Original Article

Outcome of Femoral Shaft Fracture Fixation with Titanium Elastic Nailing System in Pediatric Group of Patients with Clinical and Radiological Evaluation

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Abstract

Background: Very frequent and common paediatric orthopaedic emergency is fracture of shaft of femur. Traction and casting were the standard common practice for all femoral shaft fractures in paediatric group. Titanium Elastic Nailing System (TENS) is, now a days, a common practice for treating these fractures. In last twenty years, this fixation showed rapid union and early mobilization and have gained a general popularity.

Objective: To evaluate clinical and radiological outcome of titanium elastic nailing system for displaced femoral shaft fractures in paediatric patients.

Methods: This retrospective study was conducted in Orthopaedic Centre, CMH (Combined Military Hospital) Dhaka from January 2020 to December 2022. A total of 52 cases (34 boys, 18 girls), aged 6-14 years were fixed with TENS. Two nails of proper and equal diameter were used for each case. Plaster was used postoperatively upto soft tissue healing and stitch off (2 weeks postoperatively). Outcomes were assessed on the basis of Flynn et al scoring system.

Results: The results of the 52 cases were included in our study. Each fracture achieved complete healing at a mean of 9.1 (Range: 8-10) weeks. 44 fractures needed closed reduction and 8 needed open reduction. Nail entry site skin irritation was recorded as minor complication in 9 patients. 78.85% got excellent result and 21.15% got satisfactory result.

Conclusion: TENS has been increasingly popularized as a treatment option for paediatric shaft femur fracture over the last twenty years. It permits early mobilization and ambulation. Higher satisfaction with shorter hospital stay can be achieved with TENS. It also provides translational, angular and rotational stability to the fracture. Length can be well-achieved as well.

Keywords: Femoral Shaft Fracture, Hip Spica, Titanium Elastic Nailing System (TENS), Range of motion (ROM), Limb length discrepancy (LLD).

Introduction

Very common major injuries in school going children is femoral shaft fracture.[1] Usually, it's a high velocity injury. Road traffic accidents and fall from height are the common causes.[2]

Treatment plan is highly controversial for at the age of 6-14 years. Traditional non-operative options are 1) early hip spica, 2) a period of traction until the time of callus formation followed by application of hip spica. Femoral shaft fracture of younger than 6 years having high potential of healing is managed with the non-operative methods.[3,4]

The spica casting is used in the treatment of toddlers. Interlocking intra medullary nailing is commonly practiced in adults. The management in school going children make always a dilemma situation. Non-operative method for older than 6 years of age have some complications like loss of reduction, malunion and plaster associated problems, psychological upset and school absenteeism whereas rapid mobilization and early weight bearing is the output of operative treatment.[5-7]

Operative methods are extramedullary plating, intramedullary interlocking nailing and external fixation as well. But operative treatment has made a challenge due to growing physes at the both end of a long bone. The use of TENS here has gained popularity worldwide.[8]

TENS has become the choice of surgical practice here now a days, because of earlier union due to repeated micromotion at the fracture site, avoidance of physeal damage, earlier mobilization, earlier weight bearing, less scar formation and better patient compliance.[9] Here, the clinical and radiological outcome of intramedullary fixation of displaced femoral shaft fractures was investigated in skeletally immature children using TENS.

Materials and Methods

This retrospective study was conducted in Orthopedic Centre, CMH (Combined Military Hospital) Dhaka from January 2020 to December 2022. A total of 52 children (34 boys, 18 girls) of 6-14 years were included in this study.

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Inclusion Criteria:
1) Displaced femoral shaft fractures,
2) With or without comminution,
3) Multiple fractures.
4) Closed fractures.

Exclusion Criteria:
1) Children with less than 6 years and more than 14 years of age.
2) Subtrochanteric and supracondylar femur fractures
3) Undisplaced fractures.
4) Open fractures.
5) Pathological fractures.

Thorough pre-operative evaluation was done with all general investigation for general anesthetic fitness. Full length radiograph of the involved thigh including hip and knee joint (both anteroposterior and lateral views) was taken.

The surgeries were performed in supine position with the help of image intensifier. Two Titanium Elastic Nails of identical diameter were used. Diameter of the individual nail was selected as per Flynn et al's formula [16] (Diameter of nail = Width of the narrowest point of the medullary canal on anteroposterior and lateral view × 0.4 mm). The diameter of nail-from 2-4 mm were used.

Its length was selected on the basis of pre-operative radiograph of known magnification and confirmed on the limb before insertion. Medial and lateral incisions 2-3 cm above the physis were made. Under image intensifier, the cortex was breached with an awl. Nailing started at the distal fragment in retrograde fashion. TENS tapped along the medulla with the tip angled away from the cortex. All nails were inserted up to the fracture site. The fracture was reduced by manipulation and the nails tapped across the fracture site in an alternating manner 1 to 2 cm distal to proximal physis.

Fracture anatomy, quality of reduction, callus response and associated injuries dictates weight bearing time. Postoperatively, plaster was kept upto soft tissue healing and stitch off (2 weeks postoperatively), mobilization started without weight bearing on 2 weeks postoperatively. Partial weight bearing started at around 6 weeks. Full weight bearing by 9 weeks. Every Patient was assessed radiologically as well as clinically every 6 weeks for first 12 weeks, then once every 3 months.

Parameters studied:
1) Clinical features of union,
2) Radiological features of union,
2) Malalignment,
3) ROM of the knee of the affected side,
4) Limb length discrepancy (LLD) and
5) Any other complications found during the study.

Results

Table-I: Methods of reduction, locations of fractures, pattern of fractures (n=52)

Methods of reduction	Locations of fractures	Pattern of fractures
Close reduction- 41 fractures	7 cases- proximal third	32 cases- transverse
Open reduction- 11 fractures	38 cases- middle third	9 cases- short oblique
	7 cases- distal third of femur	4 cases- spiral
		7 cases- minimally comminuted (Winquist-1)
Total- 52	Total- 52	Total- 52

Table-II: Flynn et al's scoring system for TENS and present study result (n=52)

	Excellent	Satisfactory	Poor
Pain	None	None	Present
Malalignment	<5°	5°-10°	>10°
LLD (Limb Length Discrepancy)	<1 cm	1-2 cm	>2 cm
Complication	None	Minor	Major and/or lasting morbidity
Total - 52	n=41	n=11	n=0

Table-III: Complications in the study (n=23)

Complications	Number (n=23)
Entry site irritation/ Friction bursitis	9
Superficial infection	3
Deep infection	0
LLD (Limb Length Discrepancy) (up to 2 cm)	11

Friction bursitis at the entry point caused by cut ends of the nail. Superficial infection at the nail entry site which resolved within 7 days of oral antibiotics. Deep infection, joint penetration by nail, nail breakage and implant failure, iatrogenic fracture, nonunion or any neurovascular complications were nil. Major complication was recorded zero.

All the 52 patients were available for evaluation after a mean duration of follow-up for 60 weeks. The mean operation time was 41.4 (range 31- 47) minutes. The mean duration of hospital stay was 9.16 (range 7-14) days. Mean time of clinical union was 7.7 (range 7- 10) weeks. Mean time of radiological healing at 9.3 (Range 8-11) weeks. Full weight bearing was possible in a mean time of 8.8 (range 7-11) weeks. All the patients achieved full ROM by an average of 9.7 (range 8-12) weeks. None developed any angular deformity of >5 degrees. LLD (up to 2 cm) in 11 cases, which was clinically insignificant.

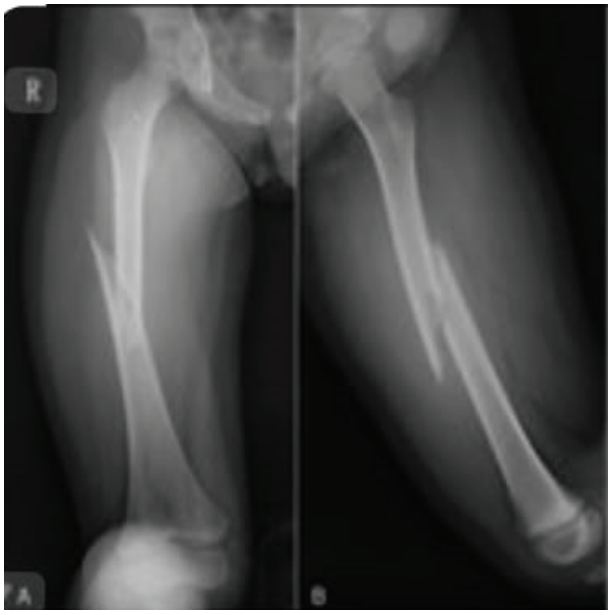

Figure-1: Fracture of Shaft of Femur

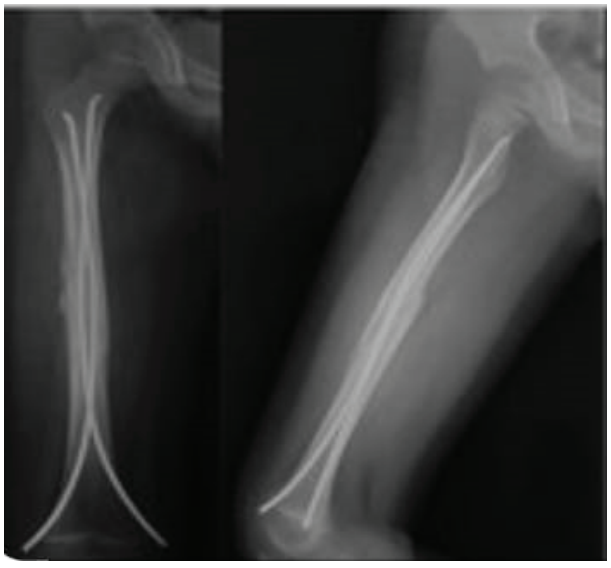

Figure-2: One month postoperatively

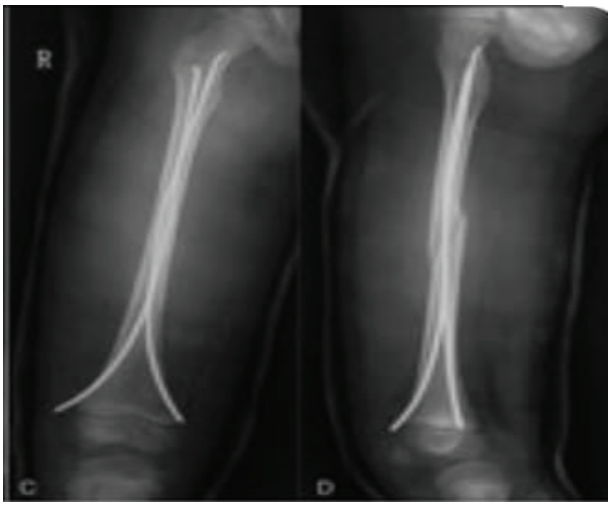

Figure-3: United fracture of Shaft of Femur

Figure-4: After removal of implant

Results evaluation were performed by Flynn et al's scoring system; 78.85% had excellent result and 21.15% had satisfactory. The nail removal was performed after an average of 42.3 (range 38-47) weeks. Complication associated with the nail removal procedure was nil. Refracture after nail removal till the last follow up was observed zero.

Discussion

Treatment of fracture in pediatric shaft of femur is controversial as well as debatable. Treatment for this fracture in pediatric age group is variable. There are a couple of options available to treat this fracture.

Common standard practices are:

- Non operative – Traction, Gallows traction, early spica casting, Pavlik harness[3]
- Operative- elastic intramedullary nailing, compression plate fixation, external fixation[10]

Hip spica casting is associated with complications like

- Breakage of plaster
- Loss of reduction,
- Malunion,
- Pressure sore,
- Quadriceps weakness,
- Prolonged period of immobilization,
- Delayed mobilization and weight bearing
- Prolonged bed occupancy and hospital stay,
- Loss of education and loss of school attendance,
- Psychological burden, intolerance.

Abovementioned complications of non-operative options direct towards operative stabilization.[11,12] The result of this study was 78.85% (41 cases) had excellent whereas 21.15% (11 cases) had satisfactory result and none had poor outcome as per the scoring system for TENS by Flynn et al.[13] The operative stabilization by TENS is gaining popularity for last twenty years.[14]

Compression plating has the demerits of

- Larger soft tissue dissection,
- Large scar,
- High risk of infection,
- Delayed weight bearing and
- Second major operation for implant removal.[15]

External fixator is associated with

- Pin track infection
- Refractures through the pin tracks.[16]

Skeletally mature patient needs rigid intramedullary nailing. But skeletally immature child has the problems of • Physeal injury and growth disturbances,

- Coxa valga,
- Avascular necrosis of the femoral head[17,18]

TENS is a flexible intramedullary nail which is a load sharing implant, acts as an internal splint. It maintains length and alignment and doesn't disturb periosteum or fracture hematoma if closed procedure is done. It has less risk of infection and nonunion. TENS has the advantages of titanium such as more strength, light weight, corrosion resistance and MRI compatibility. Ligier et al, first described the benefits of titanium nail for femur fractures in children.[19] All femoral diaphyseal fractures except Gustilo-Anderson type III open fractures could be fixed with TENS in children >6 years of age.[20]

The mean operation time was 41.4 (range 30-47) minutes in our study whereas Gwyn et al showed it was 38 (range 30-45) minutes for same procedure.[4] The mean duration of hospital stay was 9.16 (range 7-14) days in this study whereas Narayanan et al showed it was 8.16 (range 7-12) days for same procedure.[6] Mean time of clinical union was 7.7 (range 7-10) weeks in this study whereas Flynn et al showed it was 7.9 (range 7-9) weeks for same procedure. But for Plate fixation it took 9.1 (range 8-12) weeks.[13] Mean time of radiological healing at 9.3 (range 8-11) weeks in this study whereas Flynn et al showed it was 9.1 (range 7.9-10.9) weeks for same procedure. But for Plate fixation it took 9.8 (range 9-12) weeks.[13] Full weight bearing was possible in a mean time of 8.8 (range 7-11) weeks in this study whereas Saikia et al showed it was 11.5 (range 9.5-14.2) weeks for hip spica.[10] All the patients achieved full ROM by an average of 9.7 (range 8-12) weeks in this study whereas Mazda et al showed it was 9.6 (range 8-11) weeks for same procedure and 12.6 (range 9.4-15.4) weeks for hip spica.[21] None developed any angular deformity of >5 degrees in our study whereas Flynn et al showed it was of >10 degrees in 19% and of >5 degrees in 41% for spica casting.[13] LLD (up to 2 cm) in 11 cases, which was clinically insignificant in this study whereas Flynn et al showed it was >3 cm of LLD in 39% for spica casting.[13] Results evaluation were performed by Flynn et al's scoring criteria. In this study 78.85% had excellent result and 21.15% had satisfactory outcome whereas Flynn et al showed it was 84.61% had excellent result and 15.39% had satisfactory outcome for same procedure.[13]

Conclusion

TENS has been popularized day by day as a treatment option for paediatric shaft femur fracture over the last twenty years. It permits early mobilization and ambulation. It has higher satisfaction with shorter hospital stay. It also provides translational, angular and rotational stability. Titanium elastic nailing seems to be more physiological and effective method of treatment of femoral shaft fractures in 6-14 years old children. Length can be well-achieved as well. Overall we can say, TENS for pediatric shaft femur fracture is a safe, cost effective procedure with very few short term complications.

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