# FLEXIBLE INTRAMEDULLARY NAILING IN PEDIATRIC FRACTURES: EARLY OUTCOME IN 54 CASES

**Mian Qaiser Ali Shah, Muhammad Asif Rasheed, Shakil Sarwar, Aneeqa Naz, Zartash Ahmed Sakhi**

Combined Military Hospital Gujranwala Pakistan

## ABSTRACT

***Objective:*** The aim of this study was to record the experience of managing different pediatric fractures with flexible nails, document postoperative complications and assess the early outcome using this novel technique.
***Study Design:*** Cross sectional study.
***Place and Duration of Study:*** Combined Military Hospital Gujranwala, from Dec 2015 to Nov 2016.
***Material and Methods:*** All cases of pediatric fractures fulfilling inclusion criteria were included in the study. A minimum of 6 months follow up was done in all cases. Data was analyzed using statistical package for social sciences version 18.
***Results:*** A total of 54 cases were included. Mean Age was 7.06 years and mean weight was 24.19 kilograms. There were 21 femur (38%), 24 radius and ulna (44.4%), 3 tibia (5.6%), 3 radius (5.6%) and 3 ulna (5.6%). Mean narrowest canal diameter was 7.00 ± 1.26 millimeters and Nail diameter was 2.86 ± 0.41 millimeters. Mean duration of surgery was 27.11 ± 7.42 minutes and mean hospital stay was 2.25 ± 0.51 days. Mean time for radiological union was 8.61 ± 2.39 weeks. Encountered complications were 17 (31.5%) including Limb length discrepancy 1-2 centimeters (5), skin impingement (4), surgical site infection (3), Need to approach fracture site (3) and angulation 5-10 degrees (2) while no case of malunion and migration was observed. The final outcome graded according to Flyn and Schwend score was excellent in 49 cases (90.7%) and satisfactory in 5 cases (9.3%).
***Conclusion:*** Flexible intramedullary nailing was found reliable and safe for fractures in patients aged 3-12 years. It was relatively free of serious complications and provided good recovery and a very high union rate with an acceptable rate of minor complications.

**Keywords:** Child, Complications, Flexible intramedullary nails, Fracture fixation.



## INTRODUCTION

Pediatric fractures have a significant impact not only on a young developing brain but also on their family network. The traditional approach of casting and immobilization has produced attractive results initially[1-3]. In the last two decades, there has been an increasing tendency towards the trend of operative management for pediatric fractures. The aim is to achieve healing without complications, easy nursing care, rapid rehabilitation and minimal psychological impact[4,5]. Flexible intramedullary Nail (FIN) is a simple and minimally invasive technique[6]. The principle involves insertion of two nails in medullary cavity via dual entry windows on lateral and medial side[7] thus counteracting the trifocal buttressing effect. The technique bears the theoretical advantage of closed insertion of implant, preservation of fracture hematoma and epiphysis sparing entry point[7-9].

Considering the widespread use in skeletally immature patients, we conducted a retrospective study of all pediatric fractures treated with FIN at our hospital. The aim of this study was to record the experience of managing different pediatric fractures, document postoperative complications and assess the early outcome using this novel technique.

## PATIENTS AND METHODS

This descriptive cross sectional study was carried out in surgical department of Combined Military hospital Gujranwala from December 2015 to November 2016. All cases were received through emergency and were initially immobi-

**Correspondence: Dr Muhammad Asif Rasheed,** Classified Surgical Specialist, CMH Gujranwala Pakistan
*Email: drasifrasheed@hotmail.com*
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lized to be prepared for surgery. The data was retrieved from department record and follow up book. A total of 54 cases were included in the study using non-probability consecutive sampling technique fulfilling the criteria as below.

Inclusion criteria included: (a) Femur, tibia, humerus and forearm fractures (b) Age 3-12 years (c) Presence of growth plate was a mandatory criterion to be fulfilled. Open fractures and pathological fractures associated with bone tumor were excluded from the data. The routine practice at our setup was to immobilize the fracture and get standard anteroposterior and lateral radiographs. Preoperative data included the age, gender, weight of child, fracture site, type and narrowest canal diameter in both views. Surgeries were carried out after optimal preoperative workup and planning. Nails were calculated according to Flyn *et al* formula using Canal diameter as follows: width ofthe narrowest point of the medullary canal on anteroposteriorand lateral view × 0.4 mm[9]. However diameter of inserted nail was subjected to variation depending upon the peroperative appearance under image intensifier.

All surgeries were carried out on fracture table under general anesthesia and guidance of image intensifier, preferably within 3 days of trauma. The approach to the cortex varied according to the site of fracture beingretrograde for femur/radius and ante grade for tibia/ulna. A window was created through a small stab incision 1.5 centimeters away from epiphysis for femur and tibia. For radius the entry point was made proximal to Lister's tubercle and for ulna, cortex was approached just distal to olecranon process. Appropriately sized nail was pushed under image guidance negotiating the fracture site. The size of titanium made flexible nails available with us ranged from 3.00 to 5.00mm. In cases of radius and ulna modified Nail (K wires) were inserted due to unavailability of size less than 3 mm. Peroperatively, alignment was ensured in all three planes. Data included Nail insertion direction (Antegradevs. Retrograde), nail diameter, number of nails, duration of surgery from skin incision to closure and duration of hospital stay.

**Table-I: Demographics of various fractures treated.**

| Parameters | Number (n) | Percentage (%) | Cumulative Percentage |
|---|---|---|---|
| **Gender** | | | |
| Male | 36 | 66.7 | 66.7 |
| Female | 18 | 33.3 | 100 |
| **Fracture Site** | | | |
| Femur | 21 | 38.9 | 38.9 |
| Tibia | 3 | 5.6 | 44.4 |
| Radius | 3 | 5.6 | 50.0 |
| Ulna | 3 | 5.6 | 55.6 |
| Radius/Ulna | 24 | 44.4 | 100.0 |
| **Fracture Type** | | | |
| Transverse | 42 | 77.8 | 77.8 |
| Oblique | 6 | 11.1 | 88.9 |
| Spiral | 3 | 5.6 | 94.4 |
| Comminuted | 3 | 5.6 | 100.0 |
| Total | 54 | 100 | 100 |

The protocol we followed at our setup was to discharge the patient with immobilization cast and follow up weekly for first two weeks and then two weekly afterwards. Wounds were assessed at first visit for presence of surgical site infection. At two weeks, immobilization cast was removed and movements were encouraged at joints to prevent joint stiffness. Nails were removed when radiological union was achieved.

A minimum of 6 months follow up was done in all cases. Long term postoperative data included radiological union time, limb length discrepancy (LLD), skin impingement, migration of nailand malunion. The final outcome was graded excellent, satisfactory or poor according to the Flyn and Schwend scoring criteria[10].

Data was endorsed in notebook by surgeon and was analyzed using computer software, Statistical package for Social Sciences (SPSS) version 18.0. Mean and standard deviation for quantitative variables and frequency and percentages for qualitative variables were calculated.

## RESULTS

A total of 54 cases were included in the study fulfilling the inclusion and exclusion criteria. The mean age was 7.06 ± 2.95years. The minimum age was 3 years and maximum age was 12 years. Male patients were 36 (66.7%) while female patients were 18 (33.3%) with a male to female ratio of 2:1. The mean weight of the patients treated was 24.19 ± 8.19 kilograms (kg). The minimum weight was 12 kgs and maximum weight was 41 kgs. The operated cases included 21 femur (38%), 3 tibia (5.6%), 3 radius (5.6%), 3 ulna (5.6%) and 24 cases of both radius and ulna (44.4%). The types of fractures included were transverse 42 (77.8%) loblique 6 (11.1%), spiral 3 (5.6%) and comminuted 3 (5.6%) (table-I). The mean diameter of canal on preoperative radiographs was calculated to be 7.00 ± 1.26 millimeters (mm).

In all cases two flexible nails were inserted. The mean diameter of the nail inserted was 2.86 ± 0.41mm. Mean duration of surgery was 27.11 ± 7.42 minutes and mean hospital stay was 2.25 ± 0.51 days. The mean time for radiological union and nail removal was 8.61 ± 2.39 weeks. The details of operative parameters and radiological union according to the fracture site are shown as table-II.

A total of 17 complications were encountered (31.5%) which are depicted in fig-1. LLD 1-2 centimeters (cm) was observed in a total of 5 cases (9.3%) and angulation of 5-10 degrees was seen in 2 cases (3.5%). None of the cases developed LLD >2 cm or angulation >10 degrees. Three cases mandated a need to approach fracture site (5.6%), 3 cases developed a superficial surgical site infection (5.6%) and 4 cases complained of skin impingement (7.4%). In none of the cases, migration of nail or malunion was seen. The final outcome graded according to Flyn and Schwend score[10] was excellent in 49 cases (90.7%) and satisfactory in 5 cases (9.3%) while none of the cases was found to have a poor score (fig-2).

**Table-II: Data showing operative parameters and radiological union.**

| Fracture Site/Operative Parameters | Canal Diameter mm (M ± SD) | Nail Diameter mm (M ± SD) | Surgery Duration minutes (M ± SD) | Hospital Stay days (M ± SD) | Time for Radiological Union weeks (M ± SD) |
|---|---|---|---|---|---|
| Femur (21) | 8.00 ± 0.99 | 3.21 ± 0.25 | 35.0 ± 1.73 | 2.29 ± 0.60 | 10.93 ± 0.80 |
| Tibia (3) | 7.00 ± 0.00 | 3.00 ± 0.00 | 29.00 ± 0.00 | 1.50 ± 0.00 | 12.00 ± 0.00 |
| Radius (3) | 5.00 ± 0.00 | 2.00 ± 0.00 | 14.00 ± 0.00 | 2.00 ± 0.00 | 5.00 ± 0.00 |
| Ulna (3) | 5.50 ± 0.00 | 2.50 ± 0.00 | 13.00 ± 0.00 | 2.50 ± 0.00 | 5.00 ± 0.00 |
| Radius/Ulna (24) | 6.56 ± 0.94 | 2.69 ± 0.25 | 23.38 ± 2.04 | 2.31 ± 0.44 | 7.06 ± 0.54 |
| TOTAL (n=54) | 7.00 ± 1.26 | 2.86 ± 0.41 | 27.11 ± 7.42 | 2.25 ± 0.51 | 8.61 ± 2.39 |

M=Mean, SD=Standard Deviation, mm=millimeters

## DISCUSSION

The growing bones have a surprising ability to regrow and remodel to the extent that it can even wipe out the radiological evidence of malunion in a fracture. Keeping in view the advent of implants with sophisticated biomechanics, it is unfair to rely upon this natural

phenomenon to get accurate results, ignoring the possibility of significant risk of deformity. Introduced for femoral fractures by Nancy group in 1982[11], the technique is the treatment of choice at our hospital due to its simplicity, short learning curve, lack of complications and favorable results.

The experience in children 5 to 13 years of literature where multiple fractures were managed in minimal time utilizing flexible nails[13].

The standard recommendation is following a 40% rule while selecting the nail diameter as compared to the narrowest canal diameter. We followed this rule to our maximum at our centre by getting optimal pre-operative workup by radiologist. However minimal variation of

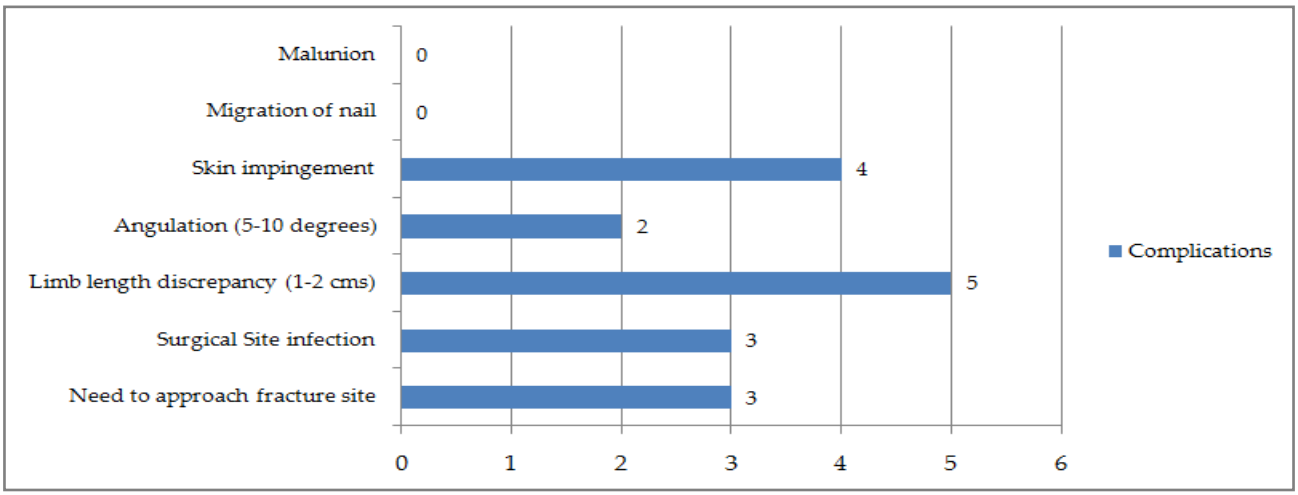


**Figure-1: Bar graph depicting various complications (n=17).**

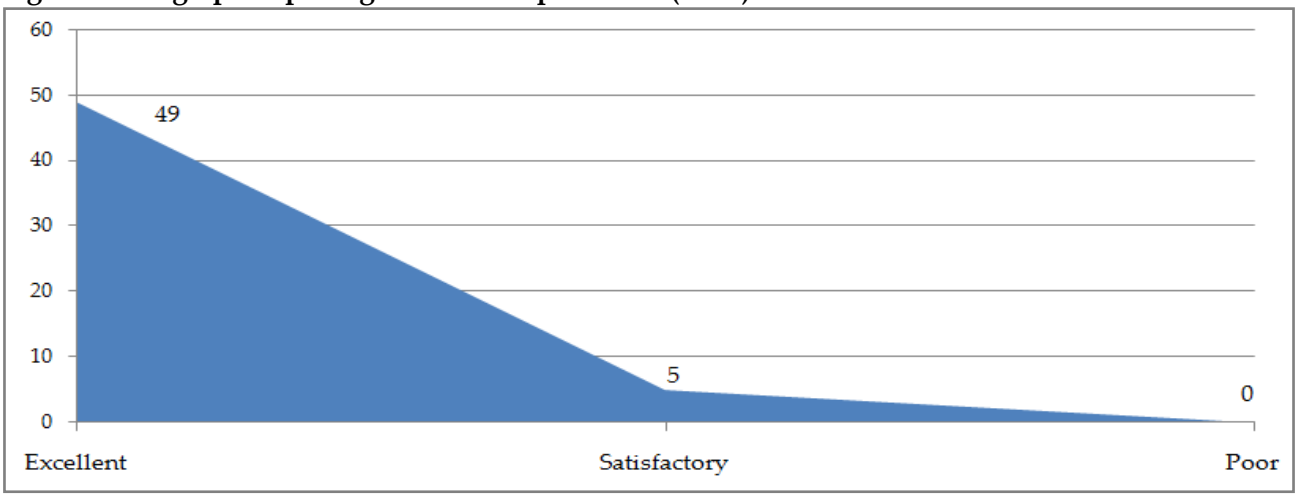


**Figure-2: Outcome in terms of Flyn and schwend score 10 (n=54).**

age shared in literature proves the utility of FIN in terms of less immobilization, less psychological impact and rapid recovery[12]. Huber *et al* believed intramedullary nailing with flexible titanium pins as an easy and safe method which corrects angulation without plaster immobilization in pediatricdiaphyseal fractures. The utility in poly traumatized children has also been published in few millimeters more or less was done per operatively depending upon the availability of nail closest to the calculated size and asper operative feasibility.

We encountered an overall 31.5% (n=17) complication rate with none of them as a major complication affecting the union or outcome. In a study of humeral fractures treated with FIN, the

tips and techniques have been explained in detail. Implant prominence was the most significant complication observed[14]. Four cases of skin impingement were observed while no case of nail migration was observed in our series. The probable explanation is a strict adherence to standard principles of FIN and optimal preoperative workup. Similar emphasis has been given by Lascombes *et al* where avoiding weak assembly due to inappropriate nail/canal diameter has been shown to limit complications including migration and skin impingement[15]. Our outcome in 54 cases in terms of flyn and Schwend score is comparable to the experience shared in literature. Vransky *et al* reported 141 cases with good results and no complication[16]. Flyn etal reported one poor outcome in 58 cases[10].

The radiological union in our series is comparable to the union time as reported in other series[17-19]. The incidence of malunion particularly in fractures treated with FIN is reported ranging from 0-10%[10]. A high incidence of malunion has been associated with length unstable fractures and increasing weight of the child especially greater than 49 kgs[20,21]. Mean weight in our series was 24.19 kgs and maximum weight was 41 kgs. A strict safe inclusion criterion might be the reason for no malunion reported in this series.

The limitation of this study is that this is a retrospective study from a single centre, with a small sample size and limited safe inclusion of pediatric fractures over a limited period of time. Future studies with wide inclusion of cases especially older and heavy weight children should be carried out to clarify the widespread utility of this novel technique.

## CONCLUSION

Flexible intramedullary nailing was found reliable and safe for treating pediatric fractures in age 3-12 years. It was relatively free of serious complications and provided good recovery and a very high union rate with an acceptable rate of minor complications. Further studies proving the quality of results utilizing FIN are needed as trend of operative treatment in pediatric fractures is at rise.

### Author's Contribution

MQAS: Collection of data, interpretation of data and revision of manuscript for intellectual content; MAR: contribution towards conception, design and development of study, collection of data, interpretation of data, statistical analysis, literature review, draft and review of manuscript for final approval; SS: contribution towards draft of manuscript, literature review and review of manuscript; AN: statistical analysis, drafting and review of manuscript, contribution towards final approval of article. ZAS: collection of data, draft of manuscript.

## CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

## REFERENCES

1. Irani RN, Nicholson JT, Chung SM. Long-term results in the treatment offemoral-shaft fractures in young children by immediate spicaimmobilization. J Bone Joint Surg Am 1976; 58(7): 945-51.
2. Sugi M, Cole WG. Early plaster treatment for fractures of the femoralshaft in childhood. J Bone Joint Surg Br 1987; 69(5): 743-5.
3. Czertak DJ, Hennrikus WL. The treatment of pediatric femur fractures withearly 90-90 spica casting. J Pediatr Orthop 1999; 19(2): 229-32.
4. Hughes BF, Sponseller PD, Thompson JD. Pediatric femur fractures: Effectsof spica cast treatment on family and community. J Pediatr Orthop 1995; 15(4): 457-60.
5. Stans AA, Morrissy RT, Renwick SE. Femoral shaft fractures treatment inpatients aged 6 to 16 years. J Pediatr Orthop 1999; 19: 222-38.
6. Khazzam M, Tassone C, Liu XC, Lyon R, Freeto B, Schwab J etal. Use of flexible intramedullary nail fixation in treating femur fractures in children. Am J Orthop (Belle Mead NJ) 2009; 38(3): E49-55.
7. Metaizeau JP. Stable elastic intramedullary nailing for fractures of the femurin children. J Bone Joint Surg Br 2004; 86(7): 954-7.
8. Carey TP, Galpin RD. Flexible intramedullary nail fixationof pediatric femoral fractures. Clin Orthop 1996; 332: 110–8.
9. Flynn JM, Skaggs DL, Sponseller PD, Ganley TJ, Kay RM, leitch KK. The surgical management of pediatric fractures of the lower extremity. Instr Course Lect 2003; 52: 647-59.
10. Flynn JM, Hresko T, Reynolds RA, Blasier RD, Davidson R, Kasser J. Titanium elastic nails for pediatric femur fractures: Amulticenter study of early results with analysis of complications. J Pediatr Orthop 2001; 21(1): 4-8.
11. Ligier JN, Metaizeau JP, Prévot J, Lascombes P: Elastic stableintramedullary nailing of femoral shaft fractures in children. J Bone Joint Surg Br 1988; 70(1): 74-7.

12. Kapil-Mani KC, Dirgha-Raj RC, Parimal A. Paediatric femoral shaft fractures treated by flexible intramedullary nailing. Chin J Traumatol 2015; 18(5): 284-7.
13. Huber RI, Keller HW, Huber PM, Rehm KE. Flexible intra-medullary nailing as fracture treatment in Children. J Pediatr Orthop 1996; 16(5): 602-5.
14. Kelly DM. Flexible intramedullary nailing of pediatric humeral fracture: Indications, Techniques and Tips. J Paediatr Orthop 2016; 36 (Suppl-1): S49-55.
15. Lascombes P, Nespola A, Poircuitte JM, Popkov D, De Gheldere A. Early complications with flexible intrame-dullary nailing in childhood fracture: 100 cases managed with precurved tip and shaft nails. Orthop Traumatol Surg Res 2012; 98(4): 369-75.
16. Vrsansky P, Bourdelat D, Al Faour A. Flexible intramedullary pinningtechnique in the treatment of pediatric fractures. J Pediatr Orthop 2000; 20(1): 23-7.
17. Saikia K, Bhuyan S, Bhattacharya T, Saikia S. Titanium elastic nailing infemoral diaphyseal fractures of children in 6-16 years of age. Indian J Orthop 2007; 41(4): 381-5.
18. El-Adl G, Mostafa MF, Khalil MA, Enan A. Titanium elastic nail fixation forpaediatric femoral and tibial fractures. Acta Orthop Belg 2009; 75(4): 512-20.
19. Mortier D, De Ridder K. Flexible intramedullary nailing in the treatmentof diaphyseal fractures of the femur in preschool children. Acta Orthop Belg 2008; 74(2): 190-4.
20. Moroz L, Launay F, Kocher MS, Newton PO, Frick SL, Sponseller PD, et al. Titanium elastic nailing of fracturesof the femur in children: Predictors of complications and pooroutcome. J Bone Joint Surg Br 2006; 88(10): 1361-6.
21. Melisie F, Krug E, Duiiff JW, Kriinen P, Schipper IB. Age-specific treatment of femoral shaft fractures in children. Ned Tiidschr Geneeskd 2012; 156(12): A3976.