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FUNCTIONAL OUTCOME OF LOWER LIMB DIAPHYSEAL FRACTURES IN CHILDREN TREATED WITH TITANIUM ELASTIC NAILING SYSTEM

Orthopaedics

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ABSTRACT

A prospective observational study including 50 children and adolescents in the age group of 5-16 years diagnosed with femur and tibia diaphyseal fractures who were admitted to the Department of Orthopaedics in Great Eastern Medical School, Srikakulam, meeting the inclusion criteria were selected during the study period from May 2022 to April 2024. In our study, 60% were male children and 40% were female children, whereas 70% were Femur shaft fractures and 30% were Tibia shaft fractures. All patients were treated with Closed reduction and Titanium Elastic Nailing fixation for the Femur and Tibia fractures. Postoperatively, patients were followed up for a period of 6 months at 4,8,12 and 24 weeks. Functional evaluation was done using Flynn's criteria which showed excellent outcomes in 34 (68%) cases, satisfactory outcomes in 16 (32%) cases and there were no cases of poor outcome. In conclusion, the Titanium elastic nailing system provides a rapid union of fractures by preserving the fracture hematoma and limiting soft tissue exposure. It also helps in preventing damage to the physis of long bones. Our study confers all the advantages which the previous studies have shown at various institutes and is fairly a simple and reliable technique with a shorter learning curve imparting a lot of advantages over other intramedullary techniques or other treatment methods followed for the management of lower limb diaphyseal fractures in paediatric population.

KEYWORDS

Titanium Elastic Nailing System, Diaphyseal Fractures

INTRODUCTION:

Management of long bone diaphyseal fractures in children continues to improve as new & advanced techniques evolve. Formerly, the majority of the fractures were effectively managed with conservative methods & only unstable and displaced fractures were treated by fixation. Even though a wide range of other intramedullary fixation devices like Rush nails or Enders nails are available for the fixation of paediatric long bone fractures, these provide poor elasticity, and rotational stability and require multiple nails to achieve absolute fracture stability.[6]

There exists minimal controversy over the treatment of lower limb long bone diaphyseal fractures with intramedullary nail fixation in adults. Likewise, there is little controversy over the treatment of midshaft fractures of femur and tibia in infants and toddlers by using spica casting, but the treatment of paediatric and adolescent (age 5 to 15 years) Femur and Tibia shaft fractures remains controversial.

Hence, there was a transformation in the treatment modalities for managing these paediatric fractures. Treatment of paediatric fractures significantly changed in 1982 when Metaizeau et al from France, developed the technique of Elastic stable intramedullary nailing for long bones.

For the last two decades, there has been an escalated interest in the surgical treatment of paediatric fractures, although there is debate over its indication. There is little conflict regarding the management of long bone fractures in children below 6 years with pop casting and adolescents over 16 years with intramedullary nailing.[2,6]

There are greatest opinion differences regarding the treatment of patients who are too old for early spica casting and yet too young for adult type of treatment with a reamed Intramedullary interlocking nailing.

Current treatment modalities include early spica casting, traction, external fixation, Open Reduction & Internal Fixation [ORIF] with plating, flexible intramedullary nailing and reamed intramedullary nailing. The major drawbacks with various types of traction and plaster cast immobilization are prolonged bed rest causing separation of the child from routine activities, the expenditure incurred on the treatment during the hospital stay and parental non-acceptance.

Over a period of time, clinicians have experienced that long bone diaphyseal fractures do not always unite with conservative treatment. Angulation, malrotation and shortening could not be corrected effectively. Whatever may be the method of treatment, the goal is to stabilise the fracture, maintain the length and alignment, promote fracture healing and minimize the morbidity and complications for the child as well as the family[6].

There will be a continuous challenge for Orthopaedic surgeons to treat this age group with less morbidity at a lower cost, as no clear guidelines have been postulated to date despite efforts done initially by French surgeons, followed by European surgeons and recently by The Paediatric Orthopaedic Society of North America (POSNA).[7]

The management of paediatric lower limb long bone fractures has gradually shifted towards an operative approach in the last decade. ORIF with plating provides rigid fixation of fracture but it requires a larger soft tissue exposure with increased potential for blood loss and scarring. Plate is a load-bearing device and there is a risk of re-fracture and growth disturbance. Also, the technique of antegrade nailing has shown a risk of proximal femoral and tibial deformities and avascular necrosis of the femoral head. The recently favoured technique of Elastic internal fixation in the form of flexible intramedullary nailing provides a healthy environment for fracture healing with micro movement leading to increased callus formation. This method is minimally invasive which prevents physeal damage and it has relatively reduced hospital stay and high parental acceptance after a short learning curve.

MATERIALS AND METHODS:

A prospective observational study of 50 children in the age group of 5-16 years with diaphyseal fractures of the femur and/or tibia admitted at Great Eastern Medical School & Hospital, Srikakulam - meeting the inclusion and exclusion criteria (as given below) during the study period from May 2022 to April 2024 were taken as the subjects of the study. The Institutional ethical committee clearance was obtained before starting the study.

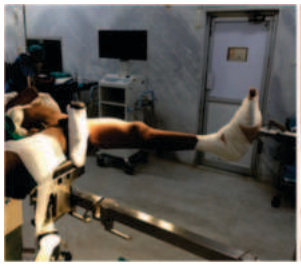
Inclusion criteria: 5-16 years of age, Diaphyseal fractures, Simple fractures (closed fractures), Ipsilateral fractures, Fracture without head injury.

Exclusion criteria: Metaphyseal fractures, Compound fractures, Pathological fractures.

After admission, patients were evaluated by a paediatrician for fitness, routine pre-anaesthetic check-up was done and informed written consent was obtained from parents before surgery.

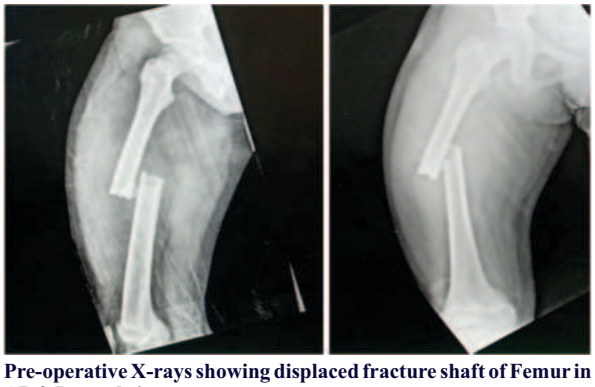
Intraoperatively- The patient's position on the conventional operation table, bony landmarks and surgical incision for the nail

Insertion, fracture reduction modalities under image intensifier, time duration for surgery, amount of blood loss and any other challenges faced during the procedure were carefully noted, including sizing and suitability of titanium elastic nails as per A.O. guidance. Postoperatively, after 24 hours - Wound Inspection was done, a check X-ray was taken to assess reduction and active static exercises/passive exercises/active neighbouring joint movement were encouraged at the earliest. Between 8 to 10 days - wound inspection and suture/staple removal was carried out. The patient was called for periodic follow-up at 4 weeks, 8 weeks, 12 weeks and 6 months for clinical and radiological assessment. Pain, range of movements (hip, knee & ankle), limb length and time of weight bearing (partial/complete) were assessed clinically during follow-up visits. Radiological evaluation for – the position of the nail, coronal and sagittal alignment, loss of reduction/deformity and delayed/non-union is done.

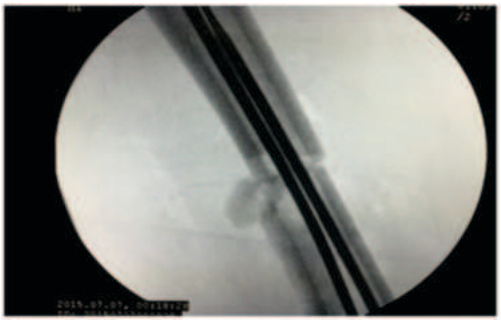


Intraoperative patient positioning

Entry of TENS from the distal end of Femur



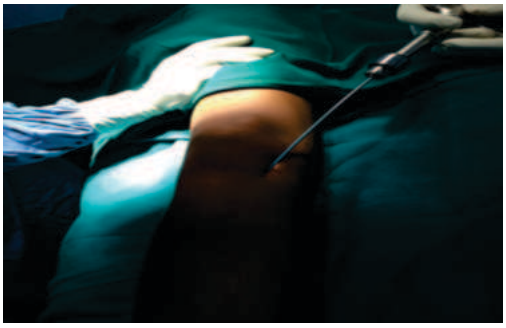
Pre-operative X-rays showing displaced fracture shaft of Femur in AP & Lateral views



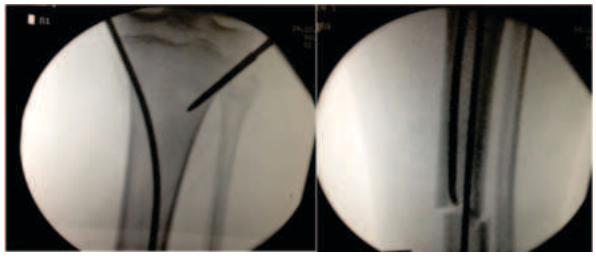
Fluoroscopy picture of femur fracture reduction with TENS

Post-operative X-ray showing reduced femur fracture with TENS

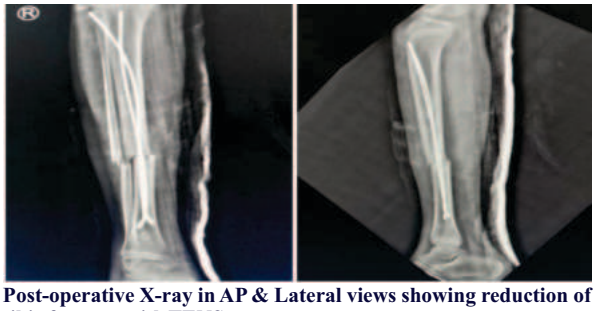
Pre-operative X-ray showing right shaft of Tibia and Fibula fractures



Entry of TENS from the proximal end of Tibia



Fluoroscopy images of TENS entry into the Tibia and passage through the fracture



Post-operative X-ray in AP & Lateral views showing reduction of tibia fracture with TENS

X-ray at 6 months follow-up showing good union

DISCUSSION:

In present study, union was achieved in below 3 months in all 50 (100%) cases. The average time to union was 10.5 weeks. Oh C.W et al in their study reported the average time for union as 10.5 weeks. Aksoy C, et al compared the results of compression plate fixation and flexible intramedullary nail insertion. Their average time to union was 7.7 (4 to 10) months in the plating group and 4 (3 to 7) months for flexible intramedullary nailing.

STUDIES	TIME OF UNION [IN WEEKS]
PRESENT STUDY	10.5
Oh C.W, et al	10.5
Aksoy C, et al	16

In our study, closed reduction of the fracture, leading to preservation of fracture hematoma, improved biomechanical stability and minimal soft tissue dissection led to a rapid union of the fracture compared to compression plate fixation.

COMPLICATIONS:

Pain at the site of nail insertion:

In the present study, 10(20%) patients had developed pain at the site of nail insertion during initial follow-up evaluation which resolved completely in all of them by the end of twenty-four weeks. J.M. Flynn et al. reported 38 (16.2%) cases of pain at the site of nail insertion out of 234 fractures treated with titanium elastic nails.

Infection:

Superficial infection was seen in 3(6%) cases in our study which was controlled by antibiotics & regular dressings on alternate days within a week. 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. Bar-on E, et al reported 2 cases of deep pin tract infection in their cases treated with external fixation.

Range of motion:

All patients had a full range of hip, knee and ankle motion by 10 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.

Limb length discrepancy:

This is the most common sequelae after femoral shaft fractures in children and adolescents. 2(4%) patients had shortening of femur and 1(2%) had lengthening of femur. No patient in our study had major limb length discrepancy (i.e. > ± 2cm). Beaty et al. reported that two patients had overgrowth of more than 2.5 cm necessitating epiphysiodesis, after conservative treatment. Ozturkman Y. et al observed a mean leg lengthening of 7mm in 4 (5%) patients and a mean shortening of 6mm in 2 (2.5%) children. Cramer KE, et al noted average limb lengthening of 7mm (range l 19mm) in their study. Clinically significant limb discrepancy (> 2cm) did not occur in any patient in their study. John Ferguson et al noted more than 2cm shortening in 4 children after spica treatment of paediatric femoral shaft fracture. In the present study, a limb length discrepancy of less than 10mm was present in 2 (10%) cases. Compared to limb length discrepancy in conservative methods, limb length discrepancy in our study was within acceptable limits.

Assessment of Outcome In the present study, the final outcome was excellent in 34(68%) cases, satisfactory in 16(32%) 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. Hossam M kandil, treated thirty-two children, aged 4.9–13.2 years, with femoral shaft fractures, the outcome scoring to evaluate functional results showed excellent results in twenty-six patients (81.25%), satisfactory results in six patients (18.75%), and no poor results. In K.C. Saikia et al in their study of 22 children with femoral shaft fractures, the results were 13 (59%) excellent, 6 (27.2%) satisfactory and 3(13.6%) poor results.

STUDIES	OUTCOME %		
	EXCELLENT	SATISFACTORY	POOR
PRESENT STUDY	68%	32%	-
Hossam M Kandil	81.25%	18.75%	-
J.M. Flynn et al	65%	25%	10%
K.C. Saikia et al	59%	27.2%	13.6%

CONCLUSION:

Based on our observation and results, we arrive at an opinion that the Titanium Elastic Nailing System is an ideal method for the treatment of paediatric lower limb diaphyseal fractures. It provides elastic mobility promoting rapid fracture union and stability, which is most necessary for early mobilisation with minimal complication rates and good functional and radiological outcomes when compared with other modalities of treatment.

It is a simple, easy, rapid, reliable and effective approach for the management of paediatric diaphyseal fractures in the age group of 5 to 16 years, with shorter surgical duration, lesser blood loss, lesser radiation exposure, shorter hospital stays, and reasonable time to bone healing.

Given the possibility for early weight bearing, rapid fracture union and minimal damage to the physis, intramedullary fixation by TENS may be considered to be a physiological method of treatment. The use of TENS for definitive stabilization of femur and tibia shaft fractures in children is considered to be a reliable, minimally invasive, and more significantly a physeal protective treatment method.

Our study confers all the advantages which the former studies have shown at numerous institutes and it is fairly a simple and dependable approach with a shorter study curve imparting a lot of advantages over other methods followed for the treatment of paediatric diaphyseal fractures in the lower limb.

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