INTERNATIONAL JOURNAL OF CURRENT MEDICAL AND PHARMACEUTICAL RESEARCH

IJCMPR

Available Online at http://www.journalcmpr.com

RESEARCH ARTICLE

A STUDY OF FUNCTIONAL OUTCOME OF TITANIUM ELASTIC NAILING IN PAEDIATRIC FEMORAL DIAPHYSEAL FRACTURES

Magesh Babu Palanisamy ., Kanthimathi Balasubramanian ., Santhosh Kumar and Manikanda Rajan.A

Division of Orthopaedics, Rajah Muthiah Medical college Hospital, Chidambaram, Tamilnadu, India

ARTICLE INFO

Article History:

Received 11th July, 2016
Received in revised form 8thAugust, 2016 Accepted 6th September, 2016
Published online 26th October, 2016

Key words:

Paediatric, Femoral fractures, Titanium elastic nails, Intra medullary elastic nailing

ABSTRACT

***Background*:** Femoral diaphyseal fractures are the most common major orthopaedic injury and the most common orthopaedic injury in paediatric age group requiring hospitalisation. Over the past two decades advantages of operative fixation and early mobilisation for paediatric femoral diaphyseal fractures have been increasingly recognised. Titanium elastic nailing has emerged as the treatment of choice in treating paediatric femoral diaphyseal fractures. Our study aims at the analysis of functional outcome of TENS nailing in paediatric femoral diaphyseal fractures.

***Materials And Methods*:** A prospective study was conducted on twenty patients between the age of 3 to 15 years of either sex with closed shaft of femur fractures, admitted to Rajah Muthiah Medical College and Hospital, Chidambaram, Tamilnadu, over a period of two years (from July 2014 to October 2016).Two of the patients had poly-trauma. All of them were treated by retrograde flexible intramedullary nailing using two TENS nails. The results were analysed regarding the functional outcome of this treatment modality.

***Results*:** The mean age of the patients were 10 years. Patient follow up was in the range of minimum of 6 months to maximum of 24 months. Radiological union in all cases were achieved in a mean time of 8.4 weeks and full weight bearing were achieved in a mean time of 8.8 weeks. The results were excellent in 19 patients and satisfactory in 1 patient. All had early return to school.

***Conclusion*:** Titanium Elastic nailing in is an effective method of treatment in treating paediatric femoral diaphyseal fractures.

INTRODUCTION

Fractures of the femur are the most incapacitating fractures in children. They account for approximately 2% of all bony injuries in children[1]. Fractures of the femoral shaft in children have been traditionally treated by immobilization in a spica cast, either immediately or after a period of traction. Surgical treatment is limited to open fracture or patient with head injury or multiple injuries[2].

Conservative treatment necessitates a long stay in hospital for traction and subsequent immobilization in an uncomfortable cast. This treatment is not well tolerated specially in adolescence. Moreover, near the end of growth, accurate reduction is necessary as malunion is no longer correctable by bony maturation [3].

Operative treatment results in shorter hospitalization, early mobilization and early return to school, which has psychological, social, educational and economical advantages over conservative treatment.

MATERIALS AND METHODS

This is a prospective study conducted during the period July 2014 to October 2016. This study included 20 patients of both sexes and age group between 3 and 15 years, admitted in the orthopaedic wards with fractures of the shaft of femur. The cases were followed up for a minimum of 6 months period and maximum of 18 months period. Cases having sustained multiple system trauma were also included in the study. Children <3 years and >15 years of age, with femoral metaphyseal fractures, a metabolic bone disorder or pathological fractures were excluded from the study. The youngest patient was 3 years old and the eldest was 15 years old with an average age of 910 years. The male: female ratio was 3:1. Road traffic accident was the most common cause of injury, accounting for 45% (9) of the cases. Associated injuries were found in 10% (2) cases. The left sided fractures occurred in lesser frequency than right sided with 65% (13) of them right sided. The most common site of fracture was middle third (55%). Majority of the fractures were transverse type. Duration

of time lag between the time of injury and definitive management ranged from 3 to 16 days, the average being 4.1 days. In all the cases, skin traction was applied as a preoperative traction.

TENS available in standard length of 440 mm, were used. The diameter of the nail (range 2.0 mm - 4.0 mm) to be used was determined on the basis of the size of medullary canal of the femur of the particular patient. To determine the size of the titanium nails to be used, femoral diaphyseal internal diameter was measured on both antero-posterior and lateral roentgenograms and was divided by 2 and 0.5 mm was subtracted from that calculation for the eventual nail diameter as determined by Kasser and Beaty[1].

Operative technique

Position of the patient is supine in a free position or on a fracture table with a traction boot. If a fracture reduction can be accomplished by manual traction, a standard table may be used. The fracture is reduced under image intensifier. If closed reduction is not possible, then open reduction is done. The entry point of the nail is 2.5 cm - 3.0 cm proximal to the physis. We generally use an awl to penetrate the near cortex. Care was taken to ensure that the entry point is in the middle of the width of the presenting cortex. With too anterior or posterior entry points the direction of the nail insertion is altered. An anterior entry point can cause inadvertent penetration of the knee joint. Vertically insert the awl down to the bone and then lower the awl to an angle of 45 degrees in relation to the shaft axis and continue perforating the cortical bone at an upward angle. The opening should be slightly larger than the selected nail diameter.

The selected nail is contoured with a long gentle bend such that the apex of the convexity tends to lie at the level of the fracture. The nail tip was also bent to facilitate placement and also to allow the nail to bounce off the opposite cortex at the time of insertion. This also facilitated the spreading of the nail ends in proximal femoral metaphysis. The nail was manually pushed with the help of a T-insertion handle until resistance was met and then gently hammered with the curve tip sliding on the inner cortex, until the fracture site was reached. Then, the medial incision was given and the second nail was inserted in a similar retrograde manner, up to the fracture site. The fracture was reduced by manipulation and traction under image intensifier control. In 3 fractures (33%), open reduction was required, mainly because of failure of closed reduction. The two nails were then driven into the proximal end of the femur. The tip of the nail that entered from the lateral femoral cortex came to rest just distal to trochanteric apophysis. The opposite nail was made to lie at the same level but pointing towards the calcar region of femoral neck. If the contouring of the nails has been accurate, they will come to rest with their maximum separation at the level of the fracture, crossing in the medulla above and below this site. This so-called trifocal buttressing of each nail within the medullary cavity will impart the maximum stability to the fixation. Distally the nail was cut so that 1 cm of nail remains outside the cortex. The extraosseous portion of the nail was bent slightly away from the bone for easy removal after fracture union. Too much bending was avoided to prevent the formation of painful bursa over nail ends. After discharge, patients were called for follow-up after every 2 weeks up to two months and subsequently at monthly intervals. Patients were assessed clinically and radiologically at each follow-up.

CASE 1 X-Ray Images of 14 Year Old Boy with Femoral Diaphyseal Fracture

PREOPERATIVE

IMMEDIATE POST OPERATIVE

7 MONTHS POST OPERATIVE

CLINICAL PICTURE OF THE BOY 7 MONTHS POST OPERATIVE

Time of weight bearing was individualized depending on comminution, stability of reduction and rigidity of fixation. The final results were evaluated using criteria by Flynn *et al*.[4]

RESULTS

Mean duration of surgery was 54 minutes with a range of 35-150 minutes, and median hospital stay was 10.2 days with a range of 7-31 days. The hospital stay was dictated by adequacy of fixation, type of reduction and associated injury where 2 cases of polytrauma has to stay longer. In majority of the cases (85%), no postoperative immobilization was used. In 2 cases, derotation splint was used and in one case (5%) an above knee Plaster of paris slab was applied. Bridging callus was first noted on follow-up radiograph at an average of 4.5 weeks. The union of fracture was assessed by standard radiological and clinical criteria. Absence of pain on walking was the clinical indicator of union. Majority of the patients (16) achieved union by 8 weeks with average time to union being 8.4 weeks and at this time full weight bearing was started which averaged around 8.8 weeks. Majority of the patients (16) achieved full range of knee motion by 8 weeks.

Three cases had terminal restriction of knee flexion (20°-30°), which improved after physiotherapy and exercises.

Table 1 The Scoring Criteria for Tens Flynn et al scoring

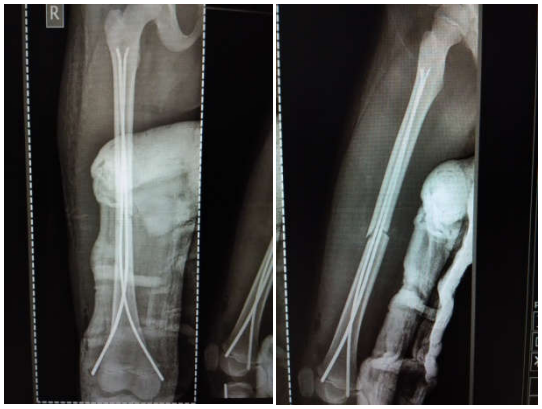
	Excellent	Successful	Poor
Limb length Discrepancy	< 1.0cm	< 2cm	> 2cm
Sequence disorder	5°	10°	>10°
Pain	Absent	Absent	Present
			Major Complication or increased morbidity

Only one patient who had associated ipsilateral medial condyle fracture of femur had knee flexion upto $90^{0.}$ No case of angulation, delayed union and non-union were seen. No patient had superficial or deep infections. Results were evaluated using Flynn *et al* scoring criteria and was seen excellent in 19 (95 %) cases, while it was satisfactory in 1 (5%) cases. No patient had poor result.

The most common complication encountered was soft tissue irritation at the nail entry site seen in 2 cases. Clinically, lengthening of 5 mm was noticed in 1 (5%) case, while 1(5%) patient had shortening of 7 mm.

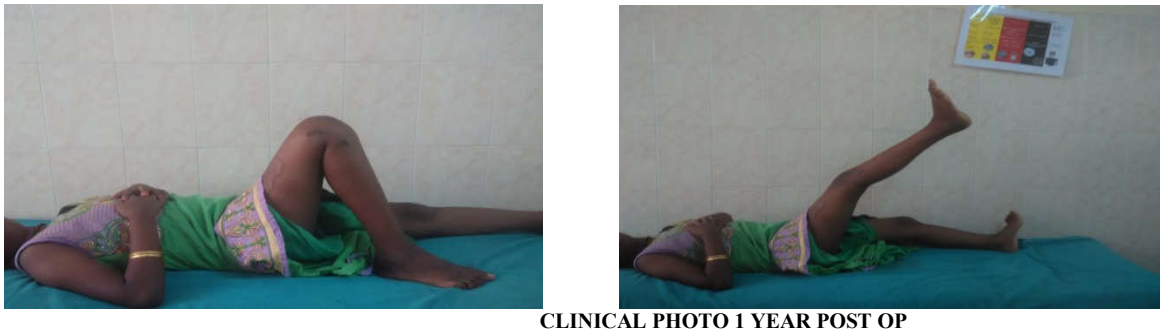
CASE 2 11 Year Old Girl With Floating Knee

PRE OP X-RAY IMAGES



IMMEDIATE POST OP

1 YEAR POST OP



CLINICAL PHOTO 1 YEAR POST OP

DISCUSSION

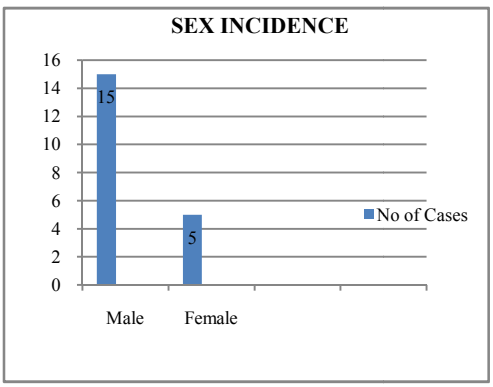
Although femoral shaft fractures constitute fewer than 2% of all paediatric fractures, the choice of treatment has remained a constant challenge. Until recently, skeletal traction and application of a Plaster of Paris cast were the preferred method for treatment of diaphyseal femoral fractures in children and young adolescents[5]. This method stands the test of time because it is conservative and complications impairing future function are rare. However, orthopaedists have tried a variety of methods to avoid prolonged immobilization and provide better nursing care. Recent studies have also increased our awareness of the psychosocial and economic effects of spica cast immobilization on children and their families[6,7].

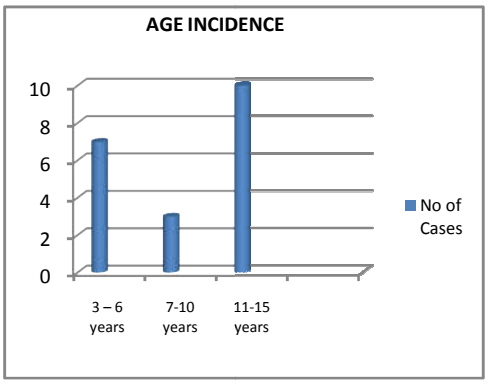
A variety of therapeutic alternatives such as external fixator, compression plating, rigid intramedullary nailing and flexible intramedullary nailing are being used for femoral shaft fractures in children. In recent years, perhaps the best results have been achieved by flexible intramedullary nailing.

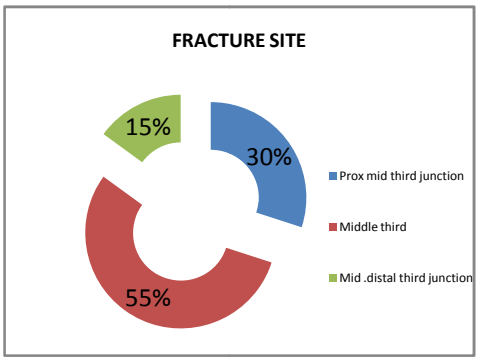
Titanium elastic nail with its newer design and better material seems advantageous over other surgical methods particularly in this age group because it is a load sharing internal splint that does not violate open physes, allows early mobilization and maintains alignment. Micromotion conferred by the elasticity of the fixation promotes faster external bridging callus formation. The periosteum is not disturbed and being a closed procedure in most cases, there is no disturbance of the fracture hematoma, thereby early union.

In this series, the average duration of surgery was 54 minutes, which was almost similar to the study conducted by Salem *et al* [8] (45 minutes) and Heybeli *et al* [9] (55 minutes) and it was lesser than the study conducted by Saikia *et al* [10] (70 minutes) and Mann *et al* [11] (94 minutes).The most important factor, which impacts on the time is the experience level associated with the technique used and in some cases, failure of closed reduction resulting in open reduction.

Median hospital stay in our study was 11 days and the average hospitalization time was 10.2 days. This was much higher than reported in the study by Ann Ho *et al* [12] (5.3 days) and Heybeli *et al* [9] (5.5 days). However, the results were similar to other studies conducted in Indian setup by Saikia *et al* [10] (9.8 days). Herndon *et al* [13] showed that the hospital stay in the non-surgical group averaged 28 days and in the surgical group averaged 17 days, which was significant. Flynn *et al* [4] reported that compared with children treated with traction and cast, those treated with titanium elastic nails had shorter hospitalization, walked with support sooner, walked independently sooner and returned to school earlier.





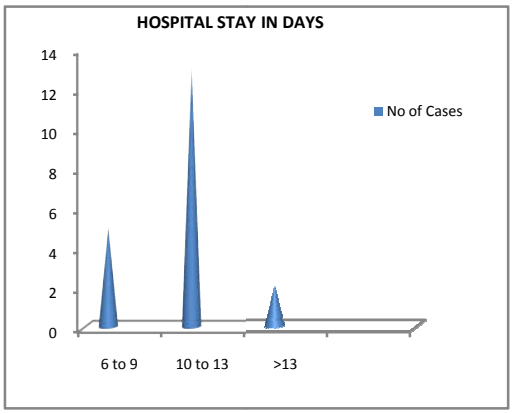


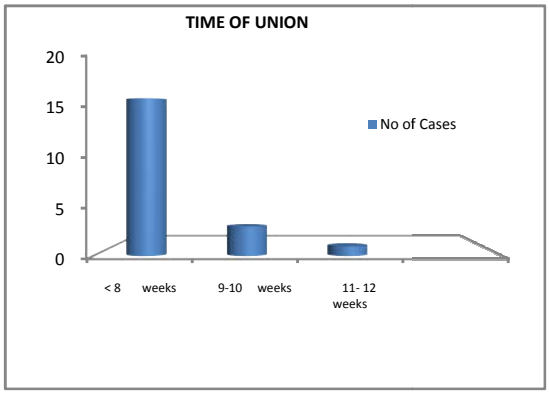
Postoperative immobilization was used only in 3 cases in which derotation splint was used to provide rotational stability for 2 patients and above knee plaster used for 1 patient .The decision regarding the need for and type of external stabilization is based on surgeon preference rather than on strict protocol.

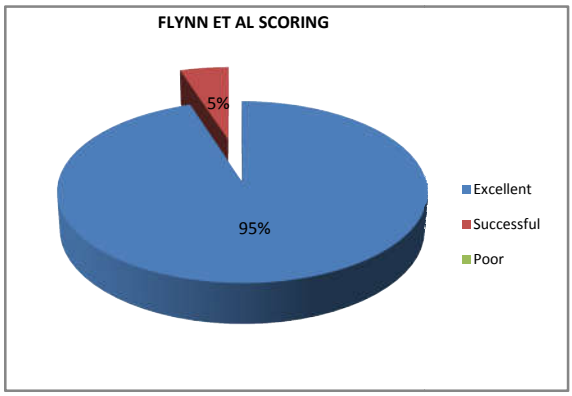
In the present study, bridging callus was first noted on follow-up radiographs at an average of 4.5 weeks. This is similar to the study conducted by Flynn *et al* [4] (4 weeks) but greater than the study conducted by Cramer *et al* [14] (3 weeks).

Partial and full weight bearing in the present study averaged 8 weeks and 9 weeks respectively. These are comparable to other studies [4,9,15]. Earlier mobilization resulted in benefits like shorter hospital stay, less school days loss, less joint stiffness and muscle atrophy.

Normal weight bearing was permitted only after achieving clinical and radiological union, which was around 8.6 weeks on an average. As reported by Flynn *et al* [4], Cramer *et al* [14], Mann *et al* [15] and Galpin *et al* [16], in our study too there was no case of delayed and nonunion.







Return to school averaged 10 weeks in the present series causing less disturbance in the continuation of studies of the patients. In the series of 15 children observed by Griesberg *et al* [17] school absence averaged 120 days for patients in the casts while for ESIN group it was only 29 days. Flynn *et al* [4] reported that compared with children treated with traction and cast, those treated with TENs had shorter hospitalization, walked with support sooner, walked independently sooner, and returned to school earlier.

All patients were taught a home exercise program which included a range of motion exercises, hip abductor and knee extensor strengthening exercises during the postoperative period. In our study, majority of the patients (75%) achieved full range of knee motion by 8 weeks. Fifteen percent cases had terminal restriction of knee motion (20°-30°), which improved after physiotherapy and exercises. Only one patient who had associated ipsilateral medial condyle fracture of femur had knee flexion of only upto 90 ^{0} .Similar findings were noted in the study conducted by Bar-On *et al* [2] and Cramer *et al* [14].

In our study, lengthening was seen in 1 case. Ann Ho *et al* [12] found that as the follow-up of patients increased, the number of cases of lengthening decreased (10 cases at 12 months and 3 cases at 18 months). So, longer periods of follow-up would be ideal before the precise final difference in the lower extremity lengths of each patient can be determined.

Malalignment was seen in none of the patients. Herndon *et al* [13] reported malunion in 7 of 24 patients who were treated with traction while no malunion was observed in 21 children who were treated using intramedullary nailing. It is believed that using nails of same thickness and pre-bending them minimises chance of malalignment.

Soft tissue irritation at the entry portal due to prominent nail ends was reported in 2 cases in our study. Review of the cases showed that the nails were left too long and excessively bent. These cases were in the initial phase of the study. In subsequent cases proper insertion sites and advancement of the nails was done so that they lie against the supracondylar flare of the femur. Similar result is reported in the study conducted by Ligier *et al* [18] (10.5%), and Flynn *et al* [4] (6.8%). Luhmann *et al* [19] indicated that the technical problems can be minimized if the part of the nail that is outside the femur is smaller than 2.5 cm and the biggest diameter of the nail is used. The nail ends are cut straight rather than bending them to avoid symptoms at the insertion site.

Migration of the nails was not seen in the present study. This is probably because titanium elastic nailing technique requires balancing the forces of two opposing flexible implants. On the contrary, Ender nails which work on the principle of stacking the medullary canal tend to migrate.

There was neither superficial infection at the entry site nor deep seated infection in any of the cases. This may be attributed to the fact that titanium elastic nailing requires only small incisions and lesser operative time. Similar results, regarding infection were observed by Herndon *et al* [13].

Perioperative difficulties encountered in our study were failure of closed reduction in 3 cases, mainly because they were operated late (after one week of injury) in two cases and soft tissue interposition in one case. It is thus recommended that proper traction must be applied if operative procedure is likely to be delayed. Excessive rotation of the nail during difficult negotiation of the fracture site resulted in winding of the nail around the other. This “cork screw phenomenon” was seen in one case during the operative procedure. The nail was then removed and replaced with another correctly.

Most of the complication associated with this technique are in fact features of inaccurate technique and can be eliminated by strictly adhering to the basic principles and technical aspects.
Nail removal was done in only nine cases. It was done under anaesthesia after 9-18 month post operatively. Theoretically, it is possible to remove nails 3 months after surgery and in the literature nails have been removed as early as 6 weeks [20]. There are always chances of refracture with early removals and delayed nail removal may be the factor responsible for no refracture in the present study.

This study has several limitations. Factors such as weight and body mass index were not taken into account. There may be a threshold weight and size for the use of titanium flexible nails in adolescents. In a study by Moroz *et al* [21], they found children weighing more than 49 kg were 5 times more likely to have a poor outcome than those weighing less. Accurate measurement of time to union, time to partial and full weight bearing and time of bridging callus is influenced by the frequency of follow-up, which in our study was at the interval of 2 weeks initially for 2 months followed by subsequent visits at 12 weeks, 24 weeks and 1 year.

CONCLUSION

Titanium elastic nails are relatively easy to use with a short learning curve, minimally invasive, physeal-protective implant system done as a closed procedure with less risk of exposure to infections, non union and with higher rate of good and excellent outcomes in children of the age group of 3-15 years. The considerably decreased hospitalization time has resulted in the decrease in the hospital bed occupancy, early return of

patients to their home environment and early return to school, thus cutting the cost of treatment and have psychosocial advantages. It is also a cost effective treatment modality, as the parents can get back to their work earlier. From our study we conclude that Titanium elastic nailing is an effective method of treatment in treating Paediatric femoral diaphyseal fractures.

References

1. Kasser JR, Beaty JH. Femoral shaft fractures. In: Beaty JH, Kasser JR, ed. Rockwood and Wilkins fractures in children. 6th ed. New York: Lippincott Williams and Wilkins, 2006:893.
2. Bar-On E, Sagiv S, Porat S. External fixation or flexible intramedullary nailing for femoral shaft fracture in children. *J Bone Joint Surg Br* 1997;79(6):975-8.
3. Metaizeau JP. Stable elastic intramedullary nailing for fractures of the femur in children. *J Bone Joint Surg Br* 2004;86(7): 954-7.
4. Flynn JM, Hresko T, Reynolds RA, *et al*. Titanium elastic nails for paediatric femur fractures: a multicenter study of early results with analysis of complications. *J Paed Orthop* 2001; 21(1):4-8.
5. Flynn JM, Skaggs DL, Sponseller PD, *et al*. The surgical management of paediatric fractures of the lower extremity. Instr Course Lect 2003;52:647-59.
6. Reeves RB, Ballard RI, Hughes JL. Internal fixation versus traction and casting of adolescent femoral shaft fractures. *J Paediatr Orthop* 1990;10(5):592-5.
7. Hughes BF, Sponseller PD, Thompson JD. Paediatric femur fractures: effect of spica cast treatment on family and community. *J Paediatr Orthop* 1995;15(4):457-60.
8. Salem KH, Lindemann I, Keppler P. Flexible intramedullary nailing in paediatric lower limb fractures. *J Paediatr Orthop* 2006;26(4):505-9.
9. Heybeli M, Muratli HH, Celebi L, *et al*. The results of intramedullary fixation with titanium elastic nails in children with femoral fractures. Acta Orthop Traumatol Turc 2004;38(3):178-87.
10. Saikia KC, Bhuyan SK, Bhattacharya TD, *et al*. Titanium elastic nailing in femoral diaphyseal fractures of children in 6-16 years of age. *Indian J Orthop* 2007;41(4):381-5
11. Mann DC, Weddington J, Davenport K. Closed Ender nailing of femoral shaft fractures in adolescents. *J Paediatr Orthop* 1986;6(6):651-5.
12. Ann Ho C, Skaggs DL, Tang CW, *et al*. Use of flexible intramedullary nails in paediatric femur fractures. *J Paediatr Orthop* 2006;26(4):497-504.
13. Herndon WA, Mahnken RF, Yngve DA, *et al*. Management of femoral shaft fractures in the adolescent. J Paediatr Orthop 1989;9(1):29-32.
14. Cramer KE, Tornetta P 3rd, Spero CR, *et al*. Ender rod fixation of femoral shaft fractures in children. Clin Orthop Relat Res 2000;(376):119-23.
15. Mazda K, Khairouni A, Pennecot GF, *et al*. Closed flexible intramedullary nailing of the femoral shaft fractures in children. *J Paediatr Orthop B* 1997;6(3):198-202.
16. Galpin RD, Willis RB, Sabano N. Intramedullary nailing of paediatric femoral fractures. *J Paediar Orthop* 1994;14(2): 184-9.
17. Greisberg J, Bliss MJ, Eberson CP, *et al*. Social and economic benefits of flexible intramedullary nails in the treatment of pediatric femoral shaft fractures. Orthopaedics. 2002; 25(10): 1067-70.
18. Luhmann SJ, Schootman M, Schoenecker PL, *et al*. Complications of titanium elastic nails for paediatric femoral shaft fractures. *J Paediatr Orthop* 2003;23(4):443-7.
19. Ligier JN, Metaizeau JP, Prevot J, *et al*. Elastic stable intramedullary nailing of femoral shaft fractures in children. *J Bone Joint Surg Br* 1988;70(1):74-7.
20. Houshian S, Gothgen CB, Pedersen NW, *et al*. Femoral shaft fractures in children: elastic stable intramedullary nailing in 31 cases. Acta Orthop Scand 2004;75(3):249-51.
21. Moroz LA, Launay F, Kocher MS, *et al*. Titanium elastic nailing of fractures of the femur in children. Predictors of complications and poor outcome. *J Bone Joint Surg Br 2*.