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Study of Titanium Elastic Nailing for Fracture Shaft Femur in Children between 3 to 13 Years of Age

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Abstract: ***Treatment of Displaced diaphyseal femoral shaft fracture in children between 3 to 13 years is controversial. Various methods are available for treatment. Titanium elastic nailing is one of the methods for treatment of femur shaft fracture in children. In our study we have assessed the outcome of titanium elastic nailing for fracture shaft femur in children. We have found that titanium elastic nailing has excellent results in treatment of femur shaft fracture in children. Also it is less time consuming.***

Keywords: Elastic titanium nailing, intramedullary nail, pediatric femoral fractures.

1. Introduction

Femoral shaft fractures account for 1.6% of all paediatric bony injuries. Spica casting remains the most popular accepted method for treatment of femoral shaft fractures in infants and toddlers.[2] Treatment of paediatric and adolescent (age 3 to 13 years) femur fractures remains controversial. Opinion differs widely for treatment of children who are too old for early spica casting and yet too young for adult type of treatment with a reamed rod.

Treatment options include early spica casting, traction, external fixation, open reduction and internal fixation with plating, flexible intramedullary nails and reamed intramedullary rods.[3]

In children fractures of the femoral shaft are commonly treated by various types of traction for about 3 weeks, followed by spica cast immobilization. The two major drawbacks with this treatment are prolonged bed rest and delayed mobilisation leading to separation of the child from routine activities.[4]

2. Literature Survey

Time and experience of many clinicians have shown that children with diaphyseal femur fracture do not always recover with conservative treatment because of the complications like angulations; malrotation and shortening are not always corrected effectively. The management of paediatric femoral shaft fractures gradually has evolved towards a more operative approach in the past decade. This is because of a more rapid recovery and re-integration of the patients. Shorter hospitalization, early mobilisation and early return to activity are other benefits.

There is less disruption of family life with operative treatment.[6] Plating of femoral shaft fracture in children offers rigid fixation, it requires a larger exposure with the potential for increased blood loss, soft tissue injury, periosteal stripping and scarring. It is a load bearing device and re-fracture is a risk. Antegrade nailing techniques have shown a risk of proximal femoral deformities owing to damage to epiphysis and avascular necrosis of the femoral head.[7][8]

Percutaneous elastic internal fixation of femoral shaft fracture in children in the form of flexible intra medullary nailing provides a healthy environment for fracture healing with some motion leading to increased callus formation.[9] It is simple, effective and minimally invasive. It allows stable fixation, rapid healing, decreased hospital stay, early ambulation and a prompt return of the child to normal activity. There is less disruption of family life and has better psycho socioeconomic outcomes. Functional results are excellent and complications are minor.[7]

3. Methodology

In this study 60 patients, aged 3 to 13 years, with fracture shaft of the femur were treated with percutaneous retrograde flexible intramedullary (titanium elastic) nailing at in the period from December 2012 to October 2014.

As soon as the patient was brought to casually, patient's airway, breathing and circulation were assessed. Then a complete survey was carried out to rule out other significant injuries. Plain radiographs of antero-posterior and lateral views of the femur were taken including both hip and knee joints. Diagnostic radiographs must be of sufficient quality. Radiograph of whole length of femur with knee and hip joints is mandatory in all patients to avoid missing of associated fractures of the trochanter and neck of femur.

Routine investigations were done for all children. Patients were operated as early as possible once the general condition of the patient was stable and patient was fit for surgery. In patient medical records, outpatient clinic notes, and radiographs were reviewed for all patients. Data collected of each patient were demographics, surgery/injury date, diagnosis, mechanism of injury, associated injuries, fracture location, fracture pattern, degree of communition, and additional surgical procedures.

Postoperative data collected were active immobilization, duration of non-weight-bearing, length of stay in hospital, range of motion (hip, knee, and ankle), limb alignment, limb length discrepancies, signs of irritation at nail insertion site, and major complications (non-union, delayed union, re-fracture).Limb length discrepancies were evaluated clinically in skin traction.

All the patients were followed until fracture union occurred. The follow up period ranged from 6 months to 1 year. Results were analyzed both clinically and radiologically.

4. Results & Discussions

Majority of the patients i.e. 31 (52%) were in the age group of 3-6 years, followed by 20 (33%) patients in 7 to 10 years age group and 9(15%) in age group between 11 to 13 years. The youngest patients were 3 years old and oldest patient was 13 year. 34 patients were males and 26 patients were females. Left femur was involved in 28 (47%) patients and right femur in 31 (52%) patients. 1 patients had bilateral femur fracture. The major causes of fracture in our study were Road traffic accidents in 33 (55%) patients and fall in 24 (40%) patients. Fall from height accounted for only 3 cases. In the present series 41 (68%) cases had fracture at middle fractures, 15 (25%) were proximal 1/3 fracture and 9 (15%) were at distal 1/3 fractures. In the present series 30 (50%) were transverse fractures, 15 (25%) were spiral fracture and 15 (25%) were oblique fractures.

The average time interval between trauma, and surgery was 4.04 days with avg. time taken for surgery was 45 minutes. Patients with Head injury, blunt chest trauma, blunt abdomen trauma and ipsilateral tibia fracture stayed for longer duration otherwise avg. duration of stay was 3 days. Only 2 cases required open reduction. Others were reduced by closed method.
Major complication occurred in very few patients. Most of the complications that occurred were minor.14 patients had pain at fracture site. Limb length discrepancies which were minor occurred in 4 patients.only patient had mal-allingnment which remodeled later. Infection occurred in only 2 patients. 40 patients had excellent outcome, rest 20 had satisfactory outcome. None of the patients had poor outcomes.

The treatment of femoral shaft fractures in children, particularly those who are between 3 to 13 years of age has various options. Operative treatment is becoming well accepted and closed reduction with flexible nail is gaining popularity. Each of the surgical methods described have specific advantages and potential complications that must be appreciated by treating surgeon.

The present study was conducted to assess the results of titanium elastic nail fixation of femoral shaft fractures in children and adolescent patients. Because of the increasing cost of health care, surgical fixation of children fracture with resultant early mobilisation and discharge from the hospital has become increasingly popular.

Recognizing the relative safety and efficacy of femoral fracture fixation with flexible intramedullary nails, several large medical centres in the United States and Europe have reported on series of femoral fractures in children and adolescent, proving the value of this method.

In the present study 31(52%) of the patients were 3-6 years, 20 (33.3%) were 7 to 10 years and 9 (15%) were 11 to 13 years age group with the average age being 7.05 years. J. N. Ligier et al studied children ranged from 5-16 years with a mean of 10.2 years.[10] There were 34(57%) boys and 26 (43%) girls in the present study. The sex incidence is comparable to other studies in the literature. In the study by J. N. Ligier et al. out of 118 cases, had 80 (67.7%) boys and 38 (32.3%) 16 girls.[10] H Neville et al. In study of 130 children, there were 100 (77%) male and 18 (23%) females.[11] In this study Right side femur was affected in 31(52%) patients, left side was involved in 28(47%) patients and in one case bilateral femur was involved. In a study conducted by J N Ligier on 128 patients right side was involved in 64 (50%) patients, left side was involved in 59(46.1%) patients and bilateral femur was involved 5(3.9%) patients.[10]In a study by hasan et al 13(38%) patients right while 20(58%) patients had left femoral shaft fractures .One patient had bilateral femur shaft fracture.[12]

In the present study road traffic accident was the most common mode of injury accounting for 33 (55%) cases, self fall accounted for 24 (40%) cases and fall from height accounted for 3 (5%) of the cases. J. M .Flynn et. al, in their study assessing 234 cases, 136(58.1%) were following road traffic accident, 46 (19.6%) were following self fall and remaining 43(28.8%) were as a result of fall from height.[13] In a study on 34 patients by hasan et al, 28 (82%) were road traffic accident and 6(18%) were due to fall.[12] Fractures involving the middle l/3rd accounted for 41 (68%) cases, proximal 1/3rd 10 (17%) and distal l/3rd 9 (15%) of cases in our study. In their study J. N. Ligier et al among 123 femoral shaft fractures 42 were in proximal 1/3rd, 45 in the middle 1/3rd , 36 were in the distal 1/3rd. [10]In a study by H Neville 24% fractures occurred at proximal1/3, 66.2 at middle 1/3 and 9.8 at distal 1/3. [63] In our study, transverse fractures accounted for 30 (50%) cases, oblique fractures 15 (25%), spiral fractures 15 (25%) and there were no segmental fractures.In their study J. N. Ligier et al out of 123 femoral fractures studied 47 (38.2%) were transverse fractures, oblique fractures 7(23.3%), spiral fractures19 (15.4%) and 4 (3.2%) were segmental fractures.[10] In a study by hasan et al on 34 patients, 15(43%), 11(31%), 6 (17 %) and 3(9%) were transverse, oblique, spiral and segmental respectively.[12]

In the present series, 28 (47%) patients underwent surgery within 4 days after trauma, 25(42%) in 5 - 7 days, 7 (11%) beyond 7 days. Average duration between trauma and surgery was 6.05 days. In the study Gamal Et-Al et al operated 56.1% of cases between 3-4 days after injury, 21.2% cases between 4-7 days and 22.7% cases after 7 days.[14]K C Saikia et al. operated 77.27% patients within 7 days of injury.[50]Hasan et al mean interval was 2.09 days. [15] In the present study, duration of surgery was < 45 mins in 9(15%) cases, 45- 75 mins in 45(75%) cases, and 76-90 mins in another 6 (10%) cases. The average duration of surgery in our study was 53 minutes. In Khurram Barlas et al. study, the average duration of surgery was 70 mins.[16] In a study by Hasan et al., the average duration of surgery was 55 minutes. [12] The duration of stay in the hospital was 3- 7 days for 18 (30%) patients, 8-12 days for 28 (47%), 12 days for 14 (23%).The average duration of stay in the hospital in our study was 9.1 day. Average hospitalization time was 11.4 days in the study conducted by Mann et a1.[17]The Mean duration of hospitalization in a study by Hasan et al was 5.5 days. [12]The mean hospital stay in a study by Winquist RA was 13.3 days. [18]

In our study union was achieved in <3 months in 42 (70%) cases, rest 18 cases united within 4 months. Average time to union was 8.77 weeks. Oh C.W et al reported average time for union as 10.5 weeks.[19] In a study conducted by Winquist RA et al average time of union was 12 weeks.[18]Study conducted by Hasan et al mean time of union was 7.4 weeks.[12]

In this study 25 patients had associated injuries. Head injury was seen in 8 patients. 4 patients had tibia fractures of which one was compound. Blunt trauma to chest and abdomen was seen in 3 patients each. Radius and ulna fracture was seen in 3 patients. Pelvis injuries were seen in patients and 2 patients had associated fracture humerus on same side. Crammer KE et al noted 17 patients (33%) with associated injuries and 7(12.28%) of this had associated head injury.[7]Hasan et al found that 32.5% of patients had associated injuries.[12]JM Flynn et al reported associated injuries in 28.8 % patients.[11]

In the present study, 14 (23.33%) patients had developed pain at site of nail insertion, during initial follow up evaluation it resolved completely in all of them by the end of 24 weeks. J.M.Flynn et al. reported 38 (16.2%) cases of pain at site of nail insertion out of 234 fractures treated with titanium elastic nails.[13]Superficial infection was seen in 2(3.3%) case in our study which was controlled by antibiotics. J.M.Flynn et al. reported 4 (1.7%) cases of superficial infection at the site of nail insertion out of 234 fractures treated with titanium elastic nails.[13] Bar-on E, et al reported 2 cases of deep nail insertion site infection in their patients treated with external fixation.[20] All patients had full range of hip and knee motion by 12 weeks in the present study. J.M.Flynn et al. reported 2 (0.9%) cases of knee stiffness out of 234 fractures treated with titanium elastic nails.[13]

This is the most common sequel after femoral shaft fractures in children and adolescents. 2(3.3%) patient had shortening of femur and 2(3.3%) had lengthening of femur. No patient in our study had major limb length discrepancy (i.e. > ± 2cm). JM Flynn observed limb length discrepancies in 5(2.1%) patients. [13] Cramer KE, et al noted average limb lengthening of 7mm (range l- 19 mm) in their study. Clinically significant limb discrepancy (> 2cm) did not occur in any patient in their study.[7] In the present series, nail back out was not seen in any of the cases. Carrey T.P. et al out of 38 cases, noted nail back out in one case in their study, which necessitated early removal.[6]

Some degree of angular deformity is frequent after femoral shaft fractures in children, but this usually remodels after growth. In our study there was one case which had minor malalignment. J.M.Flynn et al. reported 10 (4.3%) cases of minor angulation out of 234 fractures treated with titanium elastic nails.[13] Heinrich SD, et al reported 11 % of fractures had an average varus or valgus malalignment of $6^{0.5}$ Herndon WA, et al compared the results of femoral shaft fractures by spica casting and intramedullary nailing in adolescents. They noticed varus angulation ranging from 7 to 25° in 4 patients treated with spica casting and no varus angulation in surgical group. In the present study, no patients had anteroposterior angulation. 8% of the patients had an average anterior or posterior angulation of 8^{0} in Heinrich SD et al, study.[5] Beaty et al in study of 30 observed no patients having angular malalignment.[24] Cramer KE et al in a study of 57 patients observed that no patients had clinically significant anteroposterior angulation. [7] A difference of more than 10° has been the criterion of significant deformity. No patient in our study had significant rotational deformity. Heinrich SD et al, out of 183 fractures studied, reported 8° out toeing in 4 children and two children with 5° in toeing following flexible intramedulary nailing. [5] Beaty et al observed no rotational deformities in a study of 30 patients.[24] Crammer KE et al observed that no patient had any clinically significant rotational malalignment in a study of 57 patients.[7] In the present study, the final outcome was excellent in 40 (66.66%) cases, satisfactory in 20(33.33%) cases and there were no poor outcome cases. J.M.Flynn et al. treated 234 femoral shaft fractures and the outcome was excellent in 150(65%) cases, satisfactory in 57 (25%) cases and poor in 23(10%) of cases.[13] In K.C. Saikia et al in their study of 22 children with femoral shaft fractures 13 (59%) excellent, in 6 (27.2%) satisfactory and 3(13.6%) poor results.[15]

5. Conclusions

Based on our experience and results, we conclude that Titanium Elastic Nailing System is one of the best method for treatment of paediatric femoral shaft fractures. It promotes rapid union at fracture site and gives stability which is ideal for early mobilization with lower complication rate, good outcome.

It is a simple, easy, rapid, reliable and effective method for management of paediatric femoral fractures between the age of 3 to 13 years, with shorter operative time, lesser blood loss, lesser radiation exposure, shorter hospital stay, and early return to activity.

Because of early mobilisation, rapid healing and minimal disturbance of bone growth, titanium elastic nail may be considered to be a physiological method of treatment.

Use of titanium elastic nails for definitive stabilization of femoral shaft fractures in children is a reliable, minimally invasive, and avoids complications like damage to physis, infection and blood loss.

Our study confers all the advantages which the previous studies have shown at various institutes and is fairly a simple, reliable technique with a shorter learning curve.

With less complications like malrotation, shortening, angulation and with advantages of Less number of days of hospitalisation offers a psychosocial benefit to parents and family of child. Early discharge allows parent to work soon and gives financial benefit to families.

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