Original Research Article

Study to assess the functional outcome of Intramedullary Titanium Elastic Nails in the Paediatric Lower Limb Long Bone Fractures

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Abstract

Introduction: Femoral and tibial shaft fractures add up to less than 2% of all pediatric fractures, the preferred management has remained a real challenge to the orthopaedic fraternity. Upto the recent past conservative treatment was the method of choice for the treatment of shaft fractures in young adolescents and children. In order to avoid the effects of long immobilization, to decrease the loss of schooling and for finer post operative care, the operative approach has been popular for the last twenty years. **Material and Methods:** This study was conducted in department of orthopaedics, Rohilkhand medical college and hospital after seeking clearance from institutional ethical committee. The aim is to assess the functional outcome of intramedullary titanium elastic nails in paediatric lower limb long bones fractures**.** The patients attending the OPD and emergency department diagnosed with the fracture of femur and tibia was admitted for the study. This one year study was conducted from November 2018 to October 2019. A total of 30 children with diaphyseal fracture femur and tibia were enrolled in the study. When the patient arrives, a detailed history was gathered from the parents and/or attendants about age, sex, mode of injury and duration. Patients were assessed for associated injuries. Clinical and local examination was then performed following surgery. **Results:** The results were assessed as per criteria adopted by Flynn et al. Total of 20 patients had excellent outcome. There were no poor results. All the patients of the present series were able to squat and sit cross-legged at final follow up which was statistically significant. **Conclusion:** Titanium elastic nailing system technique, through the theory of two opposing balancing forces gives good firmness at the fracture site to allow early mobilization, it provides a biological environment that amplifies both quantity of callus formation and fracture healing.It may be considered to be a physiological method of treatment and it may prove to be the ideal implant to treat many paediatric femoral and tibial fractures. The technique is relatively simple, minimally invasive and healing occurs in extremely natural way with adequate mass of callus.

Key words: Titanium Elastic Nailing System(TENS), Flynn's criteria, Visual Analog Score(VAS)

Introduction

Femoral and tibial shaft fractures, customarily provoke by debilitate trauma (RTA, Fall) are the utmost prevalent paediatric loses treated by the orthopaedic surgeon. Seventy percent of femoral and tibial fractures involve the shaft[1].

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Femoral and tibial shaft fractures repeatedly ensue at a count of approximately 20/100,000 children in the states, describing 1.6% of all fractures in the pediatric family. Previously, horizontal traction was advised by Buck in the 1860s for fracture shaft of femur. Bryant, still advised vertical traction. Hamilton, from 1890s suggested splint treatment for femoral diaphyseal fractures. Spica casting came into existence in the 1890s at Johns Hopkins University. Kuntscher introduced intramedullary nailing in 1940. Blount suggested plaster casting with or without traction and concluded that

surgery was roughly never needed. Recently, good results have reported when adolescents and children are managed operatively in comparison to those managed nonoperatively. Modern moves in traumatology have led to an operative approach to the paediatric femoral and tibial fracture[2]. In order to prevent the outcome of immobilization, to decrease the loss of schooling and for finer post operative care, the operative approach has become popular since past twenty years. From last twenty years, an increase in tendency towards a more operative approach in patients over six years of age. The outcome of a latest survey by the Nancy of the Paediatric Orthopaedic Society from North America suggested that surgery is the favoured management for older children, chiefly those with high-energy injuries. Different surgical procedures are being carried out for the treatment of femoral and tibial shaft fractures. Some of the choices for surgical procedure comprise external fixator, flexible intramedullary nails and bridge plating. TENS (flexible intramedullary nail) have an edge over other surgical modalities as it is easy, and load-sharing internal splint that doesn't contravene the growth plate, allows early weight bearing and maintains alignment[3]. Faster appearance of bridging callus is seen due to micro motions at the fracture site allowed by the elasticity of the fixation. Periosteum is neither disrupted and because it is a less invasive procedure there is no disruption for the fracture hematoma, hence less risk of infection. Implant is removal when problem with the metal work is found[4]. The removal of metal work is carried out after 9months in children of 5-15 year age group. Patients are explained that implant removal may entail a bigger incision and can lead to unsightly scars.

Materials and methods

This study was performed in the department of orthopaedics at Rohilkhand Medical College And Hospital, Bareilly. The patients attending the OPD and emergency department shall be admitted for study**.** A total of 30 children with fracture shaft femur and tibia were enrolled in the study. We conducted a prospective study for duration of one year from November 2018 to October 2019.

Inclusion Criteria: -

- All patients above 5 years age and less than 15 years of age.
- Femur diaphyseal fractures.
- Tibial diaphyseal fractures.

Exclusion Criteria: -

- Metaphyseal and diaphyseal fractures.
- Patients with any pre-existing deformity in the fractured limb or any congenital or metabolic bone diseases.

Data collection

When patient arrives, a detailed history was elicited from the parents and/or attendants about age, sex, mode of injury and duration. Patients were assessed for associated injuries. Clinical and local examination was performed. Patients selected for flexible intramedullary nailing were investigated for pre-anaesthetic fitness, X-ray (AP and lateral projections of both thighs including hip and knee joints for femur, AP and lateral projections of both legs including knee and ankle joints for tibia) and clinical records were maintained. Intravenous prophylactic antibiotic was given an hour before surgery.

Procedure

Intervention was done under spinal anaesthesia or general anaesthesia. Under spinal or general anaesthesia, child was placed on a fracture table with a traction boot and traction was given to the injured limb followed by adjustment of image intensifier (C-arm) for obtaining antero-posterior and lateral views of the injured bone intraoperatively[5]. The nail diameter was discovered on preoperative radiographs. Nail diameter (mm) = 40% of internal diameter at isthmus of contralateral bone calculated radiologically in lateral projection. After painting and draping of the injured extremity small incision was given at the selected point of entry and the cortex of the metaphyseal area was drilled. The hole was enlarged by bone awl. Then two flexible intramedullary nails of equal diameter was inserted after proper contouring through the entry holes and advanced proximally to the fracture site[6]. Then fracture was closely reduced and two nails were introduced and progressed proximally. Nails diverge laterally and medially within the femoral neck and greater trochanteric region for adequate rotational stability.

Fig 1 (a): Instruments required for TENS nailing

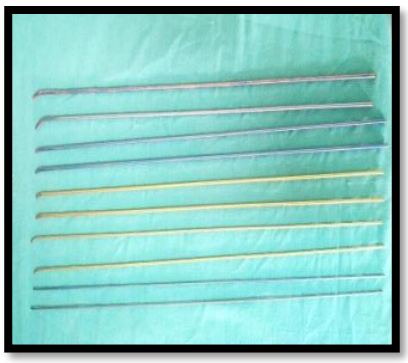

Fig 1 (b) :Titanium intramedullary nail

Throughout the procedure the position of the nails was checked using image intensifier and finally the nails were cut distally to the proper length and wounds were closed, followed by release of traction and impaction to correct any distraction at the fracture site. A little part is left out, to allow ease in later removal[7-8]. All wounds were then cleaned with normal saline and skin was closed. Sterile bandage was then applied. Intravenous fluids and blood transfusions were advised as per patient requirement. IV antibiotic was continued. Analgesics given according to the needs of the patient. Foot end of the bed was elevated. Postoperative X-ray of the involved bone were taken. Patients were advised no oral intake 4 to 6 hours post operatively.

IV antibiotics were given postoperatively for 48hours and oral antibiotics for 3 days. Hamstrings and quadriceps strengthening exercises in all, active, active assisted and passive range of motion was started within few days. Non-weight-bearing ambulation with walker support allowed under supervision was started immediate postoperatively when tolerated. Weight bearing was started as per fracture configuration[9,10]. Partial weight-bearing was advised at about 4 weeks and further to full weight-bearing when bridging callus was visible and fracture line was not seen on x-rays. Sutures were taken out on the 12 to 15th postoperative day.

Follow up: Further follow up was done at 6 weeks, 12 weeks and 24 weeks. Each patient was assessed on the basis of Flynn et al (2001) criterion

Table 1: Flynn et al (2001) criterion

	Excellent	Satisfactory	Poor
Limb Length Discrepancy	<1cm	<2cm	>2cm
Malalignment	Up to 5^0	5^0-10^0	$>10^0$
Pain	None	None	Present
Complication	None	Minor	Major and or lasting morbidity

Illustrative Case No1

Fig 2(a):Pre op X-Ray

Fig 2(b): Post-op X-Ray at 6 weeks

Fig 2(c):Post-op X-Ray at 12 weeks

Fig 2(d):Post-op X-Ray at 24 weeks

Illustrative Case No 2

Fig 3(a):Pre op X-Ray

Fig 3(b):Post-op X-Ray at 6 weeks

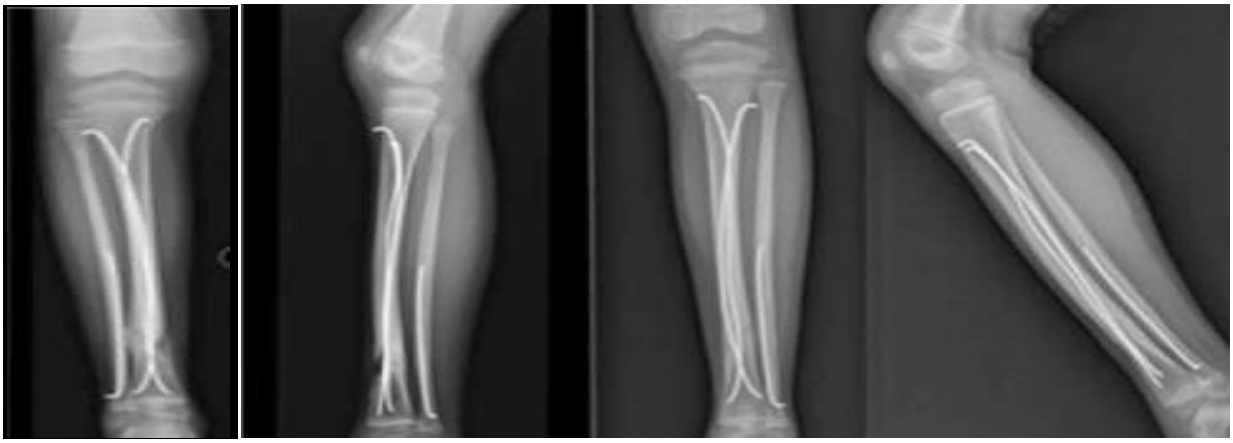

Fig 3(c): Post-op X-Ray at 12 weeks

Fig 3(d): Post-op X-Ray at 24 weeks

Observations and results

In this study 64% of the children were aged between 5 to 9 years. The youngest one was 5 years old and the eldest was 15 years old. The mean age was 8.7years. 76.7% of the patients were boys. The boy to girl ratio was 3.29.:1. The most common case was fall from height followed by road traffic accident. In this study most of the patients presented with transverse pattern of fracture in 36% while comminuted and spiral patterns were noted in 26% and 13% respectively. In the present study, 77% of the patients had middle third fracture and 23% of the patients had proximal third fracture. Majority of patients were not immobilized post operatively. Those with unstable fracture patterns were immobilised on Thomas knee splint for a maximum

period of 4 weeks in this study. Hamstring and quadriceps strengthening exercises started from immediate post op period. The patients who were not immobilised were started with active and passive range of movement exercises and allowed non weight bearing ambulation from the next day as per pain tolerance. All the patients started full weight bearing ambulation within 8 weeks and 4 patients showed a more rapid union and attained full weight bearing within 6 weeks. The average time of union was 7.2 weeks.In the present study limb length discrepancy was observed in total of 16.6% (5 patients) with shortening in 3 patients with comminuted pattern and lengthening in 2 patients with transverse pattern of fracture.Fracture malalignment was observed in 6.66% (2 patients) with valgus deformity in spiral fractures. The average time of hardware removal was 8.2 months (range 7-10 months). The results were assessed as per criteria adopted by Flynn et al. Total of 20 patients had excellent outcome. There were no poor results. At final follow up all the patients of our series performed squatting and sit cross-legged. Two patients complained of knee stiffness till 9 months which resolved by 1 year.

Discussion

It is suggested that, the best device for the treatment of most diaphyseal fractures in children would be a simple, load sharing internal splint that provides mobilization and maintain alignment and extremity length till bridging callus appears. It is reported that, these features can be achieved through flexible intramedullary nailing. Hence this study was undertaken to assess the efficacy and the functional outcome following Titanium elastic nail system (flexible intramedullary nailing) for diaphyseal fracture of children age group 5-15 years.In the present study fall from height was the mode of injury in majority of the children 50% while RTA was the cause in 30% of the children. In this study most of the patients presented with transverse pattern of fracture 37% while oblique and spiral patterns were noted in 22% and 13% respectively. Most common pattern of fractures observed was transverse which mainly resulted by fall from height (7 out of 11). Comminuted fractures were a usual result of RTA (4 out of 8). Most of the fractures, irrespective of their pattern, showed satisfactory union within 8 weeks but 1 transverse fracture took 9 weeks to unite while another transverse fracture took 10 weeks to unite. Implying that healing in transverse fractures was slow in comparison to oblique and spiral patterns. Majority (77%) of the patients had middle third fracture and 23% of the patients had upper third fracture. In the study by Singh R, et al. on 35 children, the most common mechanism of injury was that of a pedestrian being involved in a motor vehicle accident (40%), 28 fractures were in the middle third followed by proximal one-third (7%) of the femoral diaphyseal, and the most common fracture pattern was transverse fracture (15%). In the present study final outcome was evaluated based on Flynn et al. criteria and excellent outcome in 66.7% of the children while 33.3% of the children had satisfactory results. None of the child had poor results. These findings were comparable with a study by Kumar N, et al. in Indian children, where authors reported excellent results in 14 patients (70%) and successful in 6 (30%). Flynn JM et al. reported excellent results in 65% of the children while satisfactory and poor results in 25% and 10% of the cases respectively. Shankar WN et al. reported excellent results in 63.15% of the children and satisfactory and poor results in 31.57% and 5.26% of the patients. The findings of present study showed excellent results in majority of the children compared to other studies by Kumar N et al, Flynn JM et al. and Shankar WN et al.

Conclusion

Recently, orthopaedic surgeons have been motivated to consider alternatives to skeletal traction and application of a spica cast to avoid the adverse physical, psychological and social consequences of prolonged immobilization of a school aged child. TENS has considerably reduced the hospital stay leading to early discharge of the patients, thus decreasing the price of treatment and is psychologically superior.Titanium elastic nailing system technique, through the theory of two opposing balancing forces gives good firmness at the fracture site to allow early mobilization, it provides a biological environment that amplifies both quantity of callus formation and fracture healing.It may be considered to be a physiological method of treatment and it may prove to be the ideal implant to treat many paediatric femoral fractures. The procedure is relatively easy, less invasive and is cured in a very typical way with callus mass.A few complications related to it are due to unsuitable technique and can be removed by strictly sticking to the basic principles and technicality.We conclude that TENS for the treatment of paediatric diaphyseal femur and tibia fractures in the children of 5-15years is a fruitful method, as it prevents any growth disturbance by conserving the epiphyseal growth plate, it prevents damage to bone by the elasticity of the material, which allows a biocompatible load sharing internal splint, and lastly it demands a minimal risk of bone infection.

References

1. Strachota P. Implementation of the MR tractography visualization kit based on the

anisotropic Allen-Cahn equation. Kybernetika. 2009;45(4):657-69.
2. Whittle AP, Wood II. GW: Fractures of lower extremity In: Canale TS (ed.): Campbell's Operative Orthopaedics. Mosby, St Louis London Philadelphia Sydney Toronto. 2003;3(2):825-72.
3. Flynn JM, Schwend RM. Management of pediatric femoral shaft fractures. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2004 Sep 1;12(5):347-59.
4. Hinton RY, Lincoln A, Crockett MM, Sponseller P, Smith G. Fractures of the femoral shaft in children. Incidence, mechanisms, and sociodemographic risk factors. JBJS. 1999 ;81(4):500-507.
5. Leventhal JM, Thomas SA, Rosenfield NS, Markowitz RI. Fractures in young children: distinguishing child abuse from unintentional injuries. American Journal of Diseases of Children. 1993 ;147(1):87-92.
6. Lang-Stevenson AI, Sharrard WJ. Intramedullary rodding with Bailey-Dubow extensible rods in osteogenesis imperfecta. An interim report of results and complications. The Journal of Bone and Joint Surgery. British volume. 1984;66(2):227-32.
7. Walker RN, Green NE, Spindler KP. Stress fractures in skeletally immature patients. Journal of Pediatric Orthopaedics. 1996; 16(5) :578-84.
8. Kuntscher G. Die marknagelung von knochenbruchen. Arch Klin Chir. 1940;20(1):4-13.
9. Blount WP. The Classic: Forearm Fractures in Children. Clinical Orthopaedics and Related Research®. 2005;43(2):4-7.
10. Blasier RD. Treatment of fractures complicated by burn or head injuries in children. JBJS. 1999;81(7):1038-43.

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