

SURGICAL OUTCOME OF PAEDIATRICS LONG BONE SHAFT FRACTURES TREATED WITH PERCUTANEOUS TITANIUM ELASTIC NAIL SYSTEM: A PROSPECTIVE STUDY ON SCHOOL-AGED CHILDREN & ADOLESCENT IN A TERTIARY HEALTH CARE



Orthopaedics

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ABSTRACT

Background: The incidence of paediatric long bone shaft fractures have been increased drastically owing to increase in no. of Road Traffic Accidents. Flexible Titanium nails are simple, effective, minimal invasive method of fixation, Early ambulation, preservation of fracture hematoma & having a physis sparing entry with cosmetic benefit. **Materials & Methods:** A Prospective Interventional Study was conducted with 124 paediatric patients with various long bone fractures who got admitted from Trauma Care Unit of Government Medical College & General Hospital, Srikakulam, from July 2020 to November 2022. **Results:** Out of 124 patients, 75 both bone fracture forearm, 19 cases were femur fractures, 17 cases were tibia fractures and 13 cases were humerus fractures. In our surgery, we took Flynn criteria [2] found 88% (109) patient had excellent to good, 12.0 (15)% had fair. **Conclusion:** Titanium elastic nailing (TENS) is an effective & ideal method of treatment in unstable paediatric long bone diaphyseal fractures.

KEYWORDS

titanium elastic nails (TENS), diaphyseal fracture, Paediatric fractures

BACKGROUND:

The incidence of paediatric long bone shaft fractures have been increased drastically owing to increase in no. of Road Traffic Accidents. 60% of paediatric fractures are forearm fractures, 15 % Tibia- Fibula & 5% femur fractures.^[1] Simultaneously, the treatment method of long bone fractures are improving in paediatric population thanks to research in newer techniques. Conservative management is still preferred in paediatric fractures because of excellent remodelling capacity of paediatric fractures. Children can tolerate the POP cast better, Hence Most of the paediatric long bone fractures below 6 years of age is treated conservatively. Minimal change in displacement of fractures & angulation is corrected by bone remodelling. However, Preservation of Length, Alignment & Rotation is crucial in management of unstable long bone fractures in paediatrics. Surgical interventions may also be indicated in poly trauma, open fractures, compartment syndromes. Surgical fixation by means of Plate & screw lead to infection, growth disturbance, refractures. Reamed interlocking nail is mode of treatment followed for adults but it may damage growth plate and can alter growth of limbs in paediatric population. Flexible Titanium nails are simple, effective, minimal invasive method of fixation, Early ambulation, preservation of fracture hematoma & having a physis sparing entry with cosmetic benefit. It provides flexural, axial, translational & rotational stability to a fracture.

AIM OF THE STUDY:

1. To evaluate the surgical outcome of paediatric long bone fractures fixed with Titanium Elastic Nails (TENS)

MATERIALS & METHODS:

A Prospective Interventional Study was conducted with 124 paediatric patients with various long bone fractures who got admitted from Trauma Care Unit of Government Medical College & General Hospital, Srikakulam, from July 2020 to November 2022. Patients were treated with titanium elastic nails and followed up for a minimum period of 12 months. All patients were assessed by Flynn's criteria.^[2]

Inclusion Criteria

1. Failed to achieve & maintain Acceptable Reduction of Humerus, Both-bone Forearm, Femoral and Tibial shaft fractures by conservative management
2. Primary reduction is achieved but loss of reduction noticed in weekly follow up
3. Closed/ Type I open injuries with long bone fractures
4. 6-16 years age Group Patients

Exclusion Criteria

1. Epiphyseal and Metaphyseal extension of fracture

2. Fractures associated with Type II / III Open injuries
3. Greenstick fractures
4. Age > 16 years & Age < 6 years
5. Undisplaced fractures
6. Metabolic Bone injury
7. Patient with Neurovascular injuries

After thorough clinical examinations, X-Rays were taken. Necessary blood investigations were done for fitness of surgery. Prophylactic antibiotic is given 1 hour before surgery. General anesthesia was preferred for upper limb & spinal anesthesia was used for lower limb. All patients were positioned in supine position with upper limb supporting on arm board. For Humerus retrograde nailing was done with entry point made at supracondylar ridge around 2 cm proximal to distal physal line. For some cases 2 nails were passed on lateral side or 1 nail on each side of it. For radius retrograde nail passed 1 cm proximal to lateral distal radial physis. For ulna antegrade nail passed just lateral to the olecranon apophysis.

For femoral shaft fractures entry point was made 2 cm proximal to distal epiphyseal plate on both sides with two titanium nails. For tibial fractures entry point was made 2 cm distal to proximal epiphyseal plate and internal fixation done with two titanium nails.

The diameter of the individual nail was selected as per Flynn et al formula^[2]

Diameter of nail = Width of the narrowest point of the medullary canal on anteroposterior and lateral view $\times$ 0.4 mm and intra-operative assessment.

The nail tip slide in the medullary cavity & it is directed with the help of a T Handle under fluoroscopy guidance. The ends of nail, is secured in their entrance and opposite ends are secured in opposite metaphysis. Pre-bending increases the elastic capacity & produces tension inside the intramedullary canal. It decreases both the tendency to straighten out and the tendency to be further bent, limiting the potential of deformation. It forms divergent "C" configuration & act like an internal splint.

In each instance, two nails of the same size were utilized. Use of nails of different sizes would result in an unbalanced torque that would cause fracture angulation.

It works based on the fundamental idea of "three-point fixation," which is given by the symmetrical anchoring effect of two elastic nails placed into the metaphysis, each of which bears against the inner bone at three sites. Flexural, axial, translational, and rotational stability are the four

characteristics that are produced to get the best outcome.

POSTOPERATIVE CARE:

Analgesics were administered based on the patient's need. Limb elevation is maintained. IV antibiotics were administered for 72 hours post-surgery. Suture removal was done on 10th Post Operative day. Immediate post operative appropriate physiotherapy was advised. Gradual weight bearing was advised after 6 weeks. Full weight bearing was started after satisfactory callus formation on x rays. Unstable fractures were immobilized with POP for a period of 3 to 4 weeks followed by physiotherapy for 6 weeks.

All patients were monitored clinically and radiographically for any complications including compartment syndrome, skin irritation or ulceration, stiffness, nail migration, non-union, Limb length discrepancy (LLD), and aberrant gait until the fractures healed. Patients were assessed by Flynn's criteria^[2] in follow up period.

RESULTS:

124 patients of age between 6-16 years with various diaphyseal long bone fractures were treated by closed reduction and Titanium Elastic nail fixation from July 2020 to November 2022. In our study average age of patients was 10.5 years. Out of 124 patients 92 patients were male and 32 patients were female with a ratio of approximately 3:1. Out of 124 patients, 75 both bone fracture forearm, 19 cases were femur fractures, 17 cases were tibia fractures and 13 cases were humerus fractures. 75% patient had road traffic accidents, rest 25 % fractures were due to accidental fall from height. Average time period for injury to surgery was 3 days. Average surgery duration was 40 minutes. Average radiation exposure for per nail was 12 shots (1.6sec /shot in our C-arm). Average period of hospitalisation was 3 days. 2.42% (3 patient) had superficial infection & no instance of deep infection. Patients with superficial infection at entry site which healed on regular dressing & IV antibiotics. Average time for bony union was 7.5 weeks. Average time for bony union for humerus fracture was 7.8 weeks, 7 weeks for forearm fractures, 8 weeks for femur fractures & 9 weeks for tibia fractures. 4 cases had less than 2 cm shortening. 2 of the patients were treated for femur fracture & 2 patients were treated for tibia fractures. Malalignment of $<10^\circ$ was noted in 6 cases (2 for forearm, 2 for tibia & 2 for femur). 2 patients had delayed union but did not require revision surgery for femur fracture. Out of all upper limb patients, 4 patients had loss of carrying angle $<10^\circ$. 18 patients (14.5%) reported nail irritation. Around 33% of patients (7 patients) treated for femur fracture developed nail irritation. There were no cases of septic arthritis, rotational deformity, pulmonary embolism, compartment syndrome, stiffness, non-union, and abnormal gait patterns after the fractures healed. In our surgery, 88% (109 Patient) had excellent to good, 12% (15 Patient) had fair outcome as per Flynn criteria^[2].

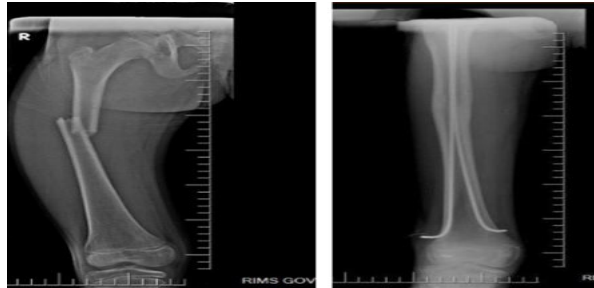
CASE 1:



Preop x-ray

7 weeks old union x-ray

CASE 2:



Preop x-ray

POST union x-ray

CASE 3:



Preop x-ray

POST union x-ray

CASE 4:



Preop x-ray

POST union x-ray

DISCUSSION:

Titanium nail surface promote monocytic lineage-derived cells encouraging recruitment of macrophages surrounding the implant. Titanium surface decrease osteoclast development through the integrin 1 / FAKpY397 signalling pathway, relieving osteoclast-induced osteogenesis inhibition.^[3] It promotes anti-inflammatory phenotype of macrophage leading to encouragement of osteoblastic mineralisation. Being toxic to microbials, it has both antimicrobial & osteoinductive property that can be beneficial in paediatric fracture patients.^[3]

D Furlan et al^[4] conducted study one 173 children to evaluate the effectiveness of TENS nail in paediatric patients. His study consisted of 55 humerus, 42 forearm, 42 femur, 36 tibia fracture. He found average age of 11.7 years which is comparable to 10.5 years in our study. He noticed bony union in 7.5 weeks on average which was similar to our study. He found bony union in 7.2 weeks in humerus (7.8 weeks in our study), 6.4 weeks in forearm (7 weeks in our study), 8.9 weeks in femur (8 weeks in our study), 7.6 week in tibia (9 weeks in our study). He noticed satisfactory results in all the cases. He noticed 6 patients of skin irritation & 2 cases of protrusion of nail. O'Brien et al. reported average radiological union in tibia by 8 weeks.

Lascombes et al^[5] with 76 cases found excellent results in 92% cases which is comparable with our study.

CONCLUSION:

TENS gives favourable results, low complication, Minimum disturbance in fracture biology, early union, better stabilisation to deforming forces with a quick mobilisation while treating paediatric long bone shaft fractures. It can also decrease the risk of infection. Post operative pain is minimal & satisfactory for patients. 88% of patient had excellent to good outcome, 12% fair with no poor outcome in this

study. The procedure is simple, rapid, less radiation exposure & require some skill for surgeon. Based on our results, we can conclude that TENS nail is ideally suited surgery for paediatric long bone shaft fractures.

Conflict Of Interest: None

Funding Resources: None

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