

*Research Article***Treatment of subtrochanteric fracture in children: Titanium elastic nails versus plate and screws****Ahmed M. Othman***, **Khaled O. Thabet***, **Karem M. Zekry*** and **Ahmed A. Abdrabo****

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Abstract

The treatment of subtrochanteric femoral fracture in children between 4 and 12 years of age is challenging. The optimal choice of internal fixation for these patients is controversial. The purpose of this study is to compare the outcomes and complications of titanium elastic nail and open reduction with plate fixation of subtrochanteric femur fractures in school-aged children. A total of 40 children aged 4 to 14 years with subtrochanteric femur fractures were treated at our hospital from January 2018 to January 2020. We prospectively compared 20 children treated with titanium elastic nails with 20 children treated with open reduction and plate fixation. The data included age, sex, body weight, fracture pattern, operation time, blood loss, and length of hospitalization. The outcomes were classified according to Flynn classification as excellent, satisfactory, or poor. All the demographic characteristics were compared with statistical analyses. All 40 fractures united properly. No major postoperative complications were noted in both groups. No significant difference was found between the titanium elastic nail and open plating groups in terms of age, sex, fracture pattern, and length of hospitalization. We noted a significant difference between 2 groups in terms of operation time, hospital stay and blood loss. In total, we observed 11 excellent and 9 satisfactory results in the titanium elastic nail group, and 14 excellent results and 6 satisfactory results in the open plating group. Titanium elastic nail and pediatric hip plate fixation represent safe and effective methods in the treatment of subtrochanteric fractures in school-aged children.

Key words: subtrochanteric, fracture in children, titanium elastic nail**Introduction**

A subtrochanteric femur fracture in pediatrics is defined as a fracture that is located within 10% of the total femur length below the lesser trochanter. Fractures in this region account for 4-10% of pediatric femur fractures ⁽¹⁾. These fractures usually result from trauma and high energy injuries. Fractures in the subtrochanteric region, are at a higher risk for complications. Correct fracture reduction is more difficult to obtain or maintain because of their special anatomical position and deforming forces of the muscles in this region ⁽²⁾.

Patients and Methods

After obtaining local ethical committee approval and assignment of the informed consent form by at least one of the parents, this comparative analytic prospective study was carried in the Orthopedic and Traumatology surgery department at Minia University Hospital from January 2018 to January 2020.

School aged 40 patients were diagnosed with subtrochanteric fracture femur; and managed by operative reduction and fixation.

The patients were randomly divided into two groups according to method of reduction and fixation: Group (A): Fluoroscopic guided reduction fixation by TENs was done. Group (B): Open reduction fixation by plate and screws was done.

Exclusion criteria were femur fractures that were not in the subtrochanteric region or those treated with any method of fixation other than titanium elastic nails or open plating. Pathologic fractures, and fractures in patients with osteogenesis imperfecta, neuromuscular disorders, or any systemic disease that was a predisposition to fractures or affect fracture healing, such as metabolic bone disease. The techniques for retrograde TENs and open plating have been previously described.

The data collected included age, weight, sex, fracture pattern, method of fixation, post-operative immobilization, length of hospitalization, time to radiographic union, time to full weightbearing, duration of follow-up and any possible complications.

Fracture pattern was classified as length stable or length unstable. Length-stable fractures were transverse and short oblique. Length-unstable fractures were comminuted and long oblique, where the length of the obliquity was twice the diameter of the femoral shaft at that level.

Radiographic union was defined as bridging callus across at least 3 of the 4 cortices seen on anteroposterior and lateral radiographs of the femur.

The Titanium Elastic Nails Outcome Scoring system⁽³⁾ was used to classify the outcomes of fractures treated with both TENs and plating. Results was classified as excellent, satisfactory, or poor based on residual leg-length inequality, fracture malalignment, pain, complications, and unplanned surgery for the treatment of complications (Table 1).

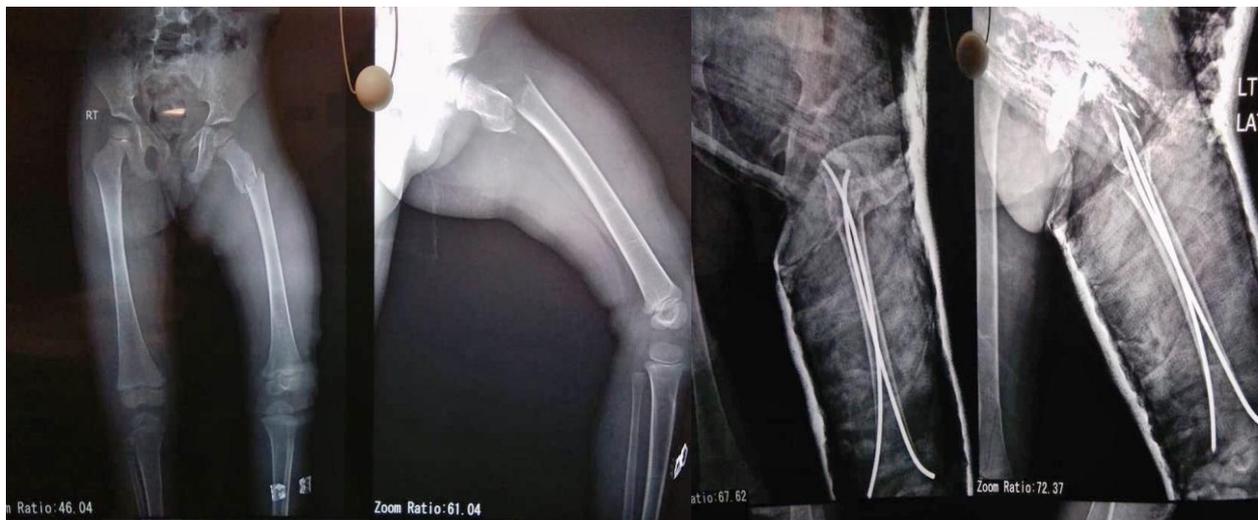
Table (1) Showing Titanium Elastic Nails Outcome Scoring System by Flynn et al.,⁽³⁾.

	Excellent results	Satisfactory results	Poor results
Malalignment	<5°	6-10°	>10°
Leg length inequality	<1 cm	1-2 cm	>2 cm
Pain	None	None	present
Complications	None	Minor and Resolved	Major complication and/or lasting morbidity

Statistical Analysis:

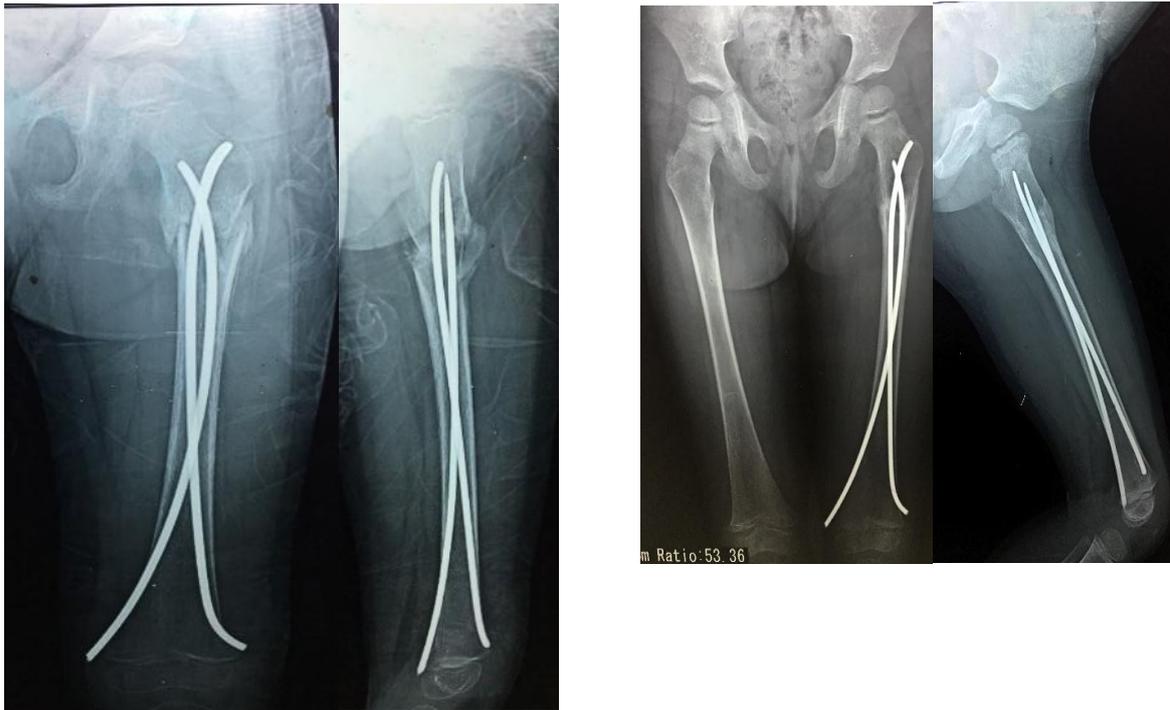
The statistical analysis was performed using IBM SPSS Statistics version 22. Continuous

(quantitative) variables were presented as mean ± standard deviation. Categorical (qualitative) variables were presented as percentages.



a= Preoperative

b= Immediate postoperative



c= 5 weeks postoperatively
d=6 months postoperatively
Fig. (1): case 1 plain x rays, a= Preoperative, b= Immediate postoperative, c= 5 weeks postoperatively, d=6 months postoperatively.

Results

No statistically significant difference between both groups in terms of age, sex, weight, side affected, mechanism of injury, fracture pattern, distance of fracture below lesser trochanter duration of postoperative immobilization and duration of follow up. However, there was a significant difference in time of operation, bleeding during the operation, length of hospital stay, number of cases used postoperative immobilization. (Table 1)

At the final follow-up, all patients were able to walk without limping and had full symmetric range of motion in the hip and knee joints with no difference to the uninvolved side in both groups.

According to the Flynn outcome scores, excellent results were demonstrated in 55% of patients in the TENs group and in 70% of patients in the plating group. Forty-five percent of patients in the TENs group and 30% of patients in the plating group had results as satisfactory. No poor results were observed in both groups.

The complication rate was 45% for TENs and 30% for plating. The most common complication in the TENs group was leg length discrepancy and malalignment (4 patients). Three patients with pain at insertion site. One patient was unable to fully extend his knee and was lost in follow up after referral to physiotherapy. Among the patients who had undergone open plating, 1 had superficial infection that that resolved with 7 days intravenous antibiotics and repeated dressing, therefore did not need any surgical debridement, 2 had malalignment <10 degrees and 2 had leg length discrepancy. No patient underwent unplanned surgery for complications in both groups.

Discussion

We prospectively compared TENs versus open plating for the treatment of subtrochanteric femur fractures in school-aged children. Forty patients were involved and randomly divided into two groups according to method of fixation, twenty patients in each group. Mean

age of patients was higher in group A than group B. However, this could not make a statistically significance. This does not go in line with some literatures such as Yunlan Xu et al.,⁽⁴⁾ who suggested plating for older children and TENs in younger cases. Males were most commonly affected in this age group, 65% of cases in all patients. Most of previous literatures about femur fractures found also male predominance.

Twenty cases were managed using TENs which is relatively fewer number when comparing to 50 cases in Patil and Abdul Azeem⁽⁵⁾ retrospective study. However, it is higher than other previous literatures discussing prospective studies such 10 cases in Barua et al., study⁽⁶⁾. Patil and Abdul Azeem⁽⁵⁾ recorded average follow up duration that was higher than the current study but their study was retrospective study. The current study has average follow up higher than other prospective studies such Barua et al.,⁽⁶⁾ study.

Leg length discrepancy was the commonest complications found in 20% of case and this goes in line with Patil and Abdul Azeem⁽⁵⁾, Parikh et al.,⁽⁷⁾ and Barua et al.,⁽⁶⁾. Unlike Alberghina et al.,⁽⁸⁾ who recorded no cases suffered such complication. No major complication that needed reoperation or unplanned removal of implants were recorded so no poor outcome according to Flynn outcome score. This goes in line with Pombo et al.,⁽⁹⁾, Barua et al.,⁽⁶⁾ and Alberghina et al.,⁽⁸⁾. Though, Patil and Abdul Azeem⁽⁵⁾ who reported 8% poor results. Also, Parikh et al.,⁽⁷⁾ found 6% of their results were poor results.

Patil and Abdul Azeem⁽⁵⁾ and Barua et al.,⁽⁶⁾ concluded in his study that Length unstable fracture have higher complication rate when treated with titanium elastic nails. In the contrary, the present and Rathjen et al.,⁽¹⁰⁾ studies suggested no difference in complication or overall outcome using TENs for length stable or unstable fracture patterns. Also, Parikh et al.,⁽⁷⁾ found that fracture pattern is not a risk factor for complication when comparing complicated versus uncomplicated cases. In a mechanical study on simulated bones, Lee et al.,⁽¹¹⁾ found axial stiffness in comminuted fractures to be equivalent to transverse fractures with retrograde flexible nailing.

El-Sayed et al.,⁽¹²⁾ recorded no deep infections but two patients (11.1%) had superficial wound infection. Many other reports documented no deep infection with plate fixation.^(4,13,14). However, Ziv et al.,⁽¹⁵⁾ reported three deep infections among five children with head injuries and with femoral shaft fractures treated by plating. Eren et al.,⁽¹⁶⁾ reported one case of osteomyelitis (2.1%) which occurred in a child with polytrauma. In our study, there was no post-operative deep infection but one patient had superficial infection that was controlled by antibiotics and proper wound care.

In our study patients were randomly divided between two groups so no statistically significant differences were noticed when comparing the demographic data, unlike Yunlan Xu et al.,⁽⁴⁾ who had significant difference between both groups regarding age and weight; patient who underwent plate fixation were older and heavier than TENs group. In contrast to Milligan et al.,⁽¹⁷⁾ patient who underwent plate fixation were younger than TENs group.

Radiographic union in the current study is almost similar to Li et al.,⁽¹⁴⁾. Secondary healing in TENs group was earlier than primary healing plating group in both studies. However, Milligan et al.,⁽¹⁷⁾ found that radiographic union was higher at 12-week review in the plate group. In the plate group, all patients had radiological union at 12 weeks, compared to 10/14 (71.4%) in the nailing group. This failed to reach significance ($p = 0.098$). El Sayed et al.,⁽¹²⁾ and chetia et al.,⁽¹³⁾ reported earlier average of union after using plates and screws; 8 weeks (range 6 to 12 weeks).

Li et al.,⁽¹⁴⁾ concluded that plate fixation of pediatric subtrochanteric femur fractures is associated with better outcome scores and a lower overall complication rate than titanium TENs. Time to radiographic union is comparable for titanium elastic nails and plating. We also found that TENs have higher complication rate 45% compared to 30% in plating group. However, most of these complications are not clinically significant and did not affect any normal activities of children.

Yunlan et al.,⁽⁴⁾ found that both TENs and plates stabilization can result in good functional outcomes according to the score by Flynn. The

rate of “excellent” and “good” results is similar in both groups. The ROM of hip and NSA of the affected limb were almost the same as those of the unaffected side. Demographic data suggested that TEN was more suitable for children with younger age and lower body weight, and TEN had more advantages with less blood loss and operation time. On the contrary, patients with older age and heavier weight may benefit from open plate fixation. However, our results suggested that patients were randomly divided between groups and no major differences were found regarding complications and overall outcome.

It is prospective study not like most of comparative study which were retrospective. Also, Comparative head to head study between two groups to which samples were Randomly divided. Cases were operated by many surgeons not a single one. Relatively few numbers of cases were included in our study. Furthermore, short duration of follow up and data of implant removal not included. uncooperating of many patients who refused to attend their post-operative follow up appointments after return to full activity without pain nor motion limitation. Also, using titanium outcome scoring system to evaluate plating results and absence of score measuring outcome of plates in fixation of femur fractures are thought to be of this study limitations.

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