

Research Article
Orthopaedics

DIAPHYSEAL FRACTURES IN CHILDREN TREATED WITH TITANIUM ELASTIC NAILING SYSTEM A PROSPECTIVE STUDY

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Abstract:

Aim : To study the effects of Titanium elastic nailing system in treating diaphyseal fractures in children.

Materials & Methods : In a series of 30 cases, during July 2015 to June 2017, in Maharaja Institute of Medical Sciences. Both bones were fractured in 25 patients, four fractured only the radius, and one experienced ulna fracture. 17 had unstable irreducible fractures, 13 had loss of reduction. Titanium elastic nails were used to stabilize the fractures. All fractures were immobilized postoperatively with an above-elbow plaster slab for 2 weeks till the swelling was completely resolved followed by encouraging range of motion exercises.

Results : Of 30 cases in this study 20 cases were male and 10 cases were female, average age of 8 yrs. Closed reduction and TENS was successful in 22 cases, including 25 double-bone fractures and five single- bone fractures. Open reduction was completed in 3 fractures of both bones, and in 5 single-bone fractures. Bone union was achieved in all patients at an average of 7 weeks. The ROM of the forearms was evaluated using the Flynn et al grading criteria. Excellent results were reported in 97% without significant complications after a mean follow-up of 20 months.

Conclusion : Titanium elastic nailing system for fixation of pediatric forearm fractures revealed several advantages, a small incision for insertion, a low rate of complications, unhindered bone healing, easier hardware removal

and good clinical and radiological results thus achieving maximum range of motion at the earliest.

Key words: TENS-Titanium elastic nailing system.

Introduction

In the last two decades, there was an increased interest in the operative treatment of paediatric fractures, although debate persisted over its indications. There is a little disagreement concerning the treatment of long bone fractures in children less than 6 years (POP cast) and adolescents older than 16 years (locked intra medullary nail), controversy persists regarding the age between 6 to 16 years. Pediatric bone is much more porous than adults. Bone absorbs more energy prior to failure than the adult bone.

Titanium elastic nail (TEN) fixation was originally meant as an ideal treatment method for femoral fractures, but was gradually applied to other long bone fractures in children, as it represents a compromise between conservative and surgical therapeutic approaches with satisfactory results and minimal complications.²

It is pointed out increasing level of treatment difficulties as the level of forearm fractures moves proximally. More proximal fractures tend to occur in older children.

Fractures of forearm bones are the most common traumatic pediatric orthopedic injuries. Distal radius and ulna are more commonly affected. The peak incident is in pre-adolescent group spurt. Biomechanical studies suggested the junction of middle and distal 3rd increased vulnerability to fracture, often rotational component, which causes fractures at different levels.

Pediatric bone is more porous than adult, because of its porosity, bone absorbs more energy prior to fracture. The majority of these fractures can be treated well with closed reduction and cast immobilization due to the unique property of the growth potential of the

immature bones.

The most common indications for surgery are failure of closed reduction, open fractures, and fracture instability. In these situations, if left untreated, malunion is more likely to occur, which will disturb the function of the upper extremities.^{4,5} Operative intervention has been recommended in prior studies for angulation $>10^\circ$, malrotation displacement $>50\%$.^{11,12,14,15}

This article analyzes the results of 30 diaphyseal forearm fractures in children. All patients in this study underwent Titanium elastic nailing system fixation.

Relevant anatomy Radius

The radius is situated on the lateral side of the ulna, which exceeds it in length and size. Its upper end is small, and forms only a small part of the elbow-joint; but its lower end is large, and forms the chief part of the wrist-joint.

The shaft of the radius is a three sided structure with two prominent curvatures. One major convexity in its mid-portion. Second curvature is more acute near the bicapital tuberosity. The deviation along the mid-portion is referred to as radial bow and maintenance of this normal contour is a goal of forearm shaft fracture cases.

The upper half is cylindrical while the lower half is comparatively flatter.

Lower Extremity The lower extremity is large, of quadrilateral form, and provided with two articular surfaces—one below, for the carpus, and another at the medial side, for the ulna. The carpal articular surface is triangular, concave, smooth, and divided by a slight antero-posterior ridge into two parts. Of these, the lateral, triangular, articulates with the navicular bone; the medial,

quadrilateral, with the lunate bone. The articular surface for the ulna is called the ulnar notch (*sigmoid cavity*) of the radius.

The most important bony landmarks of radius are-

Radial styloid

Bicapital tuberosity oriented 135° from each other.

Maintenance of the styloid – tuberosity rotational relationship is another forearm principle.

Ulna

Ulna shaft is a somewhat straight bone.

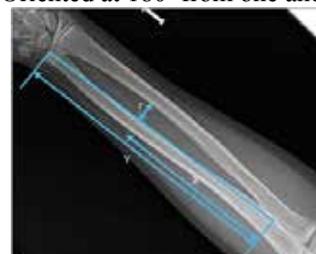
The Upper Extremity - It is broad and articulates with trochlea. It consists mainly of olecranon and coronoid processes, which are important in maintaining stability of elbow joint.

The Lower Extremity —The lower extremity of the ulna is small, and presents two eminences; the lateral and larger is a rounded, articular eminence, termed the head of the ulna; the medial, narrower and more projecting, is a non-articular eminence, the styloid process. The most important bony landmark of ulna –

Styloid process

Coronoid process

Oriented at 180° from one another.



Materials & Methods

The study was done in our teaching institution M.I.M.S. we did 30 cases in 2 yrs. span July 2015 to June 2017.

Inclusion criteria – age 5 to 16yrs, simple fractures, Diaphyseal fractures, Ipsilateral fractures.

Exclusion criteria – Infective

cases and compound fractures, pathological fractures, Metaphyseal fractures.

Union is defined as no pain at the fractured site, no pain with weight bearing.

Both bones were fractured in 25 patients, four fractured only the radius, and one experienced ulna fracture. 17 had unstable irreducible fractures, 13 had loss of reduction. Titanium elastic nails were used to stabilize the fractures. All fractures were

immobilized postoperatively with an above-elbow plaster slab for 2 weeks till the swelling is completely resolved followed by encouraging range of motion exercises. Patients underwent regular postoperative follow-up in the clinic at 2-week intervals and range of motion exercises are encouraged. Follow-up examination of patients included progress of fracture healing, range of motion (ROM), angular deformities, and measurement of limb length. Outcome is evaluated by Flynn et al grading criteria.

Results at 24wks	Excellent	Excellent	Poor
Limb-length inequality	< 1.0 cm	< 1.0 cm	< 1.0 cm
Mal alignment	5 degrees	10 degrees	>10 degrees
Unresolved pain	absent	absent	present
Other complications	none	Minor & resolved	Major & lasting morbidity

Flynn et al grading criteria.

Surgical management

Pre- operative planning

Nail width

The diameter of the individual nail is selected as per Flynn et al formula.

Flynn et al's formula^{4,5,7}

Diameter of nail= width of the narrowest point of the medullary canal on AP and lateral view X 0.4mm

In case of single nail usage, it's diameter should be more than 60% of the narrowest diameter of the medullary canal.

Nail length

Lay one of the selected nails over the forearm, and determine that it is of the appropriate length by fluoroscopy.

Procedure

All procedures done at M.I.M.S Nellimarla, vizianagaram A.P

(a teaching Institution in a rural

setup)

Under general anesthesia, a pneumatic tourniquet is positioned in case an open reduction is needed. A closed reduction is attempted. If the reduction cannot be maintained because of instability, a percutaneous intramedullary nailing is performed without opening the fracture site. If an acceptable reduction cannot be obtained, then open reduction through limited approach and intramedullary fixation is performed.

The radial bone is approached through one cm longitudinal incision performed on the lateral side of the distal metaphysis. A hole is drilled in the bone with an awl, first perpendicularly and then obliquely towards the elbow. Then an appropriate size titanium flexible intramedullary nail (with its proximal 5 mm pre-bent at 30°) is introduced and pushed retrograde with a hammer if necessary, to the fracture site. The fracture is reduced by external manipulation and

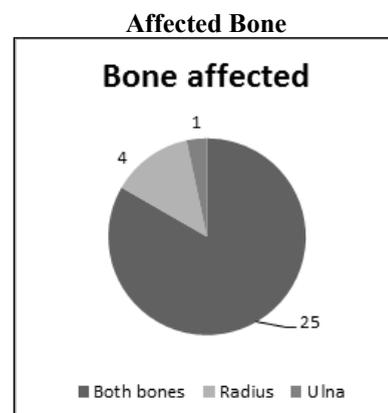
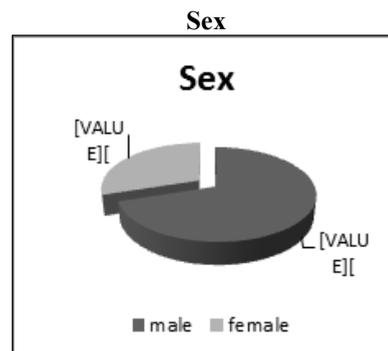
the nail is pushed proximally and fixed into the proximal metaphysis. The distal end of the nail is then cut 5-10 mm from the bone. The skin is closed with one stitch. Same procedure is performed for the ulna starting distally and pushing the nail retrograde.

Post-operative care

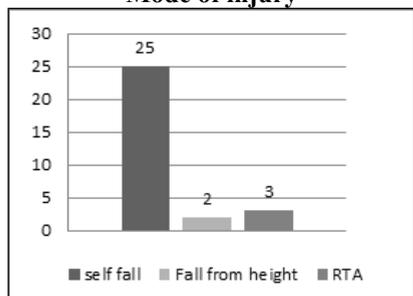
All fractures were immobilized postoperatively with an above-elbow plaster slab for 2 weeks till the swelling is completely resolved followed by encouraging range of motion exercises.

Results

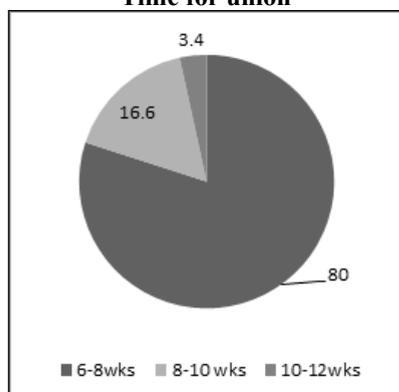
Age		
Age in yrs	N	%
5-8	13	43.3
9-12	7	23.4
13-16	10	33.3
Total	30	100



Mode of injury



Time for union



Range of movements at 24 wks

Range of movements	N	%
Full range	29	96.66
Mild restriction	1	3.33
Moderate restriction	0	
Severe restriction	0	
Total	30	

Complications

Of 30 cases 2 patients got superficial infection which was treated successfully with antibiotics.

Outcome

Excellent	Satisfactory	Poor
93.33%	6.67%	0

Discussion

Surgical intervention is required when there are unstable fractures and when closed reduction can't be achieved.¹⁶

Surgical intervention is need in old and obese children.

The disadvantages of surgical intervention included the need for surgical dissection, removal of

implants, risk of refracture from the screw holes, or further neurovascular compromise.

Management of forearm diaphyseal fractures in children use of external fixator has a limited role.^{7,21} for fixation of forearm fractures in children there is recent shift of interest in the use of titanium elastic nails.^{8,22,23}

This surgery offers stable fixation without disturbance of the periosteal blood supply or removal of the hematoma, which contributes to fracture healing. This method also allows for micro-motion to stimulate the callus to bridge the fracture gaps.

Intramedullary fixation promotes rapid union, reduces the risk of infection and synostosis, and avoids unsightly incisions that are necessary for plate fixation and hardware removal.¹²

There are very few complications reported in this study.^{24,26}

Earlier Intramedullary fixation of forearm fractures has been long reported in the adult literature and only more recently has been applied to the treatment of forearm fractures in children.^{8,9,24,25,28,29,31} the mean age of incidence was 9 yrs in our study, with males more commonly affected. 25 both bones, 4 Radius only, 1 Ulna only involved. Self-fall was the commonest cause of injury n = 25. Early union of 6-8wks was achieved in 80% of the cases. Full range of movements was achieved in 29 cases, and mild restriction in only one case. Superficial infection of entry was seen in 2 cases was completely resolved after using antibiotics.

All fractures were immobilized postoperatively with an above-elbow plaster slab for 2 weeks till the swelling is completely resolved followed by encouraging range of

motion exercises.

93.33% cases we achieved an excellent outcome, and 6.67% satisfactory outcome.

Prebent flexible nails biomechanically act as internal splints and forms internal 3 point fixation construct.

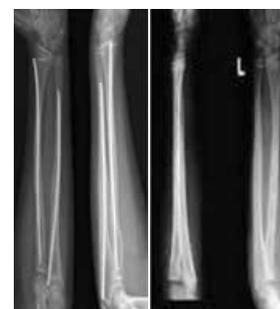
We fixed the bone that is easy to reduce.

Too large nail make incarceration and distraction at the fracture site especially in the ulna.

Large nail increases fixed rigidity and decrease callus formation leading to delayed union and non-union. Attention to restoration of appropriate radial bow is necessary. We remove the implants 12 months after surgery.

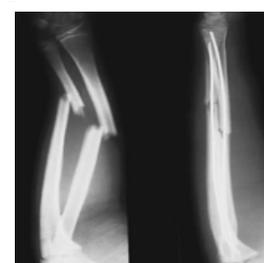


6 weeks

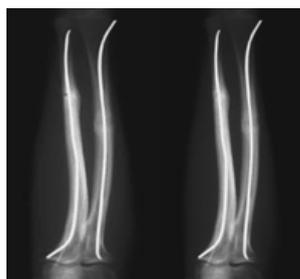


12 week 24 week

Case 1



pre op 6wks



12wks 24wks
Case 2

Conclusion

Based on our study we conclude that use of titanium elastic nailing system for intramedullary fixation of forearm diaphyseal fractures in children is an excellent method of choice. It is also useful for old and obese children. It gives elastic mobility promoting rapid union at fracture site and stability which is ideal for early mobilization. Except few complications, excellent outcome when compared to other modes of treatment.

It's an easy, simple, rapid, reliable and effective method for management of paediatric long bone fractures between the age of 5 to 16 years, with shorter operative time, lesser blood loss, lesser radiation exposure, shorter hospital stays, and reasonable time to bone healing. Especially TENS is useful for rural setup where our hospital is situated.

Titanium elastic nailing system can be considered a physiological system.

As there is an excellent outcome of this procedure in our study, surgical management of all unstable and potentially unstable diaphyseal fractures of forearm in children irrespective of age, with titanium elastic nailing system is the best modality of management, especially in a rural setup like Maharaja Institute of medical sciences.

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