

Original Research Article

Comparative study of the outcome of pediatric femur diaphyseal fractures treated with titanium elastic nails vs. compression plates

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ABSTRACT

Background: A variety of methods have been described for the management of femur diaphyseal fractures in children between ages of 5 to 12 years. Some of the techniques include closed reduction and internal fixation (CRIF) with elastic nails, open reduction and internal fixation (ORIF) with compression plates, external fixators and skeletal traction with spica casting. This study was done to compare the outcome and complications of diaphyseal femur fractures in pediatric age treated with CRIF with Titanium elastic nails vs. ORIF with compression plates.

Methods: The study was a prospective, clinical study. A total of 60 patients were studied. 30 patients were treated with CRIF with titanium nails and 30 patients were treated with ORIF with compression plates. Every patient operated was followed up at 3 weeks, 6 weeks, 3 months, 6 months and 3 months thereafter until implant removal.

Results: Only 1 wound healing complication was noted in the TENS nail group which was skin irritation at the site of pin insertion. In the compression plating group, 6 patients developed wound complications, including superficial infections, deep infections and keloids. The range of movements at knee joint in the two groups was compared. Only 1 patient had a significant loss of flexion with ROM of less than 100 degrees in the TENS nail group. In the plating group 4 patients had a significant loss of flexion with ROM of less than 100 degrees. Limb length discrepancies were seen in 3 patients in the TENS nail group whereas the compression plating group showed 1 patient. 2 patients in the TENS group developed an angular deformity due to premature weight bearing. 3 patients in the compression plating group developed deformities at the fracture site. The average time for fracture union in the compression plate group was 10.7 weeks and was 14.7 weeks in the patients treated with TENS nail.

Conclusions: No single fixation method can be considered superior in all types and patterns of pediatric diaphyseal femur fractures. Titanium elastic nails can be considered a better implant for treating pediatric femur fractures when compared to compression plates due to the lesser rates of surgical wound complications, better range of movements at knee joint and overall lesser complication rate as was recorded in this study.

Keywords: Titanium elastic nail, Compression plate, Pediatric femur fracture

INTRODUCTION

A variety of methods have been described by different studies and authors for the management of femur diaphyseal fractures of children between the ages of 5 to 12 years. Some of the techniques include closed reduction and internal fixation (CRIF) with elastic nails, open reduction and internal fixation (ORIF) with compression plates, external fixators and skeletal traction

with spica casting. Some of the factors deciding the modality of treatment to be given are age, weight, associated fractures and underlying musculoskeletal disorders.¹ Nowadays there is an increased tendency towards operative fixation of paediatric femur fractures because of rapid recovery and to avoid prolonged immobilization.² Considerable controversy exists over the most optimal treatment option for paediatric diaphyseal femur fractures and only few studies exist comparing

titanium elastic nails and compression plates as treatment options.

Paediatric diaphyseal femur fractures are the most common musculoskeletal traumatic injury requiring inpatient treatment in children.³ The most common causes of femur fractures in children include falls, road traffic accidents, bicycle falls and abuse in the decreasing order of incidence.⁴

Despite the high incidence of diaphyseal femur fractures in children, no optimal treatment modality has been described, especially in the age group of 5 to 12 years. The most important factors causing controversy are the evolving methods of treatment being available and a lack of high level evidence studies proving one treatment modality to be better than another. While elastic nails were the best regarded treatment in 1990s, recent reports suggest technical difficulties in the procedure, and also regard compression plating to be a suitable alternative to elastic nails.⁵⁻⁷ Operative treatment is preferred to avoid significant social, physical and psychological stress to the patient and his family.² External fixators are generally avoided because of the chances of infection of the pin tracts and refracture.⁸ Antegrade intramedullary nailing is outdated because of the high incidence of osteonecrosis following the procedure.⁹ Various American and European studies have recorded good outcomes following the use of titanium elastic nails and compression plating.^{7,10-12}

Our study was done to compare the radiological and functional outcome of paediatric diaphyseal femur fractures treated with closed reduction and internal fixation with titanium elastic nails and open reduction with internal fixation with compression plates in the age group of 5 to 12 years.

METHODS

Source of data

The study was conducted in the Department of Orthopaedics, K.R Hospital, Mysore Medical College and Research Institute, Mysore, between July 2013 to July 2016. The study was a prospective, clinical study. The protocol was approved by the ethics committee of our institution. After we had taken written informed consent from the study participants and obtained base line information, we treated the patients either with titanium elastic nails or with compression plates.

Sample size

A total of 60 patients were studied during the course of the study period. 30 patients were treated with CRIF with titanium nails and 30 patients were treated with ORIF with compression plates.

Inclusion criteria

All children coming to the department of orthopaedics at K.R Hospital, Mysore were included into the study provided they were aged 5 to 12 years, had a diaphyseal femur fracture and had no other significant comorbidity like bleeding diathesis, juvenile diabetes mellitus, pathological fractures etc. Patients were excluded from the study if they had compound fractures, if the fracture line extended into the proximal or distal femur, and patients who were unwilling or unfit for surgery.

Treatment

All patients were positioned on a fracture table and were operated under general anaesthesia. Fixation was then done according to the group into which the patient was added, with either CRIF with titanium elastic nails or ORIF with compression plate and screws. Transverse femur fractures were preferably treated with titanium nails and oblique or spiral fractures were preferably treated with compression plates.

CRIF with titanium elastic nails was done with 2 flexible nails of appropriate diameter (ranging from 2 to 3 mm) inserted through the distal femur at a point 2.5 cm proximal to the distal femur growth plate under C-arm guidance. The divergent C configuration is used to maintain reduction. One nail is pushed towards the neck of femur until it reaches 2 cm distal to the capital physis. The other nail is pushed towards the greater trochanter, until 1cm distal to its physeal growth plate. Average operating time was 37 minutes and average blood loss during surgery was 24 ml. Sutures were removed 2 weeks after surgery and partial weight bearing was started 4 weeks post operatively.

ORIF with compression plate and screws was done through a lateral approach. The fracture site is exposed and freshened. With the fragments held in reduction, the fracture is fixed with 6 to 8 holed 4.5 mm dynamic compression plates and 4.5 mm cortical screws. Incision is closed in layers after securing haemostasis. Average operating time was 63 minutes and average blood loss during surgery was 116 ml. Sutures were removed at 2 weeks after surgery and partial weight bearing was allowed at 2 weeks post operatively if fracture was stable and delayed to 4 weeks if unstable.

Follow up and outcome measure

Every patient operated was followed up in the outpatient department at 3 weeks, 6 weeks, 3 months, 6 months and 3 months thereafter until implant removal. The mean period of follow up was 16 months. The patients were evaluated based on the following parameters:

- Surgical wound healing complications
- Range of movements at knee joint

- Deformity at fracture site
- Limb length discrepancy
- Time of union
- Time of implant removal after surgery

RESULTS

The preoperative patient profile, intraoperative parameters and postoperative outcome of patients treated with TENS nails and compression plates were compared and the results were tabulated in Table 1 and 2.

Table 1: Patient profile.

Measure	TENS nail group	Compression plate group
Sex		
Males	18 (60%)	14 (46%)
Females	12 (40%)	16 (54%)
Mechanism of injury		
RTA	12 (40%)	14 (46%)
Fall from height	6 (20%)	4 (13%)
Sports injury	8 (26%)	10 (33%)
Others	4 (13%)	2 (7%)
Age		
Range	5 to 12 years	5 to 12 years
Mean age	9.1 years	8.4 years
Post-operative partial weight bearing		
Earliest	3 weeks	4 weeks
Latest	5 weeks	7 weeks
Average	3.8 weeks	5.2 weeks
Post-operative analgesics required	3 days	9 days
Implant removal (months)		
Earliest	6	5
Latest	9	9
Average	8.6	7.3

Table 2: Post-operative outcome.

Outcome measure	TENS group	Compression plate group
Wound healing complications	1 (3%)	6 (20%)
Average ROM at knee (degrees)	147	134
Deformity at fracture site	2 (6%)	3 (10%)
Limb length discrepancy	3 (10%)	1 (3%)
Time of union (weeks)	14.3	10.7

The TENS nail group consisted of 18 males and 12 female patients with the predominant mechanism of injury being road traffic accidents (40%) and sports injuries (26%). In the compression plate group we had 14 males (46%) and 16 female patients (54%) with the common modes of injury being similar to the TENS

group, that is road traffic accidents (46%) and sports injuries (33%).

Intraoperative parameters that were compared were intraoperative blood loss and total time duration of surgery. The average time duration of surgery and intraoperative blood loss in the TENS nail group were 37 minutes and 24 ml respectively, whereas in the compression plating group it was 63 minutes and 116 ml.

Postoperative analgesics were required for an average of 3 days in the TENS nail group as compared to 9 days in the compression plating group. Postoperative partial weight bearing was started between 3 to 5 weeks with an average of 3.8 weeks in the TENS group and in the compression plating group partial weight bearing was started between 4 to 7 weeks with an average of 5.2 weeks.

Only 1 wound healing complication was noted in the TENS nail group which was skin irritation at the site of pin insertion. The wound healed completely after implant removal. In the compression plating group, 6 (20%) patients developed wound complications, including superficial infections, deep infections and keloids as given in Figure 1.



Figure 1: 12 year old boy treated with ORIF with compression plates with surgical wound keloid.



Figure 2: Terminal flexion of knee joint is restricted in a boy treated with TENS nail at 8 weeks post-op. normal range of movements was achieved after implant removal.

The range of movements at knee joint in the TENS group ranged from 98 degrees to 152 degrees with an average of 147 degrees. Only 1 (3%) patient had a significant loss of flexion with ROM of less than 100 degrees. The range of movements at knee joint in the compression plating group ranged from 95 degrees to 155 degrees with an average of 134 degrees. 4 (13%) patient had a significant loss of flexion with ROM of less than 100 degrees as shown in Figure 2.

Limb length discrepancies were seen in 3 (10%) patients in the TENS nail group with a range of -1.1 cm to +1 cm. In the compression plating group 1 patient developed a limb length discrepancy of -1.1 cm.

2 patients in the TENS group developed an angular deformity due to premature weight bearing as shown in Figure 3. Follow up of those patients showed good remodelling and no remaining deformity. 3 patients in the compression plating group also developed deformities at the fracture site due to loose adherence to weight bearing protocols as shown in Figures 4 and 5. The timing of fracture union and implant removal were compared between the two groups as shown in Figure 6.



Figure 3: 2 patients in the TENS group developed an angular deformity due to premature weight bearing. Follow up of those patients showed good remodelling and no remaining deformity.



Figure 4: X-ray showing complete union of femur fracture of a 8 year old boy treated with TENS nail at 16 weeks.



Figure 5: X-rays showing evidence of complete union of shaft femur fracture of a 12 year old boy treated with compression plates, 12 weeks post operatively.

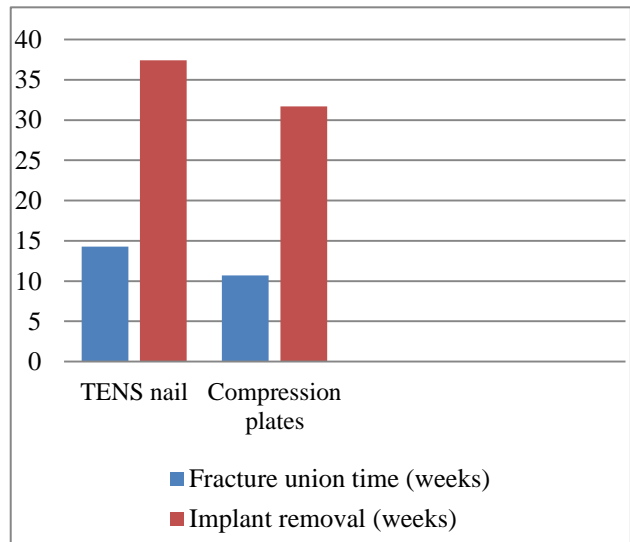


Figure 6: Comparison of the timing of fracture union and implant removal between two groups.

DISCUSSION

Although pediatric femur fractures are a common occurrence in the emergency room of our hospital, no strict guideline or protocol exists on its management, despite extensive research in this field.¹³ Most of the literature and studies available now are giving consistent results and can guide the clinician in deciding the best modality of treatment for femur fractures in a particular age group. Femur fractures in patients less than 5 years of age are treated successfully conservatively with Spica casting.¹⁴ Children beyond 12 years with femur fractures are treated with interlocking intramedullary solid nails with few complications.¹⁵ The area of controversy remains in how to best manage a femur fracture in the age group of 5 to 12 years. CRIF with Flexible titanium nails have been found to be the preferred treatment for

children between 5 to 12 years, weighing less than 50 kg and who had length stable fractures.¹⁰ Ligier et al first published their results of having fixed 123 femur fractures with titanium elastic nails in the age group of 5 to 16 years, and they reported 1 case of deep wound infection, 13 cases of superficial ulceration at nail insertion site and no disability or gait disturbance at 1 year follow up.¹⁶ Flynn et al studied 49 pediatric femur fractures treated with TENS nails and reported no case of mal-alignment or limb length discrepancy of more than 1 cm. They also reported 8 cases of nail tip irritation at insertion site.¹⁷ Our study with TENS nails showed similar complications and a similar rate of complication, except that the occurrence of deformities at fracture site in our study was more, which occurred due to premature complete weight bearing by the patient. The deformities which we recorded in the TENS nail group were insignificant after 1 year of follow up due to good remodeling at fracture site. Moroz et al stated that the rate of complication of Titanium elastic nails increased (47.5%) in patients weighing more than 50 kg or aged more than 11 years.¹⁸ Multiple studies have stated that if flexible intramedullary nails were used in the treatment of length unstable fractures it resulted in an unacceptable complication rate.¹⁹⁻²² Similar findings were reflected in our study where patients treated with TENS nail with transverse femur fractures had a better outcome as compared with those with long oblique or spiral fractures.

The viable alternative to flexible intramedullary nailing in pediatric femur fractures is fixation with compression plates. Locking compression plates have been tested and are found to provide a more biologically stable construct than flexible intramedullary nails, and are thus the treatment of choice in length unstable pediatric femur fractures.²³ Although compression plates do provide increased fracture stability, the chances of refracture especially in the 1st week after implant removal are high.²⁴ ORIF with compression plates is also notorious for the increased rates of infection, extensive soft tissue damage around the fracture and subsequent delayed fracture union.²⁵

The lesser rate of surgical wound related complications, lesser operative time, minimal blood loss and faster recovery with titanium nails used in the treatment of pediatric femur fractures as reflected in our study is also consistent in other similar studies and case series, making titanium elastic nailing the procedure of choice in fixation of pediatric femur fractures in the age group of 5 to 12 years. The alternative treatment method that was compared in this study was compression plating. ORIF with Compression plates and CRIF with Titanium elastic nails had an insignificant difference in functional and radiological outcome but a higher rate of wound complications, increased operative time and increased blood loss was recorded in the plating group.

CONCLUSION

No single fixation method can be considered superior in all types and patterns of pediatric diaphyseal femur fractures. Titanium elastic nails can be considered a better implant for treating pediatric femur fractures when compared to compression plates due to the lesser rates of surgical wound complications, better range of movements at knee joint and overall lesser complication rate as was recorded in this study. Although the time for union was recorded to be earlier in the compression plate group and earlier mobilization was allowed after plating, the difference was found to be insignificant after 1 year of follow up. The increased operating time and average blood loss during ORIF with compression plates further supports CRIF with TENS nail as being the more appropriate implant for treating diaphyseal femur fractures in children in the age group of 5 to 12 years.

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