

ISSN: 2395-1958
IJOS 2018; 4(4): 881-884
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www.orthopaper.com
Received: 09-08-2018
Accepted: 13-09-2018

Dr. Akshay Yadav D
MS Ortho Postgraduate Junior
Resident, Department of
Orthopaedics, Sree Balaji
Medical College and Hospital,
BIHER, Chennai, Tamil Nadu,
India

Dr. Madhukar
Associate Professor, Department
of Orthopaedics, Sree Balaji
Medical College and Hospital,
BIHER Chennai, Tamil Nadu,
India

Dr. Vijay Narasimman Reddy
Professor and Head, Department
of Orthopaedics, Sree Balaji
Medical College and Hospital,
Chennai, Tamil Nadu, India

Prospective study of tens in femoral diaphyseal fractures among paediatric age group

Dr. Akshay Yadav D, Dr. Madhukar and Dr. Vijay Narasimman Reddy

DOI: <https://doi.org/10.22271/ortho.2018.v4.i4l.114>

Abstract

Femoral diaphyseal fractures account for <2% of fractures among paediatric age group. However, with advancement in the field of orthopaedics, surgeons are interested in a better and more stable fixation of these fractures which were treated conservatively. The primary aim of this study is to analyse the efficacy of titanium elastic nailing in femoral diaphyseal fractures. The study was done between June 2017 to May 2018. Two titanium nails are used under the C-arm guidance for stable fixation of fracture. Follow up of minimum 4 months is carried out in this study. In this prospective study, a total of 33 cases were selected. 21(63.6%) male and 12(36.3%) female patients with average age group of 9.81years. All 33 patients with femoral diaphyseal fractures were treated with 2 titanium nails. Post operatively patients were admitted in hospital for 5 days where they were treated with analgesics and i.v antibiotics for a period of 3 days and supportive medications for next 2 days. Fracture union was identified in routine X rays at an average duration of 6.72 weeks among the operative cases. Post-operative radiographs were examined for any varus or valgus angulation, non-union, delayed union and mal-union. Patients were advised not to weight bear on the fractured limb for a duration of 8 weeks. Partial weight bearing was instructed at the end of 8 weeks and full weight bearing at the end of 10 weeks.

Keywords: femoral diaphyseal fracture, children, paediatrics, titanium elastic nailing, TENS

1. Introduction

Femoral diaphyseal fractures in paediatric age group usually result due to road traffic accidents [1]. These fractures account for less than 2% among the paediatric skeletal injuries [2]. In children 5 years or younger, early closed reduction and application of one and a half spica cast is an ideal treatment for most diaphyseal fracture [3, 10]. In the more skeletally matured adolescents, use of antegrade solid intramedullary rod has become the preferred option for treatment. But, the best treatment for children between five to sixteen years of age is still debatable. Although in this age group fracture union is faster, most of the cases when treated conservatively result in angulation of the limb due to malrotation during casting [4]. There are reports of shortening of limb, joint stiffness and intolerance against immobilisation of limb for prolong duration [4]. With advancement in field of orthopaedics, minimally invasive treatment with stable fixation and better functional outcome is always looked for in treating fractures [11]. TENS is helpful in maintaining fracture reduction and it provides micro motion which in turn helps callus formation at fracture site. By stacking TENS in the medullary cavity of femur it strengthens stability of reduction. It has shown to have less duration of post-operative stay, early recovery, negligible joint stiffness and early mobilisation [5, 12, 13]. In the past fifteen years fixation with flexible intramedullary nails have become a popular technique, for stabilizing femoral shaft fracture in school aged children [5, 7, 11-13]. TENS fixation system is a simple, effective and minimally invasive technique [6]. The main objective of this study is to hypothesis that TENS for femoral diaphyseal fractures are more cost-effective treatment in paediatrics age group.

2. Materials and Methods

2.1 Materials

This is a prospective study of functional outcome of femoral diaphyseal fractures in children aged between 5-15 years. The patients had a history of road traffic accident or a history of fall

Correspondence

Dr. Madhukar
Associate Professor, Department
of Orthopaedics, Sree Balaji
Medical College and Hospital,
BIHER Chennai, Tamil Nadu,
India

while engaging in physical activities at the time of admission in Sree Balaji medical college and hospital, chromepet, Chennai-44.

Inclusion criteria

1. Age-5-15 years
2. Femoral diaphyseal fracture
3. Closed injuries
4. Duration of injury – less than a week

Exclusion criteria

1. Age - <5 years or > 15 years
2. Epiphyseal injuries
3. Open injuries
4. Congenital hip deformities
5. Polytrauma

We had 33 patients in our study with the above criteria.

2.2 Methods

On arrival at emergency, fracture was temporarily immobilized with Thomas splint and detailed history of injury, patient's medical history, immunization status and family history were recorded. X-ray of the limb was taken under routine AP and lateral view of the femur. Patient was thoroughly evaluated by paediatrician and anaesthetist before taking up for surgery.

Fractures were classified, and anaesthetic fitness obtained. Parents/guardians of the patients were informed about the procedure, complications associated with surgery and anaesthesia. Consent was taken before surgery. Patients underwent surgery at earliest after admission and immediate post-operative X-rays were taken. Patients were monitored 24 hrs post-operatively.

33 patients in the study with femoral fractures were stabilized using 2 titanium nails of diameter 2-4mm based on the minimal diaphyseal diameter of respective femur. All the

patients were treated with closed reduction under C-arm guidance.

3. Operative technique

Procedure was performed with patient in supine position under general anaesthesia. Prophylactic antibiotic was administered according to body weight parenterally in operating theatre before beginning the procedure. All the fractures were reduced under closed reduction under c-arm guidance. Two incisions were made 1-2cms in length on medial and lateral side of the distal femur with 3cms margin above the distal femoral epiphyseal plate. Soft tissue was retracted and with the help of bone awl entry point was created. Two titanium nails of same diameter were inserted into femoral diaphysis through the entry points with the help of T handle in retrograde fashion. Diameter of the nails was calculated to be 30-40% of the minimal diaphysis diameter. Fracture reduction was checked under c-arm guidance. The distal end of titanium nails was cut with a margin of 1cm outside the cortex. Through wound wash given with normal saline. Wound was closed in layers and sterile dressing was done. All the fractured limbs were placed on a posterior above knee slab. Five days post-operatively patients were discharged, and sutures were removed at 14th day post-operatively. Moulded plastic functional brace was applied to thigh after suture removal and patients were advised not to weight bear on the fracture limb and instructed about the crutch walking/supportive walking. Follow up at 2 weeks, 5 weeks, 2 months, 6 months and 9 months after discharge was advised and findings recorded. TENS were removed 8-10 months after surgery.

Functional outcome was based on Flynn *et al.*, scoring for TENS (Table 1). Outcome was based on limb length discrepancy, malalignment, pain and complications and results were measured as excellent, satisfactory and poor based on above parameters.

Table 1: Flynn Scoring

Post-Operative Outcome	Excellent Result	Satisfactory Result	Poor Result
Limb Length Inequality (Cms)	<1.0cms	<2.0cms	>2.0cms
Malalignment (Deg)	5	10	>10
Pain	None	None	Present
Complication	None	Minor and resolved	Major complication and lasting morbidity

4. Results

Based on pre-op X-rays, fractures were classified as transverse (63.6%), spiral (21.2%) and oblique (16.1%). 1 patient had comminuted fracture i.e. at the junction of upper 1/3rd and mid 1/3rd, mid 1/3rd and lower 1/3rd. There were 21 males and 12 females.

Average duration of surgery was 35.21 mins, the minimum operating time and maximum operating time in our study was 22 mins and 48 mins respectively.

Fracture union was noted on follow-up X-rays, average duration for fracture union was observed at 6.72weeks. 1week post union patient's guardians were instructed to assist the patient in partial weight bearing. Patients were encouraged to full weight bear on the fractured limb 2 weeks post union.

Malalignment was recorded in total of 5(15.15%) cases i.e. 1 case of transverse, 2 cases of oblique and 2 cases of spiral fracture. Varus and valgus malalignment of 10-15 degrees

was considered acceptable under the study and all above cases fell within the mentioned range.

Limb lengthening was observed in 9 (27.27%) cases and noted to be < 2cms in all cases. One patient had irritation of the skin at the site of titanium nail entry. On follow-up skin break down was observed and superficial infection was present. This particular patient had fracture at 2 levels and prolonged duration of surgery. Patient had decreased range of motion at knee and pain in the distal femur. Once the implant was removed at 4 months patient's skin healed and range of motion was improved to 0-140. No complications of osteomyelitis were recorded in this study. No patient had any delayed union or non-union. This prospective study results when evaluated according to Flynn scoring showed, 26(78.78%) had excellent outcome and 7(21.21%) patients had satisfactory outcome. None of the patients had any major complications or lasting morbidity.

Table 2: Profile of patients, clinical and radiological outcomes and complications

Sl. no	Age (yrs)/ Sex	Canal diameter (mm)	Tens diameter	Duration of surgery (mins)	radiological union (weeks)	angulation	Limb length equality	pain	complication	Post-operative Outcome
1	9/M	6	2	48	6	Nil	Nil	none	none	Excellent
2	11/M	7	3	40	7	nil	Nil	none	none	Excellent
3	10/M	7	3	42	6	Nil	0.5cms	none	none	Excellent
4	9/F	7	3	45	8	nil	Nil	none	none	Excellent
5	12/M	8	3	40	6	8° Varus	1cms	none	none	Excellent
6	8/M	7	3	35	6	Nil	Nil	none	none	Excellent
7	10/M	7	3	38	7	10° Varus	1.5cms	none	none	satisfactory
8	12/M	8	3	42	6	Nil	Nil	none	none	Excellent
9	10/M	7	3	28	6	12° valgus	1.2cms	none	none	satisfactory
10	8/F	6	2	39	7	Nil	Nil	none	none	Excellent
11	10/M	7	3	45	6	Nil	Nil	none	none	Excellent
12	12/M	7	3	38	6	Nil	Nil	none	none	Excellent
13	10/F	7	3	40	6	Nil	1cms	none	none	Excellent
14	12/M	8	3	36	6	10° valgus	Nil	none	none	satisfactory
15	9/F	6	2	28	7	Nil	Nil	none	none	Excellent
16	7/F	6	2	48	6	Nil	Nil	+	minor	satisfactory
17	12/M	8	3	30	7	Nil	0.5cms	none	none	Excellent
18	14/M	9	4	32	8	Nil	Nil	none	none	Excellent
19	6/M	6	2	40	6	8° valgus	Nil	none	none	Excellent
20	10/M	7	3	28	8	Nil	1.5cms	none	none	satisfactory
21	12/F	7	3	30	7	Nil	Nil	none	none	Excellent
22	12/F	7	3	38	6	Nil	Nil	none	none	Excellent
23	7/M	6	2	34	7	Nil	Nil	none	none	Excellent
24	6/M	6	2	22	6	Nil	1cms	none	none	satisfactory
25	8/F	6	2	28	7	Nil	Nil	none	none	Excellent
26	13/F	8	3	34	8	Nil	Nil	none	none	Excellent
27	12/M	7	3	24	8	Nil	Nil	none	none	Excellent
28	10/M	7	3	28	9	Nil	Nil	none	none	Excellent
29	7/F	6	2	32	7	Nil	1.8cms	none	none	satisfactory
30	8/F	6	2	28	6	Nil	Nil	none	None	Excellent
31	10/M	7	2	40	6	Nil	Nil	none	None	Excellent
32	12/M	8	3	32	8	nil	Nil	none	None	Excellent
33	6/F	6	2	30	6	nil	Nil	none	None	Excellent

5. Discussion

Femur is an important component of biomechanics of day to day activities in all age group. It helps transmit body weight to the lower limb. A load sharing device is ideal in treating femoral diaphyseal fractures. In late adolescents and adults and antegrade intramedullary rod will meet the objective of load sharing. However, in paediatric age group due to the epiphyseal plates this method of treatment will be obsolete. TENS being a minimally invasive technique does not disturb the epiphysis or the periosteum. TENS helps in formation of bridging callus at the fracture site without disturbing the blood supply^[11, 20]. The elastic property of the titanium helps in stress shielding which in turn promotes the callus formation^[5, 8, 11]. Flynn *et al*^[11] conducted a multi-centric study in 58 patients and showed excellent or satisfactory results in fifty-seven of fifty-eight cases treated with such nails. TENS has become a standard treatment in femoral diaphyseal fracture treatment^[18, 19]. Elastic stainless-steel nails have the same properties and yield same results as titanium nails^[21]. In a study done by Kanthimathi *et al*^[16], a detailed analysis according to the number of nails used, found that similar results were seen in those patients where two or three nails were used. Poor results were only seen in those cases where a single nail was used. Therefore, concluding that using a minimum of two flexible nails in paediatric femur shaft fractures offers the desired biological fixation and adequate stability to hold the fracture. On further analysis of same study, it was found that the use of two nails is optimal for the patient. Limiting oneself to the use of the minimum number of implants needed is more cost effective, decreases operating

time, reduces radiation exposure and offers equal results as that of three nails.

In our study we found 5 cases to have a varus and valgus angulation. Varus/valgus angulations up to five degrees and anterior/posterior angulations up to 10 degrees were acceptable for 11 years to the maturity^[17]. Wallace and Hoffman^[15] had shown that the femoral shaft fractures angulated 10 to 18 degrees in children less than 13 years corrected spontaneously in 85% of cases. Limb lengthening is recorded in 9 cases in our study and are 2.0cms or lesser. Flynn *et al*^[11] also reported six cases of leg length inequality of 1 to 2 cm among their 58 fractures. P Singh, R Kumar^[14] recorded eight cases of limb length inequality out of 112 patients. Six had less than 1 cm and two had 1 to 2 cm of limb length inequality. Mazda *et al*^[9] also showed 1 to 1.5 cm lengthening among three of their 34 patients. The fractured femur may be initially short from overriding of the fragments at union; growth acceleration occurs to make up the difference, but often this acceleration continues, and the injured leg ends up being longer. The potential for growth stimulation from femoral fractures has long been recognized, but the exact cause of this phenomenon is still unknown^[17]. One patient in our study had a minor complication of skin irritation at the entry site. On follow-up there was skin break down and superficial infection. Once the implant was removed at 4 months complications resolved. Similar complications were observed in few studies^[9, 11, 13, 14, 17].

6. Conclusion

TENS in treatment of femoral diaphyseal fracture is safe,

cost-effective and minimally invasive. It has shown to have less duration of post-operative stay, early recovery, negligible joint stiffness and early mobilisation with minimal complication.

7. Case Illustrations

Case 1



Fig 1: Pre-op x-ray, immediate post-op, follow-up at 4 weeks

Case 2

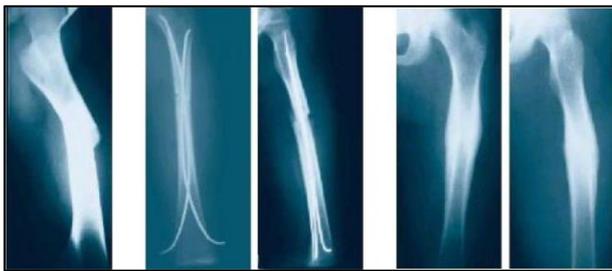


Fig 2: Pre-op x-ray, immediate post-op x-ray, follow-up at 4 weeks, post op after titanium nail removal at 9 months, follow-up at 2 months post TENS removal

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