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Research Article

Elastic nail versus plate for treatment of single close fracture of femur shaft

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Abstract

This study aims to describe the outcome of pediatric flexible nails versus plates for the treatment of femur fracture. We reviewed the medical records of 28 femur fractures in children treated with flexible nail insertion and 26 children treated with plate fixation from January 2017 to December 2019. The mean age of the children was 8.88 ± 1.86 years. Data were obtained from patient charts. Union of bones was found in all the operated children, 28 (51.9%) of the group flexible nails, while no union was found in 3 (5.6%) of the group plate with screws. Delay union was found in 5 (9.3%) of the plate with screws, while in the group of flexible nails was in 2 (3.7%). Malrotation was found in 2 (3.7%) of the flexible nails and in 1 (1.9%) in the plate and screw. Bursa was found only in the flexible nails with 7 (13%) (p = 0.007). Re-fracture was found only in the group of plates with screws with 5 (9.3%) (p = 0.021). The limbs were shortened only in 1 (1.9%) patient with flexible nails. Superficial infection was high in the group plate with screws group 4 (7.4%). Deep infection was found to be high among 3 (5.6%) of the group plate & screw. We conclude that flexible intramedullary nail fixation of fracture shaft femur in children is a very acceptable way of treatment and is associated with minimal complications.

1. Introduction

Amongst children globally, trauma is a major cause of mortality and morbidity [1,2]. After acute infections, trauma is a leading cause of morbidity and mortality in children [3, 4]. Although accounting for less than 2% of all orthopedic injuries in children [5], femoral fractures have a significant impact not only on the patient and their family network but also on regional trauma resources [6,7]. Femur fractures are frequent in the pediatric and adolescent population. Femoral shaft fracture is one of the most common traumatic musculoskeletal injuries requiring hospitalization in young patients [8]. These fractures were managed with a wide variety of methods in the past [9]. The last few decades have seen an increasing trend toward operative management of femoral shaft fractures in pediatric patients, but opinions regarding the optimal fixation method for these fractures remain divided [10]. External fixation, although producing acceptable results, is fraught with many complications, as is plate osteosynthesis and rigid intramedullary nailing, which may also require a second major surgery for the removal of the implant [4,11]. Flexible intramedullary nailing, introduced for femoral fractures by the Nancy group in 1982 [12], has become popular with many orthopedic surgeons. Among the surgical treatments, the most frequently used are external fixation, intramedullary nailing with rigid or flexible nails, and plate fixation [13]. The objective of this study centered on describing the outcomes of pediatric flexible nails versus plates for the treatment of femur fracture.

2. Materials and methods:

We performed a retrospective review of all the children with femur fractures treated operatively at Alsalam hospital in Aden, Yemen. We reviewed the medical records of 28 femur fractures in children treated with flexible nail insertion and 26 children treated with plate fixation from January 2017 to December 2019, at Alsalam hospital. The type of fractures were closed fractures, and all patients were single isolated femur fractures. The mean age of the patients in this study was 8.88 ± 1.86 years (range 6 to 13 years). There were 38 males and 16 females. All patients were followed until the fracture was completely united. The average follow-up was 12 months. Data were obtained

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from patient charts and were sex, age, the outcome of the treatment procedures like rotation, bursa, union of fracture, delay union, re-fracture, shortening, weight-bearing, time of removing nails, and surgery complications. Statistical analysis was carried out using SPSS version 22. Fisher's exact test was used, and a p-value of <0.05 was considered statistically significant for all analyses.

3. Results and Discussions

Table 1 and Figure 1 revealed that the total number of injured children in the study was 54. There were 38 (70.4%) males and 16 (29.6%) females, and the children's ages ranged between 6 and 13 years. The mean age of the children was 8.88 ± 1.86 years. The mean age of female children was 8.75 ± 1.65 years, and that of male children was 8.95 ± 1.96 (p > 0.05). Most of the children, 43 (79.6%), are in the age group 10 years and younger. The mean weight of children was 24.8 ±5.6 Kilograms, and the weight ranged between 18 and 35 Kilograms. Table 2 and Figure 2 illustrate the postoperative outcomes of the pediatric flexible nails group and plate with screws group in the treatment of pediatric femur fracture. Union of bones was found in all the operated children, 28 (51.9%) of the group pediatric flexible nails group, while no union was found in 3 (5.6%) of the group plate with screws (p > 0.05). Delay union was found in 5 (9.3%) of the group plate with screws, while in the group of pediatric flexible nails was in 2 (3.7%), (p > 0.05). Malrotation was found in 2 (3.7%) of the group pediatric flexible nails and in 1 (1.9%) in the group plate & screw (p > 0.05). Bursa was found in the group with pediatric flexible nails with 7 (13%) and not found in the group plate with screws. The relation between the values was statistically significant (p = 0.007). Re-fracture was found in the group of plates with screws with 5 (9.3%) and not found in the flexible nails group.

Table 1: Children with femur fractures related to demographic variable (n=54)

Variables	Mean & range	No	%
Sex:			
Males		38	70.4
Females		16	29.6
Age (years):			
Mean age of all patients ± SD*	8.88 ± 1.86		
Range of age of all patients	6 – 13		
Female's mean age ± SD	8.75 ± 1.65		
Males mean age ± SD	8.95 ± 1.96		
P-value between groups	< 0.05		
Age groups (years):			
≤ 10		43	79.6
> 10		11	20.4
Weight of children (kilogram):	24.8 ±5.6		
Mean weight	18 – 35		
Range of weight			

*SD = standard deviation

The relation between the values showed statistically significant (p = 0.021). Table 2 and Figure 2 illustrate the postoperative outcomes of the pediatric flexible nails group and plate with screws group in the treatment of pediatric femur fracture. Union of bones was found in all the operated children, 28 (51.9%) of the group pediatric flexible nails group, while no union was found in 3(5.6%) of the group plate with screws (p > 0.05).

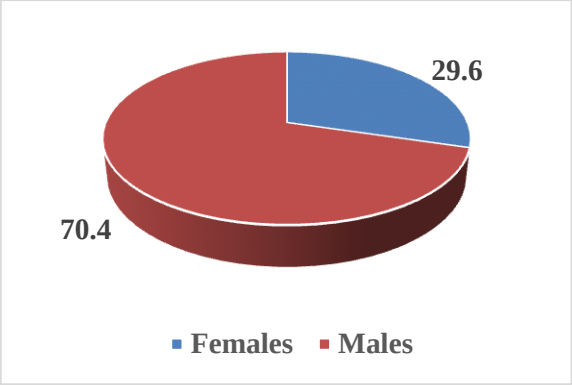

Figure 1: Distribution of study children related to sex (n=54)

Delay union was found in 5 (9.3%) of the group plate with screws, while in the group of pediatric flexible nails was in 2 (3.7%) (p > 0.05). Malrotation was found in 2 (3.7%) of the group pediatric flexible nails and in 1 (1.9%) in the group plate & screw (p > 0.05). Bursa was found in the group with pediatric flexible nails with 7 (13%) and not found in the group plate with screws. The relation between the values was statistically significant (p = 0.007). Re-fracture was found in the group of plate with screws with 5 (9.3%) and not found in the flexible nails group. The relation between the values was statistically significant (p = 0.021). Shortening of the affected limb was found only in 1 (1.9%) patient of the group with pediatric flexible nails and not found in the group the plate with screws group (p > 0.05). Superficial infection was high in the group plate with screws group 4 (7.4%) and less in the group pediatric flexible nails 3 (5.6%).

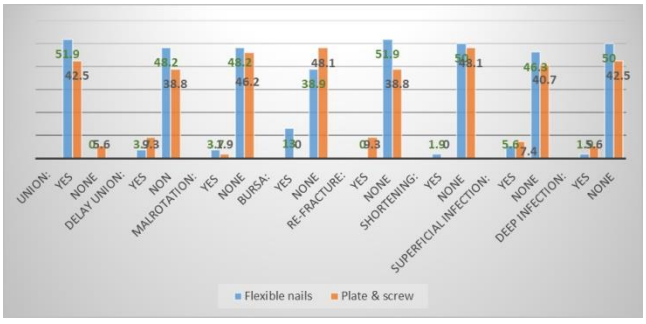

Figure 2: Distribution of outcome proportions related to type of surgical procedures

The relationship between the values was insignificant (p > 0.05). Deep infection was found high among 3 (5.6%) of the group plate & screw (p > 0.05). Table 3 showed the means of weight bearing related to pediatric flexible nails group and related to plate with screws group. We compared the mean weight bearing for the two groups and we found that they were with a mean weight bearing for pediatric flexible nails group of 4.0 ± 0. 47 weeks, while the mean weight bearing of plate with screws group was 7.4±1.5 weeks. The difference between means was statistically highly significant (p = 0.000). The mean time of removing nails in the pediatric flexible nail group was 6.82 ±1.42 months, while in the plate with screws group was 7.4 ±1.5 months. The difference between means was statistically highly significant (p = 0.000). The outcome were significantly higher in the plate with screws group compared with the pediatric flexible nail group for weight bearing (weeks) and time of removing nails (months). Femoral shaft fractures are amongst the most common diaphysis fractures of childhood [14, 15,16]. They convey a significant cause of morbidity and potential mortality in children, and various methods of fixation have evolved with limited high-quality evidence supporting their adoption [17,15]. Much debate remains in the existing literature regarding the optimal management of these injuries [18], with options varying according to patient age, size/body mass, and fracture configuration [19].

The American aacademy of Orthopaedic Surgeons states there is limited evidence to support a variety of treatment techniques, which includes intramedullary nailing and submuscular plating, for pediatric femoral shaft fractures. Both techniques have their own benefits and pitfalls [20]. Operative treatment has been shown to reduce time to weight-bearing, provide a more predictable pattern of healing, and reduce time out of school in the pediatric population [21].In this retrospective study, 54 children were operated with pediatric flexible nails and plate with screws for femur fractures. There were 38 (70.4%) males and 16 (29.6%) females, and the children's ages ranged between 6 and 13 years. The mean age of the children was 8.88 ± 1.86 years. The mean age of female children was 8.75 ± 1.65 years, and that of male children was 8.95 ± 1.96 (p > 0.05). Most of the children, 43 (79.6%) in the age group 10 years and less. The relation between the means of both groups was statistically significant (p < 0.05).

Hussien et al. [22] reported that their study was conducted on 24 patients, and they were divided into two equal groups. The first group was treated by elastic stable intramedullary nailing (ESIN), and the other one was treated by plating. The mean age of their study children was 9.17 ± 2.12 years (ranging from 5 years to 12 years). About 62.5% of cases were males and 37.5% were females. In our current study, we found a union of fracture in the pediatric flexible nail group in all operated children, 28 (51.9%) of all study children, while no union was found in 3 (5.6%) of the group plate with screws (p > 0.05).

Table 2: Distribution of postoperative outcomes related to type of surgical procedures (n=54)

Variables	**Types of surgical procedures**				**Total**		
	Flexible nails (n=28)		**Plate & screw (n=26)**				**p-value**
	No	**(%)**	**No**	**(%)**	**No**	**(%)**	
Union:							
Yes	**28**	**(51.9)**	**23**	**(42.5)**	**51**	**(84.4)**	**P > 0.05**
None	**0**	**(0.0)**	**3**	**(5.6)**	**3**	**(5.6)**	
Delay union:							
Yes	**2**	**(3.7)**	**5**	**(9.3)**	**7**	**(13.0)**	**P > 0.05**
Non	**26**	**(48.2)**	**21**	**(38.8)**	**47**	**(87.0)**	
Malrotation:							
Yes	**2**	**(3.7)**	**1**	**(1.9)**	**3**	**(5.6)**	**P > 0.05**
None	**26**	**(48.2)**	**25**	**(46.2)**	**51**	**(94.4)**	
Bursa:							
Yes	**7**	**(13.0)**	**0**	**(0.0)**	**7**	**(13.0)**	**P = 0.007**
None	**21**	**(38.9)**	**26**	**(48.1)**	**47**	**(87.0)**	
Re-fracture:							
Yes	**0**	**(0.0)**	**5**	**(9.3)**	**5**	**(9.3)**	**P = 0.021**
None	**28**	**(51.9)**	**21**	**(38.8)**	**49**	**(90.7)**	
Shortening:							
Yes	**1**	**(1.9)**	**0**	**(0.0)**	**1**	**(1.9)**	**P > 0.05**
None	**27**	**(50.0)**	**26**	**(48.1)**	**53**	**(98.1)**	
Superficial infection:							
Yes	**3**	**(5.6)**	**4**	**(7.4)**	**7**	**(13.0)**	**P > 0.05**
None	**25**	**(46.3)**	**22**	**(40.7)**	**47**	**(87.0)**	
Deep infection:							
Yes	**1**	**(1.9)**	**3**	**(5.6)**	**4**	**(7.4)**	**P > 0.05**
None	**27**	**(50.0)**	**23**	**(42.5)**	**50**	**(92.6)**	

There were delay union in (9.3%) of the group plate with screws while in the group of pediatric flexible nails was in (3.7%), ($p > 0.05$). In addition, we found in our current study malrotation in 2 (3.7%) of the group pediatric flexible nails and in 1 (1.9%) in the group plate & screw ($p > 0.05$). Bursa was found in the group with pediatric flexible nails with 7 (13%) and not found in the group plate with screws. The relation between the values was statistically significant ($p = 0.007$). Re-fracture was found in the group of plate with screws with 5 (9.3%) and not found in the flexible nails group. The relation between the values showed statistically significant ($p = 0.021$). Shortening of the affected limb was found only in 1 (1.9%) patient of the group with pediatric flexible nails and not found in the group the plate with screws group ($p > 0.05$). Additionally, superficial infection was high in the group plate with screws group 4 (7.4%) and less in the group pediatric flexible nails 3 (5.6%). The relationship between the values was insignificant ($p > 0.05$).

Table 3: Means of weight bearing and means of time of removing nails related to types of surgical procedure.

Variables	Types of surgical procedures	
	Flexible nails	Plate with screw
Mean of weight bearing (weeks)	4.0 ±0. 47	7.4 ±1.5
Relation between groups	0.000	
Mean time of removing nails (months)	6.82 ± 1.42	13.04 ± 6.75
Relation between groups	0.000	

Deep infection was found high among 3 (5.6%) of the group plate & screw ($p > 0.05$). Ul-Haq et al. [23] reported in their study that for length-stable fracture patterns, flexible nails are widely accepted to have high union rates compared to other operative techniques [24]. Nevertheless, the use of flexible nailing for length-unstable fracture patterns is still controversial. Flexible nailing for pediatric femoral shaft fractures has yielded predictably excellent union across the literature. Ligier et al. reported union in all 123 cases treated with this technique [25]. Flynn et al. [26] and Narayanan et al. [27] did not report union difficulties. Luo et al. [28] reported that open reduction with plate fixation was successful in treating diaphyseal fractures in children who have multiple injuries. A disadvantage of fixation with a plate is that a second operative procedure is needed in order to remove the plate. Infection, broken plates, and delayed union are not rare complications. Also, there is possibly more subsequent femoral overgrowth than occurs with other treatment methods [29]. Intramedullary nailing has been preferred over plating because of its better mechanical properties and lower incidence of associated infection. The use of intramedullary fixation, in general, is found to be more compatible with the natural healing process of periosteal callus formation, especially with closed intramedullary nailing that avoids periosteal stripping at the fracture site, thus sparing the periosteal blood supply [30]. As surgeons consider different methods to treat pediatric femur fractures and mobilize the injured child, the ideal mode of treatment remains controversial. Intramedullary elastic nails are popular for the management of length-stable femoral fractures in school-going children. Though plating is a treatment option for femoral fractures for ease of application and early mobilization, submuscular plating has recently been found to be a successful alternative for managing length-unstable femoral fractures in school-going children [31]. A study conducted in Nepal by Mani et al. [32] titled Pediatric Femoral Shaft Fractures Treated by Flexible Intramedullary Nailing reported that they found no cases of infection, breakage of the nails, delayed union, or nonunion in their study. Therefore, we can say that this procedure is relatively safe and lack of complications. As compared to elastic stable nails, flexible intramedullary nails can easily pass through the entry site, need no pre-bending of nails before insertion, and promote early callus formation because of the flexible nature of the nails and micromotion at the fracture site. El-Sayed [32] mentioned that flexible nail was introduced by the Nancy group in 1982 due to their better outcomes and ease of use with fewer complications. We found in our study that the mean weight bearing for the pediatric flexible nails group was 4.0 ± 0. 47 weeks, while the mean weight bearing of the plate with screws group was 7.4±1.5 weeks. The difference between means was statistically highly significant ($p = 0.000$). The mean time of removing nails in the pediatric flexible nail group was 6.82 ±1.42 months, while in the plate with screws group was 7.4 ±1.5 months. The difference between means was statistically highly significant ($p = 0.000$). The outcome was significantly higher in the plate with screws group compared with the pediatric flexible nail group for weight bearing (weeks) and time of removing nails (months). Ho et al. [24] reported in their study of treatment with operative flexible nails that the average time to full weight bearing was 10 weeks, and the time to return to the preoperative activity level averaged 4.9 months. The timing of nail removal after fracture union has not been uniform amongst previously published series, and there are no clear guidelines in the literature. Although early removal has led to occasional complications [26]. However, many authors have reported satisfactory outcomes even after the removal of nails as early as the beginning of the third postoperative month [25]. Overall, most authors have typically recommended nail removal after fracture healing at 6 months to 1 year following surgery [33].

Previous published studies reported that, plating of fractures of the femoral shaft provides anatomic reduction, stable fixation, maintenance of length, early mobilization without casting, and can be done to any size of femoral shaft but requires a large exposure, resulting in extensive soft tissue injury and stripping of the periosteum, which may result in overgrowth of the operative extremity, skin scarring, risks of plate breakage and stress fracture after plate removal [34, 35]. Flexible intramedullary nailing has increased in popularity in the United States in the 1990s and is now the most commonly used treatment method for fractures of the femur in school-aged children [36,37].

Conclusion

Compared between pediatric flexible nails and plate with screws for the treatment of femur fracture. We conclude that flexible intramedullary nail fixation of fracture shaft femur in children is a very acceptable way of treatment and is associated with minimal complications. Flexible nails have fracture union in all patients, delay union in 2 cases, no re-fracture, superficial infection in 3 cases, deep infection in 1 case, mean of weight bearing 4.0 ± 0. 47 weeks, and meantime of removing nails 6.82 ± 1.42 months. Therefore, pediatric flexible nails remain a viable option for the treatment of femur fractures in children.

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بحث علمي

مسمار مرن مقابل صفيحة لعلاج كسر واحد وثيق في عمود عظم الفخذ لدى الأطفال

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الملخص

الهدف من هذه الدراسة هو وصف نتائج مسمار مرن للأطفال مقابل صفيحة لعلاج كسر عظم الفخذ. قمنا بمراجعة السجلات الطبية لـ 28 طفل يعانون من كسور في عظم الفخذ والذين عولجوا بإدخال مساميرمرنة و 26 طفلًا عولجوا بتثبيت الصفيحة في الفترة من يناير 2017 إلى ديسمبر 2019. وكان متوسط عمر الأطفال 8.88 ± 1.86 سنة. تم الحصول على البيانات من ملفات المرضى. تم إجراء التحليل الإحصائي باستخدام اس بي اس اس الإصدار 22. وتم استخدام اختبار فيشر الدقيق واعتبر قيمة $p < 0.05$ ذو دلالة إحصائية . تم العثور على إلتحام العظام في جميع الأطفال الذين تم إجراء العمليات لهم 28 (51.9%) من مجموعة المسامير المرنة بينما لم يتم العثور على أي إلتحام في 3 (5.6%) من مجموعة الصفيحة ذات البراغي. تم العثور على اتحاد تأخيرالإلتحام في 5 (9.3٪) من مجموعة اللوحة ذات البراغي بينما في مجموعة المسامير المرنة كان في 2 (3.7٪). تم العثور على دوران في 2 (3.7٪) من المسامير المرنة وفي 1 (1.9٪) في اللوحة مع البراغي. تم العثور على الجراب فقط في المسامير المرنة بنسبة 7 (13%) (ع = 0.007). تم العثور على إعادة الكسر فقط في مجموعة الألواح ذات البراغي ذات 5 (9.3٪) (ع = 0.021). تم العثور على تقصير في الأطراف فقط في مريض واحد (1.9%) لديه أظافر مرنة. كانت العدوى السطحية مرتفعة في صفيحة المجموعة ذات البراغي المجموعة الرابعة (7.4%). تم العثور على عدوى عميقة عالية بين 3 (5.6٪) من لوحة المجموعة والمسمار.

نستنتج أن التثبيت المرن للمسامير داخل عظم الفخذ المكسورعند الأطفال هو وسيلة مقبولة جدًا للعلاج وترتبط بأقل قدر من المضاعفات.

مفاتيح البحث

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كلمات مفتاحية :

كسر عظم الفخذ،
طب الأطفال،
المسامير داخل العظم،
تثبيت الصفيحة ،
نتائج ما بعد الجراح