Aswan University Medical Journal, volume 3 / No.2/ December 2023 (229-241) Online ISSN: **2735-3117**

ORIGINAL ARTICLE

Evaluation of the results of fixation of the femoral shaft fractures using the elastic intramedullary nail

Ebeed Yasin[1], Ahmed Hamdi Ahmed*[2], Ahmed Sayed Addellatief[3] , Hesham Hamed Refae[4]

Orthopedics and Traumatology department, Faculty of Medicine- Aswan University

ABSTRACT

Keywords: Femoral shaft fracture, Nailing Intramedullary, External fixation

***Corresponding author:**
Ahmed Hamdi Ahmed

E-mail:
dhmashahmed21@gmail.com

Phone: 01159729185

Background: Elastic stable intramedullary nailing (ESIN) is used to treat fractures of the femur in pediatric patients who are not candidates for rigid intramedullary nailing . **Aim and objectives**: The aim of the work was to evaluate the results of the use of ESIN in the treatment of diaphyseal and metaphyseal femur fractures in pediatrics. **Subjects and methods**: This was a prospective study conducted on 30 patients with femoral fractures. the patients were divided into 3 groups; group A included distal 1/3 fractures, group B proximal 1/3 fractures, and group C with middle 1/3 fractures. The fractures were fixed with ESIN. Functional outcome was assessed according to Flynn's score. **Results**: The operative time in group A, B, and C was, 65±29.5, 63±16.43, and 52.89±24.17 minutes respectively (the mean was 57±24.09 and p-value = 0.0483). Flynn's score was excellent in 25 (83.33%) cases and satisfactory in 5 (16.67%) cases (p-value was 0.173). The complication rate was 26.66% (8 cases); 2 cases with infection, 2 cases with Leg Length Discrepancy, and 4 cases with knee stiffness. **Conclusion**: ESIN is a minimally invasive, and reliable method for fixation of the proximal, distal, and middle third femoral shaft fractures with minimal complications

INTRODUCTION

Fractures shaft of the femur in children account for 1.4%–1.7% of all pediatric fractures (**16**), and motor vehicle accidents account for 90 % of these fracture (**15**). Preschoolers and teenagers are the main target population, with boys affected twice as frequently as girls (**16**). Fracture shaft of the femur is anatomically classified; as proximal, middle, and distal third. According to the Arbeitsgemeineschaft für Osteosynthesefragen classification (AO/OTA), fractures of pediatric femoral shaft are coded 32 D (D mean diaphysis) and Subdivided into 4 types; 32- D 4.1 (oblique complete transverse fracture equal or less than of 30º) and 32-D 5.1 (complete spiral or oblique more than 30º) are simple fractures in addition to 2 subtypes; 32-D 4.2 (comminuted transverse equal or less than 30º) and 32-D 5.2 (comminuted spiral or oblique greater than 30º) are unstable fractures pattern the same code, 32-D, also subdivided into type 32 A- simple, type32 B- wedge, and type 32 C- complex.(**15**)

management of fractures of the femur in pediatric group has been shifted from conservative to surgical fixation, especially in children over the age of 6 years. Different methods are used for operative treatment of these fractures . The goal of surgical treatment is an anatomical stable reduction with preservation of physeal plate integrity and osteal blood supply. (**4**)

Recently Elastic stable intramedullary nailing (ESIN) become the popular method for the management of femoral shaft fractures in pediatric groups, as the ESIN is minimally invasive, stable, safe, and effective in the stabilization of these fractures. (**6**)

the surgeons preferred ESIN because of the small incision required for the entry, less blood loss, and no damage for the of greater trochanter epiphysis or distal femoral physeal plate. (**10**)

The aim of the work was to evaluate the results of the use of ESIN in the treatment of femoral shaft fractures in the pediatric population.

PATIENTS AND METHODS

This is a prospective cohort study that was conducted at the Orthopedic and Traumatology Department, Aswan University Hospital in the period between 1/1/2020 and 1/3/2021. This study was carried out on 30 patients who suffered from femoral shaft fractures and were treated with ESIN with 12 months postoperative follow-up.

the study included 30 cases (with) femoral shaft fracture and was divided into 3 groups; Group A included 6 cases (20%) with distal 1/3 fracture, group B included 5 cases (16.7) with proximal 1/3 fracture, and group C included 19 (63.3%) with middle 1/3 fracture. Regarding sex, 23 were male (76.7), and 7 were female. The mean age of studied cases was 8.12±2.52 SD with (ranged from 6 to 12) years. Thirteen (43.3%) cases were left slide, 15 (50%) right and 2 (6.7%) bilateral

Inclusion criteria: patient's age ranged from 6 to 12 years, femoral shaft fracture, recent injuries (within one week after trauma), closed fracture, and open fractures (Gustillo; I and II) (**11**). Exclusion criteria: Intra articular, neck of femur, or intertrochanteric fractures and associated neurovascular injury. History and clinical data of all patients were recorded; as Personal data including name, age, sex, and address. Associated illnesses as; DM, cardiac conditions, cerebral palsy (CP), osteogenesis imperfecata.

Femoral traction using the Thomas splint was performed for all patients temporary preoperative. Plain X-ray of the affected femur showing both hip and knee joints. Pre-operative laboratory investigations: (CBC,INR, RBS). This study was approved by the ethical committee of the faculty of medicine, at Aswan University. awritten informed consent was obtained from the relative of children.

Surgical technique

The child placed on a radiolucent operating table in a supine position. the medullary cavity's isthmus was measured using the X-ray image. The two nails in the same diameter. The femur's insertion sites for the ascending technique are 1-2 cm proximal to the distal epiphyseal plate. skin incisions is made 3–4 cm distally. cortical bone was opened by awl under fluoroscopy guidance. Pre-bending the implanted nail portion to three times the medullary canal's diameter. the apex of the curve of the pre-bended nail adjusted to the level of the fracture zone .the nail was introduced through the bony opening and then progress proximally inside the medulla with T. handle with manual toggling movement to the fracture site then confirming fracture reduction and Avoid hammering on the T-handle. this procedures was repeated for the second nail considering crossing the other nail at the fracture site. Checking both fracture alignment and nails trajectorries in both anteroposterior and lateral views under fluoroscopy guidance planes and on the opposite side of the fracture zone using the image intensifier. The nails advanced closer together until the fracture is closed. The tip of lateral nail stopped at the greater trochanter site and the medial nail inside the femoral neck. Roughly, measure the nail length then get out the nail enough length to cut . Put the nail end inside beveled impactor then push nails again inside the bone using gentile hummer to guarantee a projection of roughly 1 centimeter outside the bone.

Postoperative follow-up:
postoperative immobilization was required using a hemi-hip-Spica cast, Thomas traction was done in selected cases.
Partial weight bearing was allowed around six weeks postoperatively using crutches followed by a return to activity after complete radiological union.
Radiological assessment: The follow-up visits at 6, 8, and 10 weeks then at 3, 6, and 12 months postoperatively for evaluation and documentation of the degree of radiological union and any possible complications.

Clinical assessment: Assessment of wound condition, range of motion, full weight bearing, and deformities in the form of; frontal and sagittal plane, malrotation, and leg length discrepancy was done as follows: Assessment of the wound condition for possible complications as infection or wound dehiscence. Leg length discrepancy was assessed clinically by using a tape measure or CT scanogram. The final outcome was assessed according to Flynn's score. [**5.**]
.
Statistical analysis: Data were fed t
.o the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using numbers and percentages. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation, median, and interquartile range (IQR). The significance of the obtained results was judged at the 5% level.

RESULTS

the study included 30 cases with femoral shaft fracture and was divided into 3 groups; Group A included 6 cases (20%) with distal 1/3 fracture, group B included 5 cases (16.7) with proximal 1/3 fracture, and group C included 19 (63.3%) with middle 1/3 fracture. The dmograhic data of study Regarding sex,age, gender, and site of fracture

was reported in (table 1).

The mean follow-up was 14 ±2.33 (ranged from 10 to 17) months. According to the mechanism of trauma among the studied cases there were 7 (23.3%) fall from height (FFH) and 23 (76.7%) road traffic accident (RTA). According to AO type, there were 25 (83.3%) type A and 5 (16.7%) type B (p-value= 851). According to fracture type, there were 9 (30%) oblique fractures, 15 (50%) with transverse, 2 (6.7%) with oblique segmented, 1 (3.3%) with oblique with medial butterfly, 1 (3.3%) with spiral segmented, 1 (3.3%) medial comminution, and 1 (3.3) with transverse oblique. (table 1)

Closed fractures were reported in 27 cases. Three cases were open fractures, regarding Gastilo classification; 2 cases were open I and 1 case was open II (p-value = 0.419). According to associated fractures; 2 (6.7%) were bilateral femoral fractures, 1 (3.3%) with a ipsilateral crushed foot, 1 (3.3%) with ipsilateral distal tibia fracture, 1 (3.3%) with a spine injury (Lumbar 1 vertebra wedge fracture), and 4 (13.3%) with the midshaft tibia (3 ipsilateral and 1 contralateral side). The mean body weight of the participants was 33.33±9.50 (ranged from 20 to 53) Kilograms (kg) (P value = 0.067). One case with body weight exceeded 50 kg, with midshaft fracture, protected postoperatively. with Thomas traction for 2 months until consolidation of the fracture union. The mean operative time of studied cases was 57±24.09 (ranged from 30 to 90) minutes, in group A was 65±29.5 minutes, in group B was 63±16.43 minutes, and in group C was 52.89±24.17 minutes ,with significance difference (p-value=0.0483) where fractures of the group C were performed in less time than other groups. the mean nail size was 3.03 ±0.8 SD (ranged from 2 to 4.5) millimeters in diameter, with no significant difference between the groups (p-value = 0.395). The nail entries were distal in 27 (90%) cases and proximal in 3 (10%) cases. The proximal entry was used in 3 (50%) cases of group A and the distal entry in all cases of groups B and C, and 3 (50%) cases of group A (p-value = 0.043). The mean hospital stay of studied cases was 3 .07 ±1.05SD (ranged from 2 to 5)

days, (p-value = 0.297). the preoperative hemodynamic status was stable in 26 (86.7%) cases and unstable in 4 (13.3%) cases (p-value = 0.827). (table 1)

Postoperative immobilization was performed in all cases (100%). long above knee posterior slab was used in midshaft frcture. hip spica cast was used in proximal and distal 1/3 femur fracture . Thomas in only 2 cases weight over 50 kg, The mean union time was 8.27±2.27 SD (ranged from 6 to 12) weeks, (p-value = 0.150) .the mean disable time was 2.78 ±0.7 SD (ranged from 2.5 to 5) months, (p-value = 0.007) .the mean Walkability time was 2.75 ±0.67 SD (ranged from 2.5 to 5) months and (p-value = 0.007) .(table 2)

The overall complication rate was 26.66% (8 cases); 2 cases (6.7%) suffered from length discrepancy (LLD) less than 1 cm shortening; one in group B, and the other in group A (p-value =0.153). The infection rate was 6.7% (2 cases) one in group A, and the other in group C (p-value =0.501), the infection was early postoperative of the distal entry sites incision and was improved with daily dressing and intravenous course of 3rd generation antibiotics. Postoperative knee stiffness was reported in 4 cases (13.33%) at 3 months follow-up; 2 cases in group A, and 2 in group C, where the average knee flexion range was 40 (ranged from 30 to 60) degrees. This stiffness improved spontaneously within 5 months of follow-up with the physiotherapy program, p-value = 0.887. (table 3) According to Flynn's score, excellent in 25 (83.33%) cases of the study, in detail; group A in 4 (66.67%), group B in 4 (80%), and group C in 17 (89.47%) cases. While satisfactory in 5 (16.67%) cases of all studies, in detail, group A in 2 (33.33%), group B in 2(20%), and group C in 4(10.53%) cases, the p-value was 0.173. (table 3)

DISCUSSION

Recently ESIN has became the standard method of fixation for fracture shafts of the femur and multiple studies have been published for evaluation of the outcome of this method, most of them reported that ESIN is a reliable and simple method of fixation. (**6**,**7**,**2**,**13**) In this study, we treated 30 patients(7females and 23males) with femoral shaft fracture. The mean follow-up time was 14 ±2.33 (ranged from 10 to 17) months. According to AO type there were 25 (83.3%) type A and 5 (16.7%) type B (p-value= .205). only 3 cases were open fractures . According to the mechanism of trauma among the studied cases there were 7 (23.3%) fall from height (FFH) and 23 (76.7%) road traffic accident (RTA). The mean age of our study is close to the study by Govindasamy et al., in their retrospective analysis with mean age of 9.6 years . (**6**)

Moreover, Frei et al., reported that the age and sex composition of the 22 children were as follows: 8 girls (36.4%) and 14 boys (63.6%). (**5**) This male predominance could be attributed to boys' higher risk of all fractures from higher-risk play activities being more socially acceptable. In contrast to their female counterparts, they are also more exposed to the outside world, including riding a vehicle and participating in sports. Mughal et al., who discovered that the male to female ratio in their study was 2.2:1, support this. (**12**)

In this current study . Regarding the site of fractures, Group A included 6 cases (20%) , group B included 5 cases (16.7%), and group C included 19 (63.3%).comparing to Govindasamy et al. study , they reported 36 cases with fractures in the middle 1/3 followed by, 7 cases with proximal 1/3 and 5 cases with distal 1/3 fractures. (**6**) Also Akinyoola et al., reported 134 cases with different patterns of fractures; 38.4% of cases were transverse, 24.6% were spiral, 26.1% were oblique, 10.1% were comminuted, and 0.7% were greenstick fractures. (**1**)This is consistent with the finding Frei et al., who recorded in their study 9 (40.9%) cases with transverse, 6 (27.3%) cases with spirals, 4 (18.2%) cases with comminuted and 3 (13.6%) cases with long oblique fracture. (**5**)

the mean operative time in our study was 57±24.09 (ranged from 30 to 90) minutes, with an insignificance difference (p value=0.483) between the studied groups, with least time in midshaft fractures (52.89±24.17 minutes compared to proximal(65±29.5 minutes) and distal third fractures (63±16.43 minutes).

The mean nail diameter was 3.03±0.8 SD with range (ranged from 2 to 4.5) millimeters in diameter, with no significant difference between the groups. Regarding to the nail entries were distal in 27 (90%) cases and proximal in 3 (10%) cases. The proximal entry was used in 3 (50%) cases of group A and the distal entry in the other 3 (50%) cases of group A and all cases (100%) of groups B and C, showing significant difference between the two entries. Our results similar to Hashmi et al., who recorded the mean nail diameter of 3.03 ± 0.26 millimeters, and mean time of the surgery was 48.71±8.87 minutes. (**7**) This is consistent with the results of Jadaan et al., where they reported the average surgery time was 47 minutes in cases that performed through closed reduction and 62 minutes in cases that needed mini-open incision for facilitating difficult reduction. (**8**)

In this study we demonstrated that the mean hospital stay of studied cases was 3.07±1.05 SD with range (ranged from2 to 5) days, the mean union time was 8.27±2.27 SD (ranged from 6 to 12) weeks, with no significant difference between the groups. the mean duration of non weight bearing was 2.78 ±0.7 SD (ranged from 2.5 to 5) months, the mean Walkability was 2.75 ±0.67 SD (ranged from 2.5 to 5) months. The cases of group C recorded less disability and early walkability time than other groups (p-value = 0.007). Moreover, Amin et al., reported that the mean full fractures union time was 9.4±1.76 SD (ranged from 7 to 12) weeks. The mean Walkability time was 9.6 ±1.7 SD (ranged from 7 to 12) weeks. (**2**)

Regarding leg length discrepancy, In our study 2 cases (6.7%) with LLD (less than 1 cm shortening); one in group B, and the other in group A. Our outcome is consistent with Govindasamy et al., who recorded 5 (10%) cases suffered from LLD, 4 cases of which had LLD less than 5 mm with insignificant difference. (**6**) Nascimento et al., reported 2.5 mm shortening as LLD in 2 (6.7%) cases of their study(**13**). Also, Amin et al., (**2**) recorded LLD in 16.7% of the cases in their study. in contrary Jadaan et al., didn't reported any cases with significant LLD, recurvatum or rotational deformity. (**8**)

According to skin irritation at entry site,in our study 4cases with skin irritation ,Amin et al with only one case with soft tissue irritation.while kyaokay has 2cases with skin irritation.

Regarding superficial infectionat at entry site.in our study only 2 cases have superficial infection at entry site that is consistent with Amin et al who recorded one case with superficial infection

Coming to overall complication rate, The complication rate in our study was 26.66% (8 cases); 2 (6.7%) cases with infection of the entry sites that improved with daily dressing and antibiotics, 2 (6.7%) cases with LLD, and 4 cases with post operative skin irritation at the entry site causing partial loss of knee flexion during the 1st 3 months postoperative that improved with physiotherapy.

Amin et al. reported a complication rate 11.11%(2cases) in their study; 1 superficial infection at entry site (5.6 %), one case with soft tissue irritation (5.6%)(**2**) . While, the complication rate was 93%. (28 cases) in the study of Kyaokay et al. that suffered from soft tissue irritation at nail entry (6.7%),vrus mallignement(36%) and limb length discrepancy(50%)(**10**). Similarly the complication rates with pogorelic et al, bhuyan et al, govindasmyR et al and K.C. Kapil Mani et al . were 8.49%,32.5%,56.25%,and 28.125% Respectevly(table 4). Bhuyan et al recorded two cases involved cork screwing of nails, and four cases involved closed reduction failure during the perioperative period. (**3**) but none of these complications were encountered in our study

According to Flyn's score, excellent in 25 (83.3%) cases of all study and satisfactory in 5 (16.7%) cases of all study. Our outcome is consistent with Govindasamy et al., who recorded the outcome according to Flynn's criteria as follow; excellent in 40 (83%) patients and satisfactory in 8 (17%) patients, with no cases recorded poor results. No reported cases of rotational deformities or recurvatum. (**6**)

Limitations of study

Little number of patients and short follow up time and need more research for results of using ESIN for fixation of the proximal and distal third femoral shaft fractures.

CONCLUSION

ESIN is minimally invasive, safe, reliable, and an effective method for fixation of the proximal, distal, and middle third femoral shaft fractures with minimal complications.

REFERENCES

1.Akinyoola, Akinyele & Olaniran, Orekha & Taiwo, Festus Osho & Odunsi, AO. (2011). Outcome of non-operative management of femoral shaft fractures in children. African journal of paediatric surgery : AJPS. 8. 34-9. 10.4103/0189-6725.78666.

2.Amin, A. H., Nahla, A. M., Gaber, A. M., & Kamsawi, M. M. A. (2021). Elastic Stable Intramedullary Nailing Femoral Shaft Fractures in Children from Six to Ten Years Age. The Egyptian Journal of Hospital Medicine, 84(1), 1908–1913. https://doi.org/10.21608/ejhm.2021.178604

3.Bhuyan, B. K., & Mohan Singh, S. (2014). Titanium elastic nailing in pediatric femoral diaphyseal fractures in the age group of 5-16 years - A short term study. *Journal of clinical orthopaedics and trauma*, *5*(4), 203–210. https://doi.org/10.1016/j.jcot.2014.08.001

4. Darawade, Nilesh & Gaikwad, Yogesh & Pawar, Gaurav. (2018). Sub muscular bridge plating for pediatric femur fractures – Review of 12 patients. Indian Journal of Orthopaedics Surgery. 4. 240-244. 10.18231/2395-1362.2018.0048.

5.Frei, B., Mayr, J., de Bernardis, G., Camathias, C., Holland-Cunz, S., & Rutz, E. (2019). Elastic stabile intramedullary nailing (ESIN) of diaphyseal femur fractures in children and adolescents: A strobe-compliant study. *Medicine*, *98*(14), e15085. https://doi.org/10.1097/MD.0000000000015085

6.Govindasamy, R., Gnanasundaram, R., Kasirajan, S., Ibrahim, S., & Melepuram, J. J. (2018). Elastic Stable Intramedullary Nailing of Femoral Shaft Fracture-Experience in 48 Children. *The archives of bone and joint surgery*, *6*(1), 39–46.

7.Hashmi, M. U., Ahsan, M. N., Chughtai, B. B., & Majeed, S. (2021). EARLY OUTCOMES OF FLEXIBLE INTRAMEDULLARY NAILING IN PEDIATRIC SHAFT OF FEMUR FRACTURES. PAFMJ*, 71(6), 2157–2160.* https://doi.org/10.51253/pafmj.v71i6.6137

8.Jadaan, M., Jain, S. K., & Khayyat, G. (2016). Flexible Intramedullary Nail Fixation in Paediatric Femoral Shaft Fractures. International Journal of Orthopaedics, 3(6), 654–657.

9. Kapil Mani, K. C., Dirgha Raj, R. C., & Parimal, A. (2015). pediatric femoral shaft fractures treated by flexible intramedullary nailing. *Chinese journal of traumatology = Zhonghua chuang shang za zhi*, *18*(5), 284–287. https://doi.org/10.1016/j.cjtee.2015.05.002

10. Kayaokay, K., & Aktuglu, K. (2018). Titanium elastic nailing in pediatric femoral diaphyseal fractures in the age group of 6-15 years mid-term and long-term outcomes. *Pakistan journal of medical sciences*, *34*(6), 1529–1533. https://doi.org/10.12669/pjms.346.16297

11. ***Kim, P. H., & Leopold, S. S. (2012***). In brief: Gustilo-Anderson classification. [corrected]. *Clinical orthopaedics and related research*, *470*(11), 3270–3274. https://doi.org/10.1007/s11999-012-2376-6

12. Mughal, M. Ashraf & Dix-Peek, SI & Hoffman, EB. (2013). The epidemiology of femur shaft fractures in children. The South African Orthopaedic Journal (SAOJ). 12. 23-27.

13. Nascimento, F. P., Santili, C., Akkari, M., Waisberg, G., Reis Braga, S. D., & de Barros Fucs, P. M. (2010). Short hospitalization period with elastic stable intramedullary nails in the treatment of femoral shaft fractures in school children. *Journal of children's orthopaedics*, *4*(1), 53–60. https://doi.org/10.1007/s11832-009-0227-0

14. Pogorelić, Z., Vodopić, T., Jukić, M., & Furlan, D. (2019). Elastic Stable Intramedullary Nailing for Treatment of Pediatric Femoral Fractures; A 15-Year Single Centre Experience. *Bulletin of emergency and trauma*, *7*(2), 169–175. https://doi.org/10.29252/beat-070213

15.Slongo, T. F., Audigé, L., & AO Pediatric Classification Group (2007). Fracture and dislocation classification compendium for children: the AO pediatric comprehensive classification of long bone fractures (PCCF). *Journal of orthopaedic trauma*, *21*(10 Suppl), S135–S160. https://doi.org/10.1097/00005131-200711101-00020

16. Valenza, W.R., Soni, J.F., Gasperin, W., & Faria, F.F. (2019). Submuscular bridge plating in the treatment of unstable femur fractures in children and adolescents. *Journal of Musculoskeletal Surgery and Research, 3*, 286 - 291.

	Total (n=30)	Group A (n=6)	Group B (n=5)	Group C (n=19)	P. value
Age					
Range	6 – 12	6 – 12	6 – 9	7 - 12	
Mean ± SD	8.12±2.52	7.33±2.5	7.4±1.67	8.82±2.52	0.112
Gender					
Male	23(76.67%)	4(66.67%)	3(60%)	16(84.21%)	0.424
Female	7(23.33%)	2(33.33%)	2(40%)	3(15.79%)	
Weight (kg)					
Range	20 – 53	20 – 48	20 – 35	20 - 53	0.067
Mean ± SD	33.33±9.5	29.17±5.85	27±7.58	36.32±9.84	
MOT (mode of trauma)					
FFH	7(23.33%)	3(50%)	0(0%)	4(21.05%)	0.138
MCA	23(76.67%)	3(50%)	5(100%)	15(78.95%)	
G CLASS					
Closed	27(90%)	5(83.33%)	5(100%)	17(89.47%)	
Open1	2(6.67%)	1(16.67%)	0(0%)	1(5.26%)	0.744
Open2	1(3.33%)	0(0%)	0(0%)	1(5.26%)	
AO type					
A	25(83.33%)	6(100%)	3(60%)	16(84.21%)	0.205
B0	5(16.67%)	0(0%)	2(40%)	3(15.79%)	
Fracture limb					
Bilateral	2(6.67%)	0(0%)	2(40%)	0(0%)	
Rt	15(50%)	4(66.67%)	1(20%)	10(52.63%)	**0.022***
Lt	13(43.33%)	2(33.33%)	2(40%)	9(47.37%)	
Fracture type					
Medial commintion	1(3.33%)	0(0%)	0(0%)	1(5.26%)	
Oblique	9(30%)	3(50%)	1(20%)	5(26.32%)	
Oblique segmented	2(6.67%)	0(0%)	1(20%)	1(5.26%)	
Oblique with butterfly	1(3.33%)	0(0%)	0(0%)	1(5.26%)	0.234
Spiral segmented	1(3.33%)	0(0%)	1(20%)	0(0%)	
Transverse	15(50%)	3(50%)	1(20%)	11(57.89%)	
Transverse+oblique	1(3.33%)	0(0%)	1(20%)	0(0%)	
Associated fracture					
No	21(70%)	4(66.67%)	3(60%)	14(73.7%)	
Bilateral	2(6.67%)	0(0%)	1(20%)	1(5.26%)	
Crush foot	1(3.33%)	0(0%)	0(0%)	1(5.26%)	0.353
Midshaft tibia	4(13.3%)	2(33.33%)	1(20%)	1(5.26%)	
Distal tibia	1(3.33%)	0(0%)	0(0%)	1(5.26%)	
Spine	1(3.33%)	0(0%)	0(0%)	1(5.26%)	
Fracture comminution					
Type 0	24(80%)	6(100%)	2(40%)	16(84.21%)	
Type 1	2(6.67%)	0(0%)	1(20%)	1(5.26%)	0.152
Type 2	4(13.33%)	0(0%)	2(40%)	2(10.53%)	
Operative time (min)					
Range	30 – 90	30 – 90	45 – 90	30 - 90	
Mean ± SD	57±24.09	65±29.5	63±16.43	52.89±24.17	0.483
Hospital time (days)					
Range	2 – 5	2 – 5	3 – 3	2 - 5	
Mean ± SD	3.07±1.05	3.67±1.21	3±0	2.89±1.1	0.297
Nail size					
Range	2 - 4.5	2 - 4.5	2 - 3.5	2 - 4.5	
Mean ± SD	3.03±0.8	2.83±0.68	2.7±0.57	3.18±0.87	0.395
Entry					
Distal	27(90%)	3(507%)	5(100%)	19(100%)	**0.043***
Proximal	3(10%)	3 (50%)	0(0%)	0(0%)	

Hemodynamic					
Stable	26(86.67%)	5(83.33%)	4(80%)	17(89.47%)	0.827
Unstable	4(13.33%)	1(16.67%)	1(20%)	2(10.53%)	

Table 1: this table recorded the demographic data, fracture classification, associated fractures, hospital time, operative time, nail size, types of the nail entries, and postoperative hemodynamic status. . Group A: Distal 1/3, group B: Proximal 1/3 & group C: Midshaft. P-value < **0.05 is significant.**

	Total (n=30)	**Group A (n=6)**	**Group B (n=5)**	**Group C (n=19)**	**P. value**
Immobilization					
Hip spica Cast	10 (33.33%)	0(0.0%)	5(100%)	5(26.3%)	
Slab	18 (60%)	6(100%)	0(0.0%)	12(63.15%)	**<0.001**
Thomas	2 (6.67%)	0(0.0%)	0(0%)	2(10.52%)	
----------	----------	----------	----------	----------	----------
--	--	--	-	--	-
Union time (weeks)					
Range	6 – 12	6 – 12	8 – 12	6 - 12	
Mean ± SD	8.27±2.27	9.67±2.66	8.8±1.79	7.68±2.14	0.150
Disable time (months)					
Range	2.5 – 5	2 – 5	2.5 – 4	2 - 3	
Mean ± SD	2.78±0.7	3.42±0.92	3.1±0.55	2.5±0.5	**0.007**
Walkability (months)					
Range	2.5 – 5	2 – 5	2.5 – 3	2 - 3	
Mean ± SD	2.75±0.67	3.42±0.92	2.9±0.22	2.5±0.5	**0.007**
Hemodynamic					
Stable	26(86.67%)	5(83.33%)	4(80%)	17(89.47%)	0.827
Unstable	4(13.33%)	1(16.67%)	1(20%)	2(10.53%)	

Table 2: this table recorded the immobilization method, union time, disability time, and walkability. Group A: Distal 1/3, group B: Proximal 1/3 & group C: Midshaft. P-value < **0.05 is significant.**

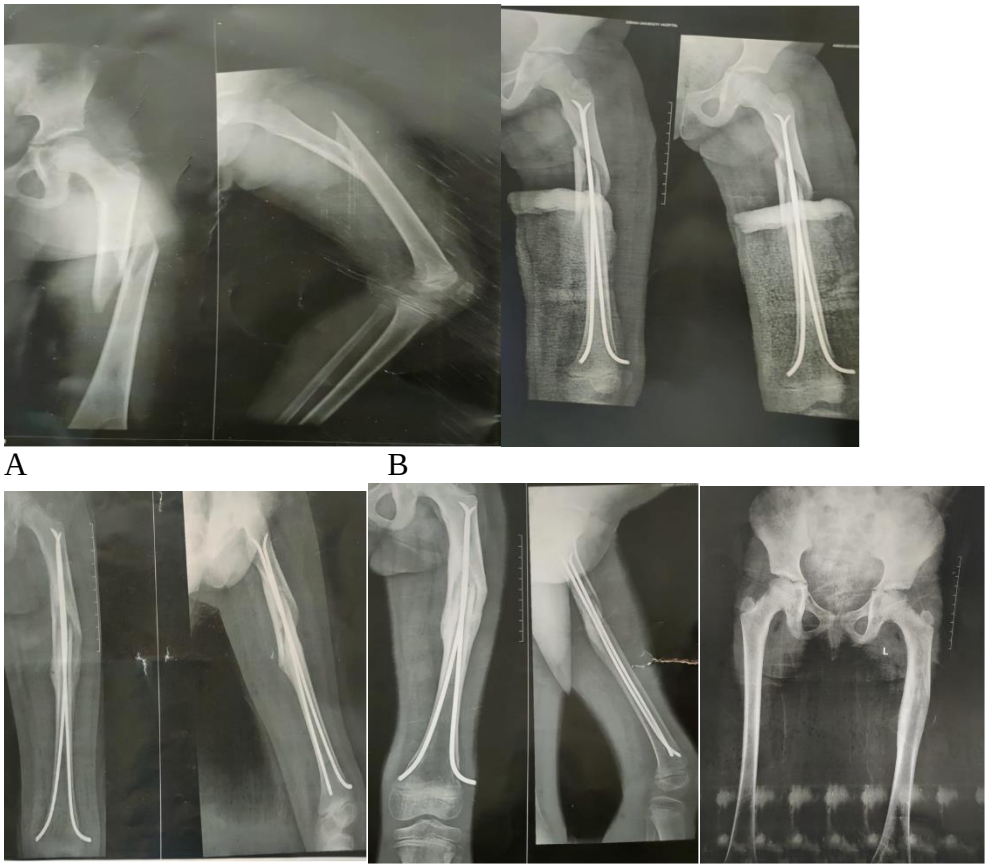
	Total (n=30)	**Group A (n=6)**	**Group B (n=5)**	**Group C (n=19)**	**P. value**
Deformity					
No	30(100%)	6(100%)	5(100%)	19(100%)	
Rotation deformity					
No	30(100%)	6(100%)	5(100%)	19(100%)	
Angulation					
No	30(100%)	6(100%)	5(100%)	19(100%)	
Intraoperative complication					
No	30(100%)	6(100%)	5(100%)	19(100%)	
Leg leg discrepancy					
No	28(93.33%)	5(83.33%)	4(80%)	19(100%)	0.153
Yes	2(6.67%)	1(16.67%)	1(20%)	0(0%)	
Blood loss					
No	30(100%)	6(100%)	5(100%)	19(100%)	
Entry site infection					
No	28(93.33%)	5(83.33%)	5(100%)	18(94.74%)	0.501
Yes	2(6.67%)	1(16.67%)	0(0%)	1(5.26%)	
Stiff knee					
No	26(86.66%)	4(66.66%)	5(100%)	17(89.47%)	0.887
Yes	4(13.33%)	2(33.33%)	0(0.0%)	2(10.52%)	
----------	----------	----------	----------	----------	----------

Flynn's score					
Satisfactory	5(16.67%)	2(33.33%)	1(20%)	2(10.53%)	0.416
Excellent	25(83.33%)	4(66.67%)	4(80%)	17(89.47%)	

Table 3: This table recorded the complications and Flynn's score of the study. Group A: Distal 1/3, group B: Proximal 1/3 & group C: Midshaft. P-value **< 0.05 is significant.**

	N^0	Mean Union time (weeks)	Complications			
			Rate	Items	N^0	%
Our study	30	8.27±2.27	26.6%	LLD Site infection Irritation at insertion site	2 2 4	(6.67%) (6.67%) (13.3%)
Kayaokay et al. 2018(**10**)	30	9.2±2.2	93%	Irritation at the insertion site Varus angulation LLD	2 11 15	(6.7%) (36%) (50%)
Pogorelic et al.2019(**14**)	106	8.5±1.3	8.49%	Entry site skin irritations Valgus angulations refracture Migration of the nail Varus angulation Delayed healing. Patients	3 2 1 1 1 1	(2.83%) (1.9%) (0.94%) (0.94%) (0.94%) (0.94%)
Amin et al.2021(**2**)	18	9.4±1.76	11.11	Irritation at entry site Superficial infection	1 1	(5.6%) (5.6%)
Bhuyan et al. 2014 (**3**)	40	9 (ranged from 8 to 10)	32.5%	LLD Varus malalighment rotational mal-alignment	6 4 3	(15%) (10%) (7.5%)
Govindasamy, R et al.2018(**4**)	48	9.7(ranged from9-2)	56.25	Soft tissue irritation around knee Limb shortening Varus malunion Site infection Nail migration	12 5 4 4 2	(25%) (10.4%) (8.33%) (8.33%) (4.167%)
K.C. Kapil Mani et al.2015(**9**)	32	9.57(ranged from 6-14)	28.125	Varus angulation Anterior angulation LLD	3 2 4	(9.375%) (6.25%) (12.5%)

Table 4: Comparison between our study and other published litratures



A B C D E

Figure 1: case 1, Patient profile: Female child, 7 Years old, with fracture of left side femur. A) Antero-posterior and lateral X-rays of the right femur showed a long oblique fracture with a medial butterfly at the junction between the proximal third and the midshaft of the femur. B) Immediate postoperative x-ray AP and Lateral views showed fixation with 2 ESIN. C) 6 weeks postoperative X-ray AP and Lateral views showed fracture callus consolidation, D) 3 months post operative X-ray AP and Lateral views showing complete fracture healing. E) 9 months post operative X-ray AP and Lateral views showed complete fracture healing and removal of the nails

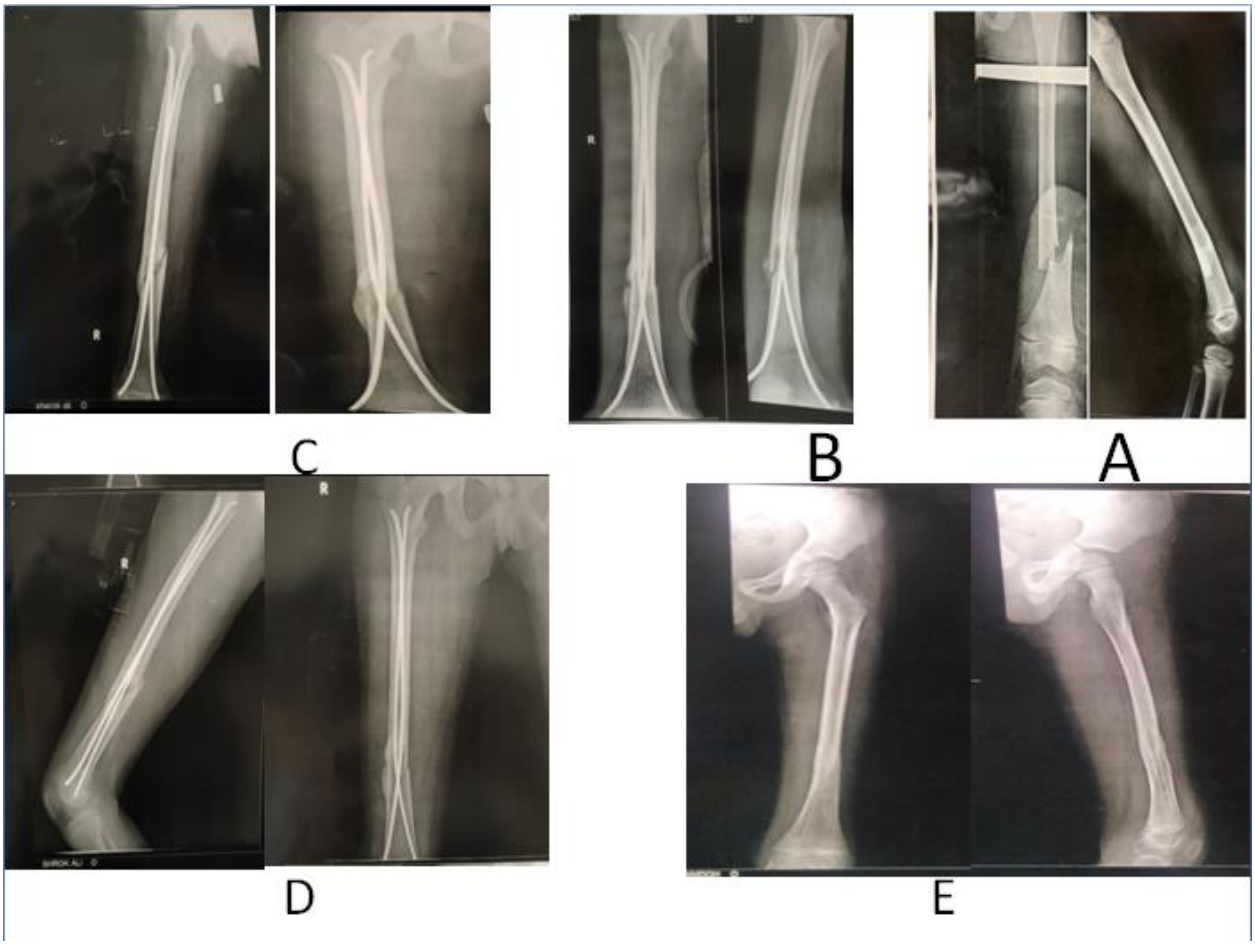


Figure 2: case 2, Female child, 6 Years old, with fracture of distal 1/3 left side femur. A) Antero-posterior and lateral X-ray of the right femur showed an oblique fracture. B) one-month postoperative x-ray AP and Lateral views showed fixation with 2 ESIN. C) 8 weeks postoperative X-ray AP and Lateral views showed fracture callus consolidation, D) 3 months postoperative X-ray AP and Lateral views showing incomplete fracture healing.E)one year followup after ESIN removal show complete fracture union

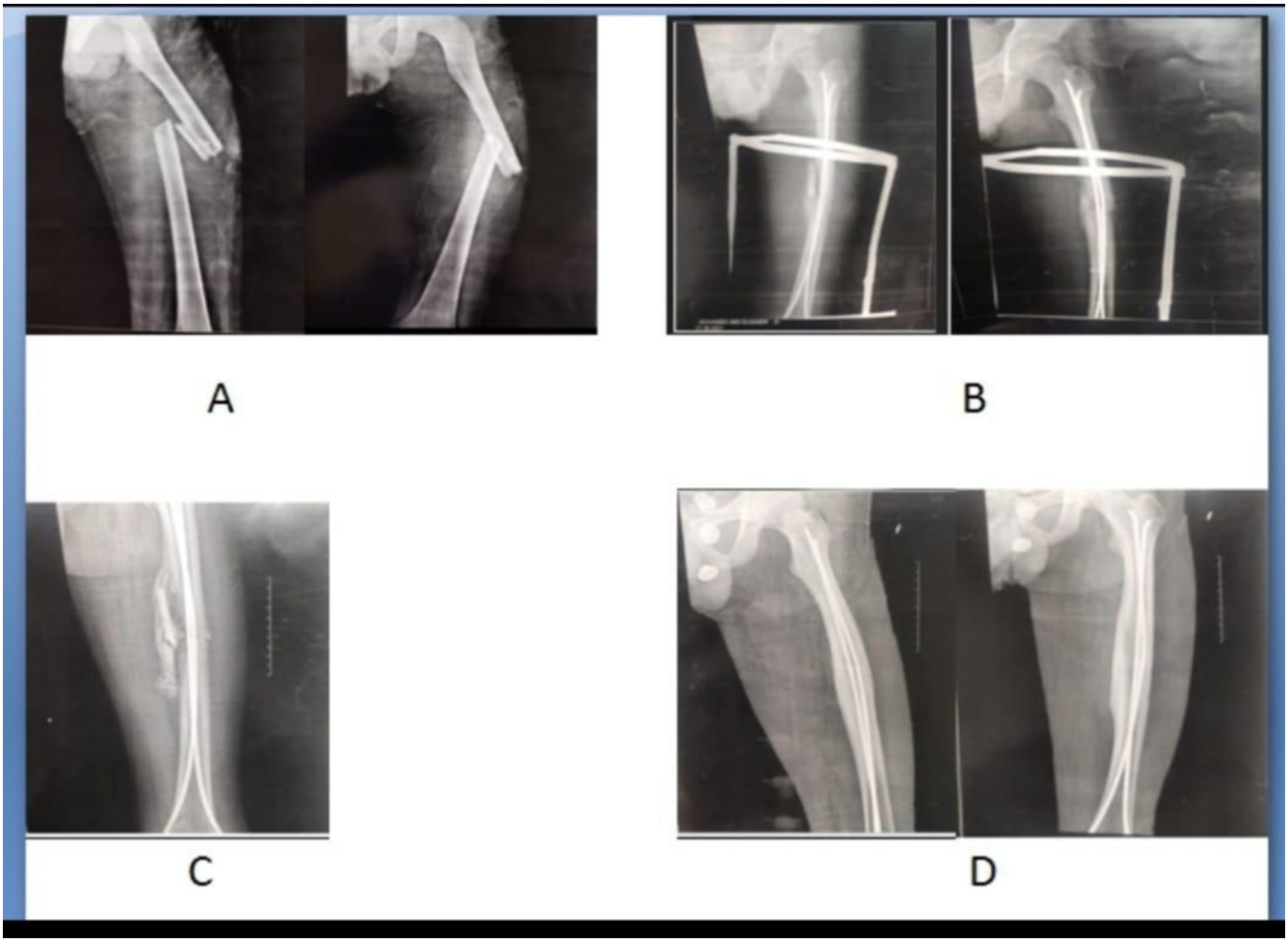


Figure 3: Patient profile: Female child, 14 Years old, with fracture of left side femur. A) Antero-posterior and lateral X-rays of the right femur showed obique midshaft fracture with wedge fragement. B) 8-week postoperative X-ray AP and Lateral views showed fracture callus consolidation, C) 3 months postoperative X-ray AP views showing incomplete fracture healing. D) one-year follow-up showed complete union and remodeling of bone