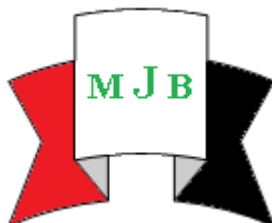


## Flexible Intramedullary Nails Versus Plaster Cast for Treating Femoral Shaft Fractures In Children: Comparative Study

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### **Abstract:**

Femoral fractures are common in children between (4) and (12) years of age, and (75%) of the lesions affect the femoral shaft. Treatment of femoral shaft fractures can be achieved either by traction followed by a plaster cast as conservative treatment or by surgical treatment. The objective of this study is to compare the results of treatment for femoral shaft fractures in children between ages of 4-12 years using intramedullary nails (titanium elastic nails, TEN) versus traction and plaster cast. Surgical treatment by TEN provides better clinical results in comparison with conservative treatment by traction and plaster cast.

### **الخلاصة:**

كسور الفخذ شائعة الحدوث عند الاطفال بين اعمار 4-12 سنوات. ٧٥% منها تصيب جسم عظم الفخذ. علاج مثل هذه الكسور يكون اما باجراء سحب جلدي للساق يعقبه تجبير الحوض والفخذ المكسور حتى القدم او اجراء العملية الجراحية. ان الهدف من هذه الدراسة هو مقارنة نتائج علاج ثلاثين مريضاً بواسطة السحب الجلدي والتجبير مع نتائج معالجة ثلاثين مريضاً بواسطة العملية الجراحية مستخدمين الوابرات المرنة. لقد تبين من خلال مقارنة النتائج بان العملية الجراحية تعطي أفضل النتائج.

### **Introduction:**

Femoral shaft fractures represent less than 2% of all orthopedic injuries in children[1]. Conservative treatment by skin traction followed by a plaster cast is universally accepted but this treatment produces undue physical and psychological stress for the patient and the family [2]. Surgical treatment by titanium elastic nails (TEN) have been used very successfully in children under the age of (12) years [3,4]. This study compares the results with conservative treatment and surgical treatment, in children of the same ages, regarding the duration of hospitalization,

lower limb length discrepancy and deformities and the time taken to achieve weight bearing and the return to daily activities and parent's satisfaction.

### **Aims of study:**

To compare treatments for femoral shaft fractures using TEN, versus traction and plaster casts in children between the ages of 4-12 years.

### **Methods:**

This prospective comparative study was conducted in a public Erbil teaching hospital and Zheen international private hospital,

covering the period between January (2007) and December (2012). In this study, (30) Patients with femoral shaft fractures had been treated using TEN and (30) patients with femoral shaft fractures had been treated using traction followed by a cast. All these patients are children with ages 4-12 years. All these patients had a period of follow up at least 24 months. Patients who presented diseases that could affect the normal anatomical and physiological characteristics of the skeleton, such as metabolic bone diseases, bone dysplasia or pathological fractures associated with neuromuscular disorders were excluded.

Regarding the patients treated with TEN, the fracture was transverse in (60.0%) of the cases and oblique in (26.7%) while those patient treated with traction and cast (36.7%) of the fractures were transverse and (40.0%) were oblique ( $P = 0.264$ ). The transverse and oblique fractures represented (81.7%) of all the fractures.

**Conservative treatment** Traction was applied to fractured limb followed by

application of plaster cast which was done at least (10) days after fracture occurrence (mean: 14 days). The cast was constructed on a children's orthopedic table, with the hips slightly flexed and abducted, with slight flexion of the knee and inclusion of the foot. X-ray screen was used for reduction control.

**Surgical treatment** the mean delay between injury and surgical fixation was (2) days. Associated injuries lengthened this period. The patients were placed on a radiolucent table in the supine position. The diameter of both nails was roughly (80%) of the respective medullary canal diameter (at the isthmus). The nails were introduced with the aid of an image intensifier, in a retrograde fashion, two centimeters proximally from the femoral distal growth plate {figure (1)}. No casts were used for complementary immobilization. Depending on the fracture characteristics and its reduction, early weight-bearing and joint movements were allowed, especially of the knee.



**Figure (1) showed the fixation with flexible wires**

In the subsequent evaluations, in addition to physical examination, radiographs of the affected limb in the anterior- posterior and lateral views were taken for all the patients.

All the patients were evaluated for duration of traction and hospitalization, time taken to heal, shortening, overgrowth, angular deformities (in degrees), weight bearing and return to daily activities {table (1)}.



**Figure (2) showed union of fracture**

Between six and eight months after fracture healing and remodeling{figure(2)}, the nails were removed surgically, in a single-day hospitalization period, and the children could walk freely thereafter. Children treated using casts had the cast removed

after consolidation, which took approximately two months to achieve. They were then allowed to bear weight partially two weeks later. Use of crutches was ended after fracture healing.

### **Results:**

The minimum length of follow-up was 24 months for the surgical patients (mean: 35.4 months) and (48) months for those treated using casts.

The mean duration of traction was (2) days for the surgical group and a mean of (14) days for the conservative group.

The mean duration of hospitalization was significantly different between the groups: (3) days for the surgically treated children and (15) days for the conservatively treated children (ANOVA;  $P < 0.001$ ). Most hospitalizations after surgical treatment were preplanned, in order to remove the nail. In the surgical group, one patient suffered soft-tissue irritation (the nail had to be removed early on). In the conservative group, four patients lost their reduction; because of poor family care of the cast resulted in loss of pelvic portion of the cast. These events required a second hospital admission.

The times taken for healing were also significantly different: (7.7) weeks for consolidation in the surgical group and (9.3) weeks in the conservative group (ANOVA;  $P = 0.005$ ).

The mean initial shortening, prior to treatment, was (2) cm, ranging from (0.5 to 4) cm for the entire group, from (0.5 to 4) cm in the conservative group and from (0.5 to 3.5) cm in the surgical group. Shortening, after a period of at least (24) months, occurred in (6.7%) of the patients in the surgical group and in (63.3%) of the patients in the conservative group (Pearson's chi-square test;  $P < 0.001$ ). In the surgical group, the mean shortening was (0.25) cm and in the conservative group the mean was (1.14) cm (ANOVA;  $P = 0.133$ ), with no significant difference between the means of the two groups.

There was overgrowth in (60.0%) of the patients in the surgical group and (13.3%) in the conservative group (Pearson's chi-square

test;  $P < 0.001$ ). The mean overgrowth was not statistically different (ANOVA;  $P = 0.072$ ) and was (0.66) cm (range: 0.25 to 1.50 cm) in the surgical group and (1.06) (range: 0.05 to 1.50 cm) in the conservative group.

Every patient presented some type of deformity. The average posterior angulation and various and valgus deformities did not exceed 10 degrees. The mean and standard deviation of the anterior angulation deformity was (6.5) degrees for patients' treated surgically and (12.1) degrees for the patients treated using traction and cast.

Partial loading was allowed after (3) weeks, on average, for the surgical group and after 10 weeks for the conservative group (Mann-Whitney;  $P < 0.001$ ). There was a relationship between increasing age and longer time taken for weight-bearing on the fractured limb to be allowed among the patients who were treated conservatively

(i.e. with casts). On the other hand, for those treated with TEN, the time taken for this remained relatively constant: for younger patients (4 to 8 years of age), the average was (2.8) weeks, and for those aged (9 to 12) years, 3.2 weeks (ANOVA;  $P = 0.000$ ). The average time taken for total weight-bearing to be allowed was (8.5) weeks for the patients treated with nails and (11) weeks for the patients treated with casts (ANOVA;  $P = 0.007$ ). None of the patients suffered a repeated fracture in either group.

The mean time taken for the patients to return to their activities was (3.7) weeks (ranging from two week to ten weeks) for the surgical group and (9.5) weeks (ranging from six weeks to 16 weeks) for the conservative group ( $P < 0.001$ ).

Complaints of patients' parents about the treatment were observed in(10%) of the patients treated with nails and in(35%) of the patients treated with cast.

**Table (1) Demographic and clinical data on the (60) children treated for femoral shaft fractures with cast or TEN (titanium elastic nails)**

|                                | cast         | TEN         |             |
|--------------------------------|--------------|-------------|-------------|
| Duration of traction           | 14 days      | 2 days      | $P < 0.001$ |
| Duration of hospitalization    | 15 days      | 3 days      | $P < 0.001$ |
| Time taken to heal             | 9.3 weeks    | 7.7 weeks   | $P = 0.005$ |
| Shortening: rate of occurrence | 63.3%        | 6.7%        | $P < 0.001$ |
| Shortening: mean               | 1.14 cm      | 0.25 cm     | $P = 0.133$ |
| Overgrowth: rate of occurrence | 13.3%        | 60%         | $P < 0.001$ |
| Overgrowth: mean               | 1.06 cm      | 0.66 cm     | $P = 0.072$ |
| Varus                          | 5.9 degrees  | 4.0 degrees | $P = 0.976$ |
| Valgus                         | 10.0 degrees | 6.7 degrees | $P = 0.094$ |
| Anterior angulation            | 12.1 degrees | 6.5 degrees | $P < 0.001$ |
| Posterior angulation           | 5.3 degrees  | 2.3 degrees | $P = 0.172$ |
| Partial weight-bearing         | 10 weeks     | 3 weeks     | $P < 0.001$ |
| Full weight-bearing            | 11 weeks     | 8.5 weeks   | $P = 0.007$ |

|                            |           |           |           |
|----------------------------|-----------|-----------|-----------|
| Return to daily activities | 9.5 weeks | 3.7 weeks | P < 0.001 |
| Complaints of the parents  | 35%       | 10%       | P<0.001   |

### Discussion:

Regarding the conservative treatment we use traction before applying the cast to minimize the possibility of significant limb shortening and bad alignment that can result from application of the cast immediately [5]. Limb discrepancies, angle deviations, compartment syndrome due to skin traction, psychological harm, longer hospitalization periods and consequent higher costs are attributed to conservative treatment [3,6]. To avoid or minimize these complications, surgical treatment can be used with TEN for femoral shaft fractures [7,8,9,10,11,12,13,14,15].

The time of traction and hospitalization is significantly different between conservative and surgical groups in our study as in the literatures; Newton and Mubarak [16] reported that their minimum hospitalization time prior to cast placement was (20.6) days for skin traction, (20.8) days for skeletal traction, (8.5) days for intramedullary nails and (2.5) days for early cast placement. Fabiano Prataet al. [17] presented significantly longer mean hospitalization times (20.5 days versus 9.4 days). Our patients were treated with conservative treatment presented mean hospitalization time (15) days and those with surgical treatment (3) days. It also should be taken into consideration that all cases treated surgically required another period of hospitalization in order to remove the nails. We chose to remove the nails six to eight months after their implantation, which is in accordance with reports from other authors, such as Flynn et al., [12], Buford et al., [18] and Prataet al., [17] at this time, the fracture presents very solid. In the conservative group, additional

hospitalizations were needed because of loss of positioning and reduction.

Ligieret al., [13] and Saseendaret al., [19] reported that elastic movements encourage callus formation. Stanset al., [20] reported that consolidation was faster using flexible nails than using cast. In our patients, the mean time taken for fracture consolidation to be achieved was 1.6 weeks shorter in the surgical cases than in the cases treated by cast which is near to the results of Prataet al., [17]). Some authors as Stanset al., [20], Reeves et al., [21] and Staheli and Sheridan [22] considered removing of the cast after eight weeks, as our study, while others like Czertak and Hennrikus [23] reported removing of the cast after six weeks.

The time taken to return to school among the patients treated with TEN, walking with the aid of crutches (i.e. partial loading), has ranged from two days to four weeks, and for full loading, from three to eleven weeks. [6,7,13,14,17,19,24]. Concerning weight-bearing and the return to normal activities in the present study, the surgical method allowed partial loading before consolidation and was earlier than with conservative treatment. This difference was highly significant (ANOVA;  $P < 0.001$ ). Partial and full weight-bearing were allowed, on average, after (3.5) and (8.8) weeks for the surgical group, and after (9.6 and 11.3) weeks for the conservative group, respectively. Therefore, there was a difference in partial load-bearing between the two methods, of approximately six weeks (ANOVA;  $P < 0.001$ ).

An agreement exists in the literature that the final shortening of the limb is produced by the initial shortening combined with the patient's potential for growth, which is greater in younger children. Cadman and

Neer [24] considered that a maximum of (3) cm of shortening was acceptable, Czertak and Hennrikus [23] considered that up to 2.5 cm was acceptable and Staheli [25] and Buehler *et al.*, [26] considered that up to (1.5) cm was acceptable. In present study, the method using traction and cast caused greater shortening (mean of 1.14 cm), occurring in (63.3%) of the patients in this group, in comparison with the surgical group, in which this occurred in only (6.7%) of the patients (mean of 0.25; Pearson's chi-square test,  $P < 0.001$ ). Despite the differences between the groups, these values were clinically very well tolerated (ANOVA = 0.133). As observed in the literature, [11,13,17] significantly greater overgrowth also occurred in our patients treated with TEN. This was present in (60.0%) of the cases, whereas it was only present in (13.3%) of the cases in the conservative group. However, even though the frequency of overgrowth was different between the groups, there was no statistically significant difference in the amount of overgrowth between the two methods used ( $P = 0.072$ ), with a mean of (0.66) cm for the surgical group and (1.06) cm for the conservative group. These results are compatible with what has been reported in the literature.[5, 11,12,13, 24,17, 27, 28].

All the patients in the present study presented some type of deformity. The means for the varus, valgus, posterior and rotational deviations were less than ten degrees with both methods. According to Flynn *et al.*, [12] angles of less than ten degrees are considered satisfactory; therefore, we can consider that the results from our patients are in conformity with the literature standards. We had high incidence of anterior angulation, with means of (6.5) degrees for the surgical group and (12.1) degrees for the conservative group.

## **Conclusion**

Children 4-12 years of age with femoral shaft fractures, treated using a flexible intramedullary nails, returned to daily activities and to school earlier, with shorter periods of traction and hospitalization and less limb shortening and a lower rate of loss of reduction, compared with those treated with traction followed by casts. Both methods showed few complications or problems relating to alignments.

## **References:**

1. Hinton R, Lincoln A, Crockett M (1999) Fractures of the femoral shaft in children. *J Bone Joint Surg Am* 81(4):500–509
2. Hughes BF, Sponseller PD, Thompson JD: Pediatric femur fractures: Effects of spica cast treatment on family and community. *J Pediatr Orthop* 1995;15:457-60.
3. Kirby RM, Winquist RA, Hansen ST Jr. (1981). Femoral shaft fractures in adolescents: a comparison between traction plus cast treatment and closed intramedullary nailing. *J Pediatr Orthop*.1(2):193-7.
4. Mann DC, Weddington J, Davenport K. (1986). Closed Ender nailing of femoral shaft fractures in adolescents. *J Pediatr Orthop*.;6(6):651-5.
5. Viljanto J, Linna MI, Kiviluoto H, Paananen M. (1975). Indications and results of operative treatment of femoral shaft fractures in children. *Acta Chir Scand*.141(5):366-9.
6. Timmerman LA, Rab GT. (1993). Intramedullary nailing of femoral shaft fractures in adolescents. *J Orthop Trauma*. 7(4):331-7.
7. Nascimento FP, Santili C, Akkari M, (2010). Short hospitalization period with elastic stable intramedullary nails in the treatment of femoral shaft fractures in school children. *J Child Orthop*. 4(1):53-60.

8. Templeton PA, Wright JG. (1998). Femoral shaft fractures: North American and European perspectives. *Current Orthopaedics*.;12(3):153-8.
9. Bopst L, Reinberg O, Lutz N. (2007). Femur fracture in preschool children: experience with flexible intramedullary nailing in 72 children. *J PediatrOrthop*.27(3):299-303.
10. Simanovsky N, Porat S, Simanovsky N, Eylon S. (2006). Close reduction and intramedullary flexible titanium nails fixation of femoral shaft fractures in children under 5 years of age. *J PediatrOrthop B*.15(4):293-7.
11. Heinrich SD, Drvaric DM, Darr K, MacEwen GD. (1994). The operative stabilization of pediatric diaphyseal femur fractures with flexible intramedullary nails: a prospective analysis. *J PediatrOrthop*.14(4):501-7.
12. Flynn JM, Hresko T, Reynolds RA. (2001). Titanium elastic nails for pediatric femur fractures: a multicenter study of early results with analysis of complications. *J PediatrOrthop*.21(1):4-8.
13. Ligier JN, Metaizeau JP, Prévot J, Lascombes P. (1988). Elastic stable intramedullary nailing of femoral shaft fractures in children. *J Bone Joint Surg Br*.70(1):74-7.
14. Vrsansky P, Bourdelat D, Al Faour A. (2000). Flexible stable intramedullary pinning technique in the treatment of pediatric fractures. *J PediatrOrthop*.20(1):23-7.
15. Huber RI, Keller HW, Huber PM, Rehm KE. (1996). Flexible intramedullary nailing as fracture treatment in children. *J PediatrOrthop*.16(5):602-5.
16. Newton PO, Mubarak SJ. (1994). Financial aspects of femoral shaft fracture treatment in children and adolescents. *J PediatrOrthop*.14(4):508-12.
17. FabianoPratadoNascimentoI, CláudioSantiliII, Miguel AkkariIII, Gilberto WaisbergIV, Susana dos Reis BragaV, Patrícia Maria Moraes de Barros FucsVI. (2011). Flexible intramedullary nails with traction versus plaster cast for treating femoral shaft fractures in children: comparative retrospective study. *Sao Paulo Med J*. 2013; 131(1):5-12
18. Buford D Jr, Christensen K, Weatherall P. (1998). Intramedullary nailing of femoral fractures in adolescents. *ClinOrthopRelat Res*.(350):85-9.
19. Saseendar S, Menon J, Patro DK. (2010). Treatment of femoral fractures in children: is titanium elastic nailing an improvement over hip spica casting? *J Child Orthop*.4(3):245-51.
20. Stans AA, Morrissy RT, Renwick SE. (1999). Femoral shaft fracture treatment in patients age 6 to 16 years. *J PediatrOrthop*.19(2):222-8.
21. Reeves RB, Ballard RI, Hughes JL. (1990). Internal fixation versus traction and casting of adolescent femoral shaft fractures. *J PediatrOrthop*.10(5):592-5.
22. Staheli LT, Sheridan GW. (1977). Early spica cast management of femoral shaft fractures in young children. A technique utilizing bilateral fixed skin traction. *ClinOrthopRelat Res*.(126):162-6.
23. Czertak DJ, Hennrikus WL. (1999). The treatment of pediatric femur fractures with early 90-90 spica casting. *J PediatrOrthop*.19(2):229-32.
24. Cadman EF, Neer CS 2nd. (1957). Treatment of fractures of the femoral shaft in children. *J Am Med Assoc*.163(8):634-7.
25. Staheli LT. (1967). Femoral and tibial growth following femoral shaft fracture in childhood. *ClinOrthopRelat Res*.55:159-63.
26. Buehler KC, Thompson JD, Sponseller PD, (1995). A prospective study of early spica casting outcomes in the treatment

- of femoral shaft fractures in children. J  
PediatrOrthop. 15(1):30-5.
27. Aronson J, Tursky EA. (1992). External  
fixation of femur fractures in children. J  
PediatrOrthop.12(2):157-63.
28. Kregor PJ, Song KM, Routt ML Jr.  
(1993). Plate fixation of femoral shaft  
fractures in multiply injured children. J  
Bone Joint Surg Am.75(12):1774-80.