Research Article

Comparison of External Fixation and Internal Fixation for the Treatment of Pediatric Femoral Shaft Fractures

Javed Hassan Raza[1], Muhammad Iqbal Mirza[2], Syed Faraz Ul Hassan Shah Gillani[3]

[1]Assistant Professor of Orthopedic Surgery, KEMU/ Mayo Hospital Lahore; [2]Associate Professor of Orthopedic Surgery, KEMU/ Mayo Hospital Lahore; [3]Senior Registrar, Orthopedic Surgery, Mayo Hospital, Lahore

Abstract

Objective: The objective of this study was to compare external versus internal fixation for the treatment of femoral shaft fractures in children in terms of post-operative results.

Method: This randomized controlled trail was done using probability simple random sampling technique from January 2012 to March 2016. Our sample size was 80 patients between 7 to 10-years of age with closed transverse femoral shaft fractures. Diagnosis was made on history, clinical examination and radiographs. These patients were divided into groups A and B. In group A, femoral shaft fractures were fixed with flexible intramedullary nail (IM) and in group B fractures were fixed with Arbeitsgemeinschaft für Osteosynthesefragen (AO) External fixator. The results were compared in terms of hospital stay, time taken for fracture union, delayed union, non-union, infection rate, implant failure, limb length discrepancy and patient compliance.

Results: Out of total 80 patients, Majority 21 patients (52.5%) in group A were between the ages of 7 to 8-year with their mean ages (8.38±0.9967), and in Group-B was 22 (55%) were between 9 to 10-year with with mean ages (8.492±1.076). Mean union time with standard deviation (Mean±SD), in group A was (9.375±1.371) and in Group B, it was (8.9±1.38) weeks.

Conclusion: External fixation with Arbeitsgemeinschaft für Osteosynthesefragen (AO) External fixator was found better treatment option for osteosynthesis in children femoral shaft fractures in terms of union, short hospital stay, low infection rate and better patient's compliance.

Received | 28-03-2017: **Accepted** | 15-02-2019

Corresponding Author | Dr. Javed Hassan Raza, Assistant Professor of Orthopedic Surgery, KEMU/ Mayo Hospital Lahore,
Email: drjavedraza@yahoo.com

Keywords | Arbeitsgemeinschaft für Osteosynthesefragen Fixator, Intramedullary Nail, Femoral Shaft Fracture, Adolescent, Image Intensifier.

Introduction

Femur shaft fractures in children accounts for 1-2% of all fractures.[1,2] There is no consensus for optimal treatment of closed femoral shaft fracture. Over the past few decades, the pediatric femoral shaft fracture has been operatively managed rather than conservative management because the former has more rapid recovery and shorter immobilization.[3,4] Small children less than five year of age are treated with close reduction and spica cast[5] and adolescent are managed with closed intra-medullary interlocking nails. The surgical treatment for the age group between 7 to 10 years includes external fixation,[6] and closed flexible intra-medullary nail.[7,8]

The operative procedure for the fixation of femoral shaft fracture should preserve femoral blood supply,

avoid damage to physis and achieve adequate fracture stability.[9] Both the flexible intramedullary nailing and external fixator for the shaft of femoral fracture preserve blood supply, don't damage the physis and provide adequate fracture stability.[10-12]

New fixation techniques have been used according to the patient age, location of the fracture, associated injury and duration of hospital stay.[13,14] Spica cast is used in children ≤ 5-years of age and it is associated with shortening and loss of reduction with older children who required prolong immobilization in cast and traction.[15] Internal fixation with plate and screw has complications of blood loss, periosteal damage, deep infection, implant failure, prolong hospital stay and re-operation.[16] Treatment in this age group with intramedullary interlocking nail is associated with physeal growth arrest.[17] The mode of treatment for 7 to 10 year child with fracture of shaft of femur is still debatable.

Therefore, in this study, we have compared both these surgical procedures in term of post-operative outcomes.

Methods

This study was carried out at the Department of Orthopedics Surgery and Traumatology, Mayo Hospital, Lahore, using probability simple random sampling technique. The duration of the study was four years and three months from January 2012 to March 2016. We recruited 80 patients and divided them into group A and B. Our target population was patient between 7 to 10 years of age with closed femoral transverse shaft fractures. Diagnosis was made on history, clinical examination and radiographs. In group A, femoral shaft fractures were fixed with flexible intra-medullary (IM) nail and in group B fractures were fixed with Arbeitsgemeinschaft für Osteosynthesefragen (AO) External Fixator.

After approval from ethical board of the hospital, purpose of the study was explained to the parents of the child. The consent was carried out from parents of children between 7 to 10 years of age. All children were admitted in the ward, and temporarily immobilized with skin traction which was suspended with weight equal to 4lb. Inclusion criterion of the study included all patient between 7 to 10 years of age who had close fracture shaft of femur. Patient having previous surgery for fracture shaft femur were excluded from the study. We collected data on a predesigned questionnaire. External fixation and flexible intramedullary nail were done under image intensifier. The length and diameter of the nail was measured from the contralateral X-ray of the femur. Data was collected from each patient including its demography, mechanism of injury, and side of the bone involved. The follow up period was ranged from 7 to 14 weeks after fixation of the fracture. Follow up data of all patients was taken to assess union, infection, delayed union and non-union and limb length discrepancy, implant failure and patient compliance.

Patients were followed at 2nd, 5th, 9th and 14th weeks with 4th and 6th month. Upon every follow up, both clinically and radiologically to assess the union, delayed union, non-union, by using Hammers et al[18] criteria, while infection by south Hampton criteria,[19] implant failure and patient's compliance. Limb length discrepancy (LLD) was assessed by comparing and measuring with un-affected limb clinically and with the help of measuring tap respectively.

Partial weight bearing was in patients treated with AO external fixator was started at 3-5 weeks and complete weight bearing was started at 9th weeks post operatively. The AO external fixator was dynamized when three cortices union was observed radiographically. Patients attendants were advised to clean the fixator with normal saline 0.25% and apply pyodine gauze around pins on every follow up. All fixators were removed in outpatient department (OPD) under local anesthesia. Partial weight bearing in patients treated with IM nailing was started 4-6 weeks. The similar instructions were given to clean the exposed nail. IM nail under general anesthesia were removed in operation theater between mean of 26 weeks post-operatively.

Data was analyzed with help of SPSS version 20.0. Quantitative variables like age were presented in mean ± S.D. Qualitative variable like gender were presented in frequencies and percentage. For comparison of two groups, external versus internal fixation, we applied Student's Chi-square with differences regarded to be significant at 5% level while outcomes of treatment difference was computed by independent t-test.

In supine position under general anesthesia, patient

put on traction table, and reduction of fracture was done under image intensifier. Pre-angled nail i.e. 440mm length and 2.0-4.0 mm length which were angled at 45°, about 2cm from one end were used. With the help of awl, approximately 2cm above the physis, an entry point was made. A nail loaded onto a T handle was then inserted through the entry point into the medullary canal, by rotator movements of the wrist joint and advanced upto the fracture site. Another nail was introduced using the same technique from medial side and advanced upto fracture site. Both nails were crossed the fracture site one by one in already reduced fracture under guidance of fluoroscopy. Traction was released when the nails crossed the fracture site and then they were advanced further. Medial nail was advanced till it was within 2 cm of proximal femoral capital physis whereas lateral nail was inserted till it was about 1 cm from greater trochanter physis. Nails were left protruding about 0.5 to 1.0 cm at the distal end for easy removal later on. Postoperative period limb was elevated with pillow.

In supine position under general anesthesia, fracture was reduced under image intensifier. With help of controlled power drill and 2.7mm bit, a hole was made in proximal and away from the fracture site within 2cm of physis that involved both cortices. Shanz screw of 3mm was loaded on T handle and forwarded in already made hole till both cortices are engaged. Similarly, a hole distal and away from the fracture within 2cm of the physis was made and Shanz screw was fixed. Shanz screw were connected with the 3.5mm rods to maintain length and hold anatomic reduction of fracture. Two holes, about 2.5cm away from the fracture site, both proximal and distal end of fracture was made and Shanz were fixed passed through the rods. Reduction was confirmed under image intensifier.

Results

Out of total 80 patients, there were 42 (52.5%) males

Table 1: *Demographic Characteristics According to Treatment*

Variables	IM Rods (n=40) (%)	AO External Fixator (n=40) (%)	N=80 (%)	p-value
Gender				
• Male	23 (57.5%)	19 (42.5%)	42 (52.5%)	
• Female	17 (42.5%)	21 (52.5%)	38 (47.5%)	
Age in years				
• 7-8	21 (52.5%)	18 (45%)	39 (48.75%)	
• 9-10	19 (47.5%)	22 (55%)	41 (51.25%)	0.467
Mean Age±SD (years)	(8.38±0.9967)	(8.492±1.076)		
Side of the fracture				
• Right side	21 (52.5%)	16 (40%)	37 (46.3%)	
• Left side	19 (47.5%)	24 (60%)	43 (53.7%)	0.32
Mean hospital stay (Days)	2.20±1.042	2.12±0.722		0.008
Mechanism of Injury				
• Fall from height	13 (32.5%)	11 (27.5%)	13 (16.2%)	
• RTA	27 (67.5%)	29 (72.5%)	67 (83.8%)	0.071
Level of the Bone				
• Mid shaft	26 (65%)	28 (70%)	54 (67.5%)	
• Proximal 3rd	4 (10%)	6 (15%)	10 (12.5%)	
• Distal 3rd	10 (25%)	6 (15%)	16 (20%)	<0.001
Complications				
• No complications	36 (90%)	30 (75%)	66 (82.5%)	
• Delayed union	02 (5%)	01 (2.5%)	03 (3.75%)	
• Non-Union	01 (2.5%)	01 (2.5%)	02 (2.5%)	
• Pin tract Infection	00 (00)	07 (17.5%)	07 (8.75%)	
• Deep Infection	00 (00%)	00 (00%)	00 (00%)	
• LLD	01 (2.5%)	01 (2.5%)	02 (2.5%)	0.757
Mean Union (Weeks)	9.375±1.371	8.9±1.38		0.769

RTA= Road traffic accident, LLD= Limb length discrepancy. IM= Intramedullary nail, AO= Arbeitsgemeinschaft für Osteosynthesefragen

Table 2: *Independent T-Test of Intramedullary Nail & AO External Fixator with Site of the Injury*

Variables	n	Mean	Standard Deviation	t	p-value
Site of the Injury					
• Intramedullary Nail	40	2.15	0.57957	3.949	<0.001
• AO External Fixator	40	1.525	0.8161		

and 38 (47.5%) females. Majority, 21 patients (52.5 %) in group A were between the ages of 7 to 8-year with their mean ages (8.38±0.9967), and in Group-B was 22 (55%) were between 9 to 10-year with with mean ages (8.492±1.076). Mean union time in group A was (9.375±1.371) weeks and in Group B, it was (8.9±1.38) weeks. Majority 67 (83.3%) of the fractures were caused by road traffic accident and 13 (16.3%) were caused by fall from height. In group A, 21 (52.5%) were right side and 19 (47.5%) were left side fractures, similarly, in Group B, 16 (40%) were right side and 24 (60%) were left side fractures. Mean hospital stay in Group A was 2.20±1.042 days and in Group-B was 2.12±0.722 days. When we evaluated the level of fracture bone, in Group A, 26 (65%) had fracture at mid shaft level, 04 (10%) had proximal 3rd and 10 (25%) had distal 3rd fractures, similarly in Group B, 28 (70%) had mid shaft level, 06 (15%) had proximal 3rd and 6 (15%) had distal 3rd fractures of femur. The mean union time in Group-A was 9.25± 0.543 weeks and in group B was 9.02±0.767 weeks (Table 01). Patients compliance was good in 23 (57.5%), satisfactory in 13 (32.5%) and poor in 04 (10%) patients in group A and it was good in 26 (65%), satisfactory 11 (27.5%), and poor in 03 (7.5%) patients in group-B. The independent t-test was applied with site of injury and two treatment methods including with intramedullary nail and AO external fixator. It was found statistically significant (p-value < 0.001). (Table 2).

Discussion

The treatment of femoral shaft fracture particularly between 7 to 10 years of age has various management options. Every treatment has its merits and demerits. Amongst operative treatment, flexible inter-medullary (IM) nailing and external fixation with AO fixator are the two different options.

The overall union was found excellent in both the treatment methods which was found in 78 (97.5%) patients. When we compared the union in two groups in our study, the mean time taken for union in patients managed with flexible intra-medullary nailing was 9.375±1.371 weeks and in group B with AO external fixator was 8.9±1.38 weeks. Our data is consistent with Bhuyan et al.[20] who reported mean union time 9.5 weeks in fracture shaft of femur treated with IM nailing. Chaudhuri et al.[21] reported mean union time at 10 weeks in children treated with IM nailing. Khan et al.[22] reported mean union time 10 weeks while it was low in our study which was observed at 8.9±1.38 weeks.

There was only one (2.5%) case of LLD, while Yaokreh et al.[23] reported LLD in 15% children treated with IM nail. There is difference in LLD which was low in our study. The most common mode of injury was RTA 67 (83.8%) in our study which was high, campared to 55 % reported by Kumar et al. [24] The mean hospital stay in group A treated with IM nailing was 2.20±1.042 days and in Group-B treated with AO fixator was 2.12±0.722 days. Mani et al.[25] reported mean hospital stay of 2 days in his data. The hospital stay with IM group was comparable to other group and it was similar in both groups. The pin tract infection was present in 07 (17.5%) cases treated with AO fixator and Imam et al.[13] reported pin tract infection in 02 (10%) cases. All pin tracts infections healed till last follow up. They were treated with re-assurance and oral antibiotic.

In this study, patients treated with AO external fixator had primary union in 30 (75%) patients, 01 (2.5%) delayed union, 01 (2.5%) non-union and 07 (17.5%) pin tract infection while Sela et al[17] reported 110% union with external fixator and one pin tract infection. All patients with external fixator had implant removal in out-door patient department under local anesthesia which is the advantage in implant removal while patients with internal fixation were re-admitted for removal of implant.

Early mobilization with crutches was more practical with external fixation than internal fixation resulting in better parents and patient compliance. It started at 9th week after the surgery. There was loosening of the

pins in external fixation which were removed during follow up of the patients. All the treatment had better results, but they were good in case of external fixation than closed IM rods.

Conclusion

Based on our experience and results we concluded that external fixation with AO external fixator is better option for treatment of pediatrics femoral shaft fracture. It promotes rapid union which is ideal for early mobilization, with lower complication rate and better outcomes. It is simple, rapid, reliable and effective method for management of pediatric femoral shaft fracture between 7 to 10 years of age, good union, short hospital stays and minimum complications.

Ethical Approval: Given
Conflict of Interest: None
Funding Source: None

References

1. Madhuri V, Dutt V, Gahukamble AD, Tharyan P. Interventions for treating femoral shaft fractures in children and adolescents. Cochrane Database Syst Rev. 2014;29(7): 1-7.
2. Naranje SM, Erali RA, Warner WC Jr, Sawyer JR, Kelly DM. Epidemiology of Pediatric Fractures Presenting to Emergency Departments in the United States. J Pediatr Orthop. 2016;36(4):45-8.
3. Hedström EM, Waernbaum I. Incidence of fractures among children and adolescents in rural and urban communities - analysis based on 9,965 fracture events. Inj Epidemiol. 2014; 1(1): 14.
4. Cosma D, Vasilescu DE. Elastic Stable Intramedullary Nailing for Fractures in Children - Specific Applications. Clujul Med. 2014;87(3):147-51.
5. Muzzafar K, Singh R, Bhat SA, Haseeb M, Ghani A. Early result of pediatric shaft femur fractures treated by hip spica cast in children upto 10 years of age. Int J Res Med Sci. 2017;5(6):2430-2.
6. Sial NA, Gillani SFuHS, Khan M. To Device Simple and Effective Method of fixation in adolescent children femur shaft fracture. J Allama Iqbal Med Coll. 2016; 14(1):13-6.
7. Pulate A, Jadhav A, Shah NB. Study of the outcome of titanium elastic nail system in diaphyseal femoral fractures in children. J Maharashtra Orthop Assoc 2012;7:6-8.
8. Ghosh S, Bag S, Datta S, Chaudhuri A, Roy DS, Biswas A. A study of management of fracture shaft femur in children in a rural population. Journal of the Scientific Society 2013;40(3): 135-9.
9. Sidhu V, Yadav A, Anand V, Gill G, Sharma R, Sikda J. Surgical Management Of Fractures Of The Femur Shaft In Children And Adolescents Using Flexible Nails – A Prospective Study. Inter J Orth Surg 2015; 23(1):1-20.
10. Ahmed E, Khalid O, Usman-ul-Haq, Siddiq AB. Comparison of Treatment with Titanium Elastic Nail Versus AO – Dynamic Compression Plate for Femoral Shaft Fractures in Children. Ann of King Edward Med Uni. 2016; 22(1): 30-4.
11. Mahesh DV, Deepak CD, Gunnaiah KG, Pasha M. Comparative study of titanium elastic nailing v/s dynamic compression plating for the management of fracture shaft of femur in adolescent age group. Int J Res Orthop. 2018;4(1):154-8.
12. Sutphen SA, Mendoza JD, Mundy AC, Yang JG, Beebe AC, Samora WP, et al. Pediatric Diaphyseal Femur Fractures: Submuscular Plating Compared With Intramedullary Nailing. Orthopedics. 2016; 39(6):353-8.
13. Imam, MA, Negida AS, Elgebaly A, Hussain AS, Ernstbrunner L, et al. Titanium Elastic Nails Versus Spica Cast in Pediatric Femoral Shaft Fractures: A Systematic Review and Meta-analysis of 1012 Patients. J Bone Joint Surg 2018;6(3):176-88.
14. Sanzarello I, Calamoneri E, D'Andrea L, Rosa MA. Algorithm for the management of femoral shaft fractures in children. Musculoskelet surg. 2014; 98(1): 53-60.
15. Allar BG, Hedequist DJ, Miller PE, Glotzbecker MP, Spencer SA, Shore BJ. Treatment outcomes after insufficiency femoral diaphyseal fractures in nonambulatory children. J Pediatr Orthop B. 2016; 25(4): 331-7
16. May C, Yen YM, Nasreddine AY, Hedequist D, Hresko MT, Heyworth BE. Complications of plate fixation of femoral shaft fractures in children and adolescents. J Child Orthop. 2013;7(3):235-43.
17. Sela Y, Hershkovich O, Sher-Lurie N, Schindler A, Givon U. Pediatric femoral shaft fractures: treatment strategies according to age - 13 years of experience in one medical center. J Orthop Surg Res. 2013; 8(1):1-6.
18. Hammer RRR, Hammerby S, Lindholm B. Accuracy of radiologic assessment of tibial shaft fracture union in humans. Clin Orthop 1985; 199:233-8.
19. Bailey IS, Karran SE, Toyn K, Brough P, Ranaboldo C, Karran SJ. Community surveillance of complications after hernia surgery. BMJ. 1992; 304(6825): 469-71.
20. Bhuyan BK, Suryansh, Singh SM. Titanium elastic

nailing in pediatric femoral diaphyseal fractures in the age group of 5 to 16 years-A short term study. J Clinic Orthop. 2014; 5: 203-10.

21. Chaudhuri A, Datta S, Ghosh S, Roy D, Bag S, Biswas A. A study of management of fracture shaft femur in children in a rural population. J Sci Soc. 2013;40(3):135-9.
22. Khan MI, Saqib M. Outcome of external fixation in pediatric femoral shaft fractures. Pak J Surg. 2014; 30(2):156-8.
23. Yaokreh JB, Odéhouri-Koudou TH, Koffi KM, Sounkere M, Kouamé YGS, Tembely S, et al. Surgical treatment of femoral diaphyseal fractures in children using elastic stable intramedullary nailing by open reduction at Yopougon Teaching Hospital. Orthop Traumatol Surg Res. 2015;101(5):589-92.
24. Kumar NR, Prasad VKV, Visvanath M, Vamshi R, Murthy GVS. Use Of Ender's Nailing in Treatment of Pediatric Fracture Shaft Femur. J Den Med Sci 2016; 15(9): 33-40.
25. Mani KC, Raj RCD, Parimal A. Pediatric femoral shaft fractures treated by flexible intramedullary nailing. Chinese J Traumato. 2015;18(5):284-7.