracture in pediatric population has been drastically changed over the last two decades. Recent studies have also increased awareness in general population regarding the psychological and economic outcomes of Spica casting on children.¹² External fixator, compression plating, rigid

intramedullary nailing and flexible intramedullary nailing are the different therapeutic alternatives.¹³ Although the external fixator is good in terms of providing stability and early mobilization but it associated with the risk of pin tract infections as well as it takes a longer time for weight bearing.^{14,15} Plate osteosynthesis needs extensive soft tissue dissection with relatively longer period of immobilization, risks of infection and plate failure. Solid intramedullary nail is ideal for skeletally matured children but is associated with few complications such as AVN of the femoral head, femoral neck thinning and growth arrest of greater trochanter with secondary coxa valga deformity, when attempted in skeletally immature patients.^{16,18} Internal fixation by elastic stable intramedullary nail is now preferable over the conservative treatment and other form of internal fixation methods between the age groups of 5–16 years. Titanium elastic nailing system (TENS) is a flexible natured intramedullary nail serving as an “internal splint” that shares loads, maintaining the length and alignment also permitting optimal fracture site motion for callus formation. Several studies proved that it allows rapid mobilization, potentially no osteonecrosis, minimal risk for physeal injury and refracture. As there is no periosteal injury due to it is being used in minimal access technique-closed operative technique- the chances of infections and loss of osteogenic cells are further very minimal.

The usefulness of titanium elastic nails (TENS) in the treatment of femur fractures of pediatric population was first reported Ligier and colleagues¹⁹. They found only 1 case of deep wound infection and 13 cases of skin ulceration or local inflammation due to nail displacement. In a one-year follow-up period they didn't notice disability and gait related problem in any patient. Loss of alignment and fixation failure could be a problem with TENS nails due to relatively less rigid fixation, but in this study no such incidence occurred and a stable fixation was achieved. Also being a load-sharing device, no risk of relative osteopenia at the ends of bones occurred, as seen in load shielding external fixation devices, hence no refracture occurred after nail removal. In the study of Flynn *et al*²⁰ there was no angulation or mal-alignment or LLD of more than 1 cm was reported but they found nail-tip irritation at the insertion site in 8 cases that led to wound dehiscence and early nail removal, 1 case had refracture because of premature nail removal, and 1 case had nail bending after a history of fall which was primarily corrected by closed reduction but eventually treated with external fixation. Narayanan *et al*.²¹ observed that, besides clinical and radiographic outcomes, some other parameters need to be taken into account for treatment choice with titanium elastic stable intramedullary nailing. They found few complications such as pain/irritation at the insertion site, malunion, refracture, temporary neurologic deficit and

wound infection. Most complications are minor, and many are preventable. They asserted that transverse, short fractures whether oblique or spiral, with minimum comminution in the 5–12 years age group are the best indications for TENS.

CONCLUSION

TEN is an effective, easy, minimally invasive, and physio-protective treatment method and has minimal complications for the treatment of femoral shaft fractures in children. Most complications can be reduced by adhere to the basic principles and technical directions. Although LLD is a common complication of childhood femur fractures, it doesn't cause a functional problem in day-to-day activity.

Ethical approval: The study was approved by the institutional ethics committee

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