

Outcome of Diaphyseal Fracture of Tibia Treated with Flexible Intramedullary Nailing in Pediatrics Age Group; A Prospective Study

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Abstract Fracture of Tibia is the most common amongst pediatric fractures. Most tibial shaft fractures are treated conservatively with close reduction and above knee cast application. Surgery is indicated only when the fracture is unstable, open fracture and associated with multiple injuries. Flexible intramedullary nailing is commonly used for diaphyseal tibial fracture and is also well used in other long bone fracture. The advantages of flexible intramedullary nailing are minimal invasive surgery, short hospital stay and early weight bearing. The objective of this prospective study was to review the functional outcome of flexible intramedullary nailing in pediatric age group. In the study, the union time, weight bearing time and complications associated with flexible intramedullary nailing were observed. There were 18 children with fracture shaft of tibia treated at the Department of Orthopedics, Manipal Teaching Hospital, Pokhara, Nepal from April 2014 to March 2015. The protocol consisted in flexible intramedullary nailing of fracture shaft of tibia in children. Angulation, shortening and other complications were checked. In our study the average age of the patient was 8.2 years (range 6–12 years). Out of 18 children with fracture shaft of tibia 15 had close fracture and 3 had open fracture. All fracture cases treated with flexible intramedullary nailing had good alignment post operatively. The average age of the patient was 8.2 years (range 6-12 years). Sixteen children had an angulation of less than 5 degrees and 2 children had angulation of 5 to 10 degrees which was acceptable to the age group. The mean time of radiological union was 13.3 weeks with early callus formation of 4.3 weeks. The average time for full weight bearing was 8.8 weeks. The average hospital stay of the patient was 5.7 days (range from 3 to 16 days). Fixation with flexible intramedullary nails in diaphyseal fracture shaft of tibia in pediatric age group is simple, effective, minimally invasive procedure with short hospital stay and having good outcome.

Keywords: Fracture Tibia, Flexible Intramedullary Nailing, Pediatrics Group

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1. Introduction

Fracture tibia is one of the common fractures in pediatric age group. It accounts about 10 to 15% of cases [1]. In majority of cases close reduction and plaster application is the main stay of the treatment [2]. Operative management in fracture tibia in pediatric age group is a matter of debate. Surgical intervention is indicated only in limited cases like failed close reduction, open fracture, fracture with neurovascular injuries, polytrauma patients, fracture with compartment syndrome and in older age group patients [3,4]. Unstable fracture in children of more than 10 years of age is also one of the indications for surgical intervention [5].

Flexible intramedullary nailing in long-bone fractures in pediatric age group has become popular because of its effectiveness and less complications. Studies have supported the use of flexible intramedullary nails in femur

having advantages like closed insertion, fracture hematoma preservation and physeal sparing entry point [6].

Flexible intramedullary nails achieved biomechanical stability from its ‘C’ configuration, which produces three points fixation and acts as an internal splint [7]. Flexible intramedullary nails allows controlled motion at the fracture site, which enhance callus formation [8].

There are many studies on flexible nailing in femur but very few studies are done on tibial fracture. This study was done to assess the outcome of flexible intramedullary nailing to treat tibial fracture in pediatric age group.

2. Methodology

This prospective study included 18 children (12 male and 6 female) with displaced fracture shaft of tibia (10 right side and 8 left side). Out of these 18 children, 15 had close fracture and 3 had open fracture (Type I-2 and Type

II-1). All the patients were admitted in the Department of Orthopedics, Manipal Teaching Hospital, Pokhara, Nepal from April 2014 to March 2015. All patients were given above knee posterior slab prior to operation and pre anesthesia checkup was done.

Sample size calculation: In a pilot study done prior to the study with 10 patients showed expected proportion of limb length discrepancy was .9, Precision (%) = 14, and Desired confidence level (%)= 95. Required sample size was 18 [9].

Prior approval was obtained from the Ethical Committee of the Manipal Teaching Hospital. Consent in writing was taken from the parents of the children before the study.

3. Operative Procedure

All patients were operated upon under general anesthesia. The affected limb was cleaned and draped. If the fracture was open, wound debridement was done. The appropriate size of nail was determined preoperatively by measuring the narrowest diameter of the medullary canal and using Flynn's formula i.e. nail diameter = $0.4 \times$ the diameter of the medullary canal. The nail was countersunk manually into a "C" shape. The nail tips were bent to 45° for easy passage of nail and to help in fracture reduction.

Small stab incision was given about 2.5 to 3 cm distal to the proximal tibial physis. Then, blunt dissection was done to reach the cortical surface of tibia. The entry point was made with bone awl into the medial cortex. Then the medial nail was attached to the inserter and inserted perpendicular to the medial cortex. When the nail reached far cortex, the inserter was rotated to direct the nail towards the medullary canal. The nail was advanced to the fracture site, once the nail reached to the fracture site close reduction was done and nail advanced distally. The proper intramedullary position of the nail was checked in image in both anteroposterior and lateral views. The lateral nail was inserted in similar method. Both the nails are advanced distally till the tips are just proximal to the distal tibial physis. We left sufficient nail proximally for removal. It is important that both the nails are of same size to avoid differential loading in opposite cortices which may lead to angular deformity.

After operation all the patients were given above knee posterior slab for a period of 6 weeks. Post-operative X-ray were taken including anteroposterior and lateral view full length of operated site. The patients were followed up in 2 weeks, 6 weeks, 12 weeks and 6 months. Patients were discharged on 3rd post-operative day except the children with open fractures who were discharged on 14th post-operative day after sutures were removed.

4. Results

In the study the average age of the patient was 8.2 years ranging from 6 years to 12 years. The average hospital stay of the patient was 5.7 days (range from 3 to 16 days). Three of the children had a longer stay because of the open fracture and for intravenous (IV) antibiotics for 14 days. For close fracture cases a single dose of IV antibiotics was given followed by oral antibiotics for 5

days. Callus was seen in children at an average of 4.3 weeks (range from 3 to 9 weeks). All the children achieved complete healing (three cortex with bridging callus in radiograph) at a mean of 13.38 weeks (range 12–18 weeks). Full weight bearing was allowed to all the children as tolerated. The mean time for full weight bearing in our study was 8.8 weeks (range 6 to 12 weeks).

Table 1. Different Parameters with Mean Value and Range

Parameters	Mean	Range
Age (years)	8.2	4-12
Hospital stays (days)	5.7	3-16
Callus formation (weeks)	4.3	3-9
Radiological union (weeks)	13.3	12-18
Full weight bearing (weeks)	8.8	6-12

At the time of final follow-up at six months, 16 children had angulation of less than 5 degrees whereas 2 children had angulation of 5 to 10 degrees and none of the children had angulation more than 10 degrees. The limb length discrepancy was less than 1 cm in 16 cases, 2 cases had 1-2 cm of shortening and none of the case had more than 2 cms. of shortening so there was no need or requirement for corrective intervention. Out of 18 children, 1 child had pain at the nail insertion site remaining 17 children had no pain. The final outcome for all the cases was positive and all the children had full range of movement at knee joint. Only 4 children complained of nail protrusion and skin irritation but there was no infection at the site.

Table 2. Distribution of Complications at 6 Months

Complications	Cases [N (%)]
Limb length discrepancy (cm)	
<1	16 (88.88)
1-2	2 (11.11)
>2	0 (0.0)
Angulations (Degrees)	
<5	16 (88.88)
5-10	2 (11.11)
>10	0 (0.0)
Pain at nail insertion site	
No	17 (94.44)
Yes	1 (5.55)
Limited knee flexion	
No	18 (100)
Yes	0 (0.0)
Nail protrusion and skin irritation	
No	14 (77.77)
Yes	4 (22.22)

5. Discussion

Tibial fracture is one of the common fractures encountered in pediatric age group and requires hospitalization. More than 20% of fracture tibia requires hospitalization [10]. Usually diaphyseal tibial fractures in children are treated with close reduction and casting [2]. However, this procedure requires prolonged immobilization and regular follow-up. Malalignment and re-displacement are common, particularly in cases of isolated tibia fracture [11]. Operative treatment is performed to avoid above complications.

The choices of implant for fixation of unstable tibia fracture are external fixation or plate and screw but they also had associated complications like infection, overgrowth, and refracture [12].

In 2005, Kubiak et al compared elastic intramedullary nails with external fixators for the treatment of fracture tibia in children. In their retrospective study of 31 children, 16 children were treated with Elastic Stable Intramedullary Nailing (ESIN) and 15 had external fixation. In the external fixation group, 7 bony complications (2 delayed unions, 3 nonunion and 2 malalignment) and in the ESIN group only 1 bony complication was observed respectively. For union in the external fixation group the mean time period was 18 weeks whereas it was only 7 weeks for the ESIN group. This study showed that intramedullary nailing is superior to external fixation [13].

A simple load-sharing device should be the ideal device to treat pediatric tibial fractures. It should maintain alignment, allow mobilization and should not cross the physis. The procedure should facilitate easy insertion and removal after bony union. The flexible intramedullary nail satisfies most of these criteria and is being used by number of surgeons.

There are few studies that were done previously that favored the use of flexible nail in pediatric tibial fracture. The result in their study is similar to the result in the study done by us.

Study done by Liu P et al showed the average healing time 10 weeks and at final follow up all the children had full range of movement, two patient had shortening of limb of less than 1 cm but without any problem and there was no case of refracture [14].

In the study done by O'Brien et al. in 16 tibial fractures, fixed with flexible intramedullary nails achieved a good functional outcome. They had 1 superficial infection, 6 coronal and 7 sagittal angulations without any functional compromise. One child had a leg shortening of more than 1.5 cm [15].

Qidawi et al described a retrospective review of 84 fractures of the tibia treated with intramedullary Kirschner wires with a mean time to union of 9.5 weeks [16].

Wiss et al reported that 48 of 52 fractures of the tibia healed at a mean of 17 weeks. Three patients developed angular malformation $> 7^\circ$ and five had shortening > 1.2 cm, but no functional restriction was noted [17].

Vallamshetla et al studied 56 unstable fractures in 54 children treated with flexible intramedullary nails. The mean time for union was 10 weeks (range 7–18 weeks). In their study, 2 children (4%) had leg length discrepancies of less than 2 cm, deep infection occurred in 2 cases, 2 patients with significant comminuting had some progression of angular deformity. No patient had any rotational deformity. There was one death as a result of polytrauma [18].

El-Adl et al prospectively studied 25 tibial fractures treated with flexible intramedullary nails. All the cases had good results with few complications such as lower limb discrepancy and irritation at the entrance points of the nails [19].

Ahmed E K.F et al studied 20 children with fracture shaft of tibia, 14 close fractures and 6 open fractures from March 2012 to June 2013 treated with intramedullary nails. The mean age of the patients in the study was 11.3 years (range 5–15 years). In their study 15 (75%) cases had excellent result and 5 (25%) cases had satisfactory result. There was no poor result according to Flynn scoring criteria for ESINs [20].

Goodwin et al. studied 19 patients with fracture shaft of tibia treated with TENs [8]. The mean follow up was 13 months and all the patients achieved union. Two patients had angulations of more than 10 degrees and 1 child developed physal arrest which was clinically insignificant.

Gordon et al retrospectively reviewed 60 diaphyseal tibial fractures managed with flexible intramedullary fixation. They achieved 45 bone unions within 18 weeks (average 8 weeks) [21]. In their study 5 patients (11%) had delayed healing, 2 of them required secondary procedures for union (mean time of 41 weeks). In our study the bone union time was average 4.3 weeks (range from 3-9 weeks), complete radiological union was seen in an average of 13.3 weeks (range from 12-18 weeks) and none of the children had delayed union. It was noted that patients with delayed healing tended to be in the older age group (mean age 14.1 years).

Comparing to the study done by Sommer et al our study shows better result over locking compression plate, in terms of postoperative complications [22]. In our study none of the case had refracture and deep infection whereas in Sommer's study they found 3% cases with refracture and 1% cases having deep infection.

Similarly in the study done by Yusof et al the union time in percutaneous plating was 13 weeks which was 4.3 week in our group which shows that union time in flexible nailing is much faster than plating group because of preservation of fracture hematoma and micro movement at the fracture site which facilitates fracture healing [4].

6. Conclusion

In the pediatric tibial shaft fractures fixation with percutaneous Flexible Intramedullary Nailing (FIN) has many advantages over conservative and other operative techniques. Due to the low cost and easy availability of FIN it is popular among the Orthopedic surgeons. The procedure being minimally invasive with short hospital stay makes it cost effective.

The amount of blood loss comparing to plating is very minimal. In contrast with the close reduction and plaster application, it helps in easy nursing care, early ambulation and avoids complications of prolonged immobilization.

Limitation of this study is that it is a prospective study with small size of patient. The time duration for follow up is very less so we could not find the long term effect of the intramedullary nailing in this study.

Declaration of Conflicting Interests

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References

- [1] Santili C, Gomes C, Waisberg G, Braga S, Lino JW, Santos FG. Tibialdiaphyseal fractures in children. *ActaOrtop Bras* 2010; 18: 44-48.
- [2] Stephen DH, James FM. In: editor. Fractures of the shaft of the tibia and fibula, diaphyseal fracture of tibia and fibula, treatment (chapter 25). *Rockwood &Willkin's fractures in children*. 6th ed. Lippincott Williams & Wilkins; 2006. 1045-1046.
- [3] Canale ST, Beaty JH, editors. Fractures and dislocations in children, tibial and fibular fractures (chapter 33). *Campbell's operative orthopaedics*. 11th ed. 2008.
- [4] Yusof NM, Oh CW, Oh JK et al. Percutaneous plating in paediatric tibial fractures. *Injury* 2009; 40: 1286-1291.
- [5] Wessel L, Seyfriedt CS, Hock S, Waag KL. [Pediatric tibial fractures: is conservative therapy still currently appropriate?] (ingerman). *Unfallchirurg* 1997; 100: 8-12.
- [6] Metaizeau J. Stable elastic intramedullary nailing of fractures of the femur in children. *J Bone Joint Surg Br* 2004; 86: 954-957.
- [7] Ligier JN, Metaizeau JP, Prevot J, Lascombes P. Elastic stable intramedullary pinning of long bone fractures in children. *Z Kinderchir* 1985; 40: 209-212.
- [8] Goodwin RC, Gaynor T, Mahar A, Oka R, Lalonde FD. Intramedullary flexible nail fixation of unstable pediatric tibialdiaphyseal fractures. *J PediatrOrthop* 2005; 25: 570-576.
- [9] Sathian B, Sreedharan J, Baboo NS, Sharan K, Abhilash ES, Rajesh E. Relevance of Sample Size Determination in Medical Research. *Nepal Journal of Epidemiology* 2010; 1 (1):4-10.
- [10] Galano GJ, Vitale MA, Kessler MW et al. The most frequent traumatic orthopaedic injuries from a national pediatric inpatient population. *J PediatrOrthop* 2005; 25: 39-44.
- [11] Yang JP, Letts RM. Isolated fractures of the tibia with intact fibula in children: a review of 95 patients. *J Pediatr Orthop* 1997; 17: 347-351.
- [12] Tolo VT. External skeletal fixation in children's fractures. *J PediatrOrthop* 1983; 3: 435-442.
- [13] Kubiak EN, Egol KA, Scher D, et al. Operative treatment of tibial fractures in children: are elastic stable intramedullary nails an improvement over external fixation? *J Bone Joint Surg [Am]* 2005; 87-A: 1761-8.
- [14] Liu P, Wei Z, Wei Y X, et al. Treatment of children's shaft fracture of tibia and fibula with ESIN fixation. *OJPed* 2011; 1: 9-11.
- [15] O'Brien T, Weisman DS, Ronchetti P, Piller CP, Maloney M. Flexible titanium nailing for the treatment of the unstable paediatric tibial fracture. *J PediatrOrthop* 2004; 24: 601-609.
- [16] Qidawi SA. Intramedullary Kirschner wiring for tibia fractures in children. *J PediatrOrthop* 2001; 21: 294-297.
- [17] Wiss D, Segal D, Gumbs VL, Salter D. Flexible nailing of tibial shaft fractures. *J Trauma* 1986; 62 12:1106-12.
- [18] Vallamshetla P, De Silva U, Bache CE, Gibbons PJ. Flexible intramedullary nails for unstable fractures of the tibia in children. An eight-year experience. *J Bone Joint Surg Br* 2006; 88: 536-540.
- [19] El-Adl G, Mostafa MF, Khalil MA, Enan A. Titanium elastic nail fixation for paediatric femoral and tibial fractures. *Acta Orthop Belg* 2009; 75: 512-520.
- [20] Ahmed E K.F, Zakaria B, Hadhood M, ShaheenA. Management of diaphysealtibial fracture in pediatric by elastic stable intramedullary nails. *Menoufia Med J* 2014; 27: 401-406.
- [21] Gordon JE, Gregush RV, Schoenecker PL et al. Complications after titanium elastic nailing of pediatric tibial fractures. *J Pediatr Orthop* 2007; 27: 442-446.
- [22] Sommer C, Gautier E, Mueller M, Helfet DL, Wagner M. First clinical results of the locking compression plate (LCP). *Injury* 2003; 34 (Suppl 2): 43-54.