



E-ISSN: 2395-1958  
P-ISSN: 2706-6630  
IJOS 2020; 6(4): 01-07  
© 2020 IJOS  
[www.orthopaper.com](http://www.orthopaper.com)  
Received: 01-08-2020  
Accepted: 04-09-2020

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## Functional outcome of flexible nailing in unstable fractures of both bones of forearm in paediatric population

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DOI: <https://doi.org/10.22271/ortho.2020.v6.i3n.2309>

### Abstract

**Aim and Objective:** Antebrachium fractures are one of the common fractures in paediatric population. Fractures of forearm comprises of about 40% in the fractures of paediatric population [1]. These fractures usually have a high degree of remodelling potential and are usually managed non operatively by closed reduction and maintaining it in a plaster cast. Nowadays the trend for management of these fractures changes towards operative management because of increasing complications by nonoperative methods. The aim of this study is to evaluate the functional outcomes of unstable both bone forearm fractures treated operatively using titanium elastic nailing.

**Materials and Methods:** Study was conducted in the department of orthopaedics at Rajah Muthiah Medical College and Hospital. Total of 20 patients aged were treated using TENS. Closed reduction with internal fixation under c-arm guidance was done in 13 cases and open reduction with internal fixation was done in 7 cases.

**Results:** Patients were followed up for a period of 6 months. Results were analysed with respect to union of fracture, symptoms with activities, range of motion of joints adjacent to the fracture using Price *et al.* criteria and Anderson *et al.* criteria. In all cases fractures united at an average of 8 - 10 weeks without any malunion. All 20 cases had excellent outcomes. 3 patient had nail prominence on the ulnar entry side leading to superficial pin site infection.

**Conclusion:** Fixation of both bone fractures of forearm using titanium elastic nailing systems showed many advantages over the conventional plating methods, in terms of smaller incision, minimal soft tissue meddling during fracture fixation, prompt osseous healing, maximum range of motion at the earliest, decrease in complication rate with excellent clinical and radiological results. Thus, titanium elastic nailing used intramedullary is an effective treatment option for the treatment of unstable both bone forearm fractures in paediatric population.

**Keywords:** both bone forearm fracture, paediatric age group, tens nail, elastic nailing

### Introduction

Diaphyseal fractures of forearm are one of the common orthopaedic injuries in the paediatric population. In most cases these fractures are treated nonoperatively by closed reduction and immobilisation with plaster casting due to the remodelling capacity of the immature bones. Nevertheless, there is a subset of patients in whom surgical intervention is indicated [2-3]. In cases where closed reduction could not be achieved or there is fracture instability and in open fractures were non operative treatment will lead to complications like mal-union, they are treated by surgical means. Children aged more than 10 years do not remodel as predicted; thus, reduction standards are less uniform [4-6]. Operative intervention has been recommended in previous studies for angulation  $>10^\circ$ , malrotation displacement  $>50\%$  [4, 5, 7, 8]. The available surgical options commonly done are open reduction and plate osteosynthesis and closed reduction and internal fixation with titanium elastic nailing. Surgical management with elastic intramedullary nail in paediatric both-bone forearm fracture has been first described by Metaizeau and Ligier [9].

Even though the optimal treatment remains controversial, increased interest prevails in determining which method can provide near perfect optimal results. Forearm fracture fixation with flexible nails have gained popularity, with proponents arguing that nailing results in decreased surgical dissection and retention of biologic factors at the fracture site [10]. Because of the elastic properties of the titanium nail (Ti 6Al14V), which gives improved stability and rotation helping in fracture stabilisation, they are preferred in clinical practise than the stainless-steel nails. In addition, titanium nails provide flexural stability, translational stability, axial stability and rotational stability which are necessary for optimal fracture union.

### Materials and Methods

Study was conducted between 2018 - 2020 in the department of orthopaedics at Rajah Muthiah Medical College and Hospital. 20 paediatric cases with unstable both bone fractures of forearm operated with titanium nails were included in this study. Patients with <50% cortical contact, >10° angulation in sagittal and coronal plane were expounded as unsatisfactory alignment. Closed reduction with internal fixation was done in 13 cases and open reduction with internal fixation was done in 7 cases. Above elbow slab was given to all patients postoperatively for a brief period. Patients were followed up at regular intervals. Fracture union, symptoms, range of motion, residual deformities, limb length measurement were assessed at intervals of 1, 3 and 6 months. For measuring the range of motion goniometer was used and compared with the opposite limb. Price *et al.* criteria and Anderson *et al.* criteria were used for outcome evaluation.

### Surgical Procedure

Patient was placed supine on the operating table with the arm on a radiolucent side table. Under sterile aseptic precautions, under general anaesthesia / regional anaesthesia, tourniquet was applied to the fractured limb at the level of arm with adequate padding, parts painted and draped. Incision of size 1 cm was placed over the distal radius above the physal line on the lateral aspect. Entry made into the medullary cavity using bone awl over the lateral aspect of distal radius above the physis. In another method, some surgeons prefer to make incision over the dorsal aspect of lister's tubercle and entry made just little lateral to the lister's tubercle after retracting the extensor pollicis longus. Depending on the diameter of the medullary cavity, titanium nail of approximate size was chosen. A 30° angulation was given to the proximal tip of the nail. Then the nail with bent tip was introduced into the medullary cavity where the entry was made in the distal radius. 180° rotation was given to the nail with the T-handle and nail tip was brought along the axis of medullary canal. Under c-arm guidance, nail was advanced into the medullary canal in twisting motions and then passed across the fracture site into the proximal fragment, till the nail tip reaches the radial head. For ulna, incision was placed over the olecranon tip. Entry was made little lateral and distal to the olecranon apophysis using bone awl. Similar to radius titanium nail of approximate size was measured and introduced into the medullary cavity in similar fashion from proximal fragment to distal fragment. Reduction of fracture fragments was checked under c-arm. If it was found to be satisfactory, protruding ends of the nail were initially bent at about 90° and were cut 1cm away from the bone. If closed reduction cannot be achieved, a small incision was made over the fracture site and the fracture was reduced and fixation was done with titanium

nail. Wound wash was given and skin incisions were sutured with 3-0 monofilament non-absorbable suture. Post operatively, an above elbow slab was given to encourage soft tissue healing. Parenteral antibiotics were given for 3 days and then changed to oral antibiotics. Implant removal was done after 6 months post operatively after seeing radiological union.



Fig 1: Positioning the Patient



Fig 2: Incision for radius



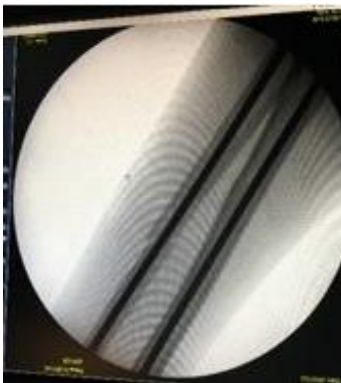
Fig 3: Radial Tens Entry



**Fig 4:** Incision for Ulna



**Fig 5:** Ulnar Tens Entry



**Fig 6:** Fracture Reduction








**Fig 7:** Proximal End



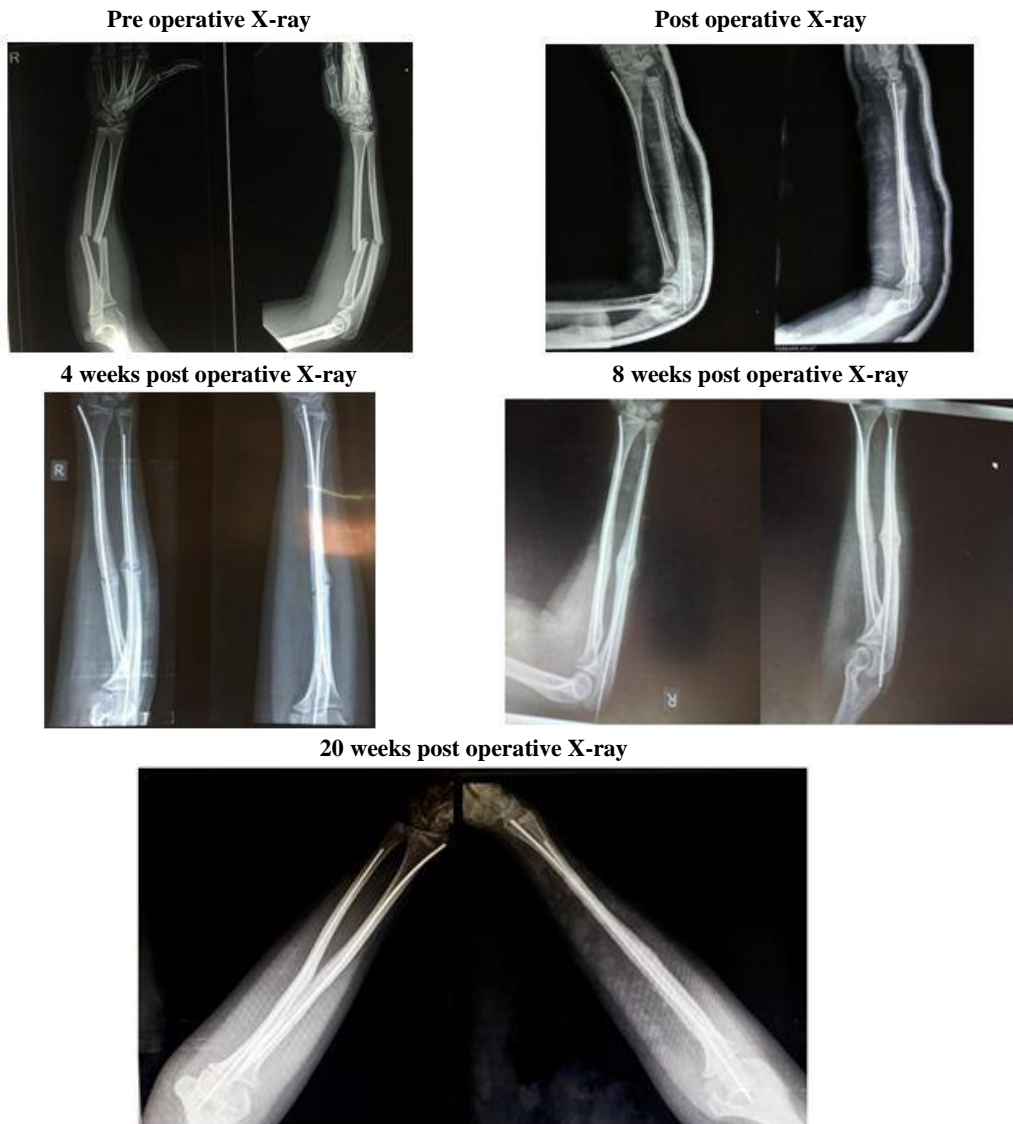
**Fig 8:** Distal End

**Case -1**

Pre operative X-ray	Post operative X-ray
	
4 weeks post operative X-ray	8weeks post operative x-ray
	
20 weeks post operative x-ray	
	



**Case 2**



**Clinical Picture  
Flexion**



**Extension**



**Neutral**

**Pronation**

**Supination**



**Results**

In order to evaluate the final functional and radiological outcome, our study utilised two criteria namely Price *et al.* criteria [11] and Anderson *et al.* criteria [12].

**Price *et al.*, Criteria**

Clinical outcome	Symptoms	Loss of forearm rotation
Excellent	No complaint with strenuous work	< 11*
Good	Mild complaint with strenuous work	11* - 30*
Fair	Mild complaint with daily work	31* - 90*
Poor	All other results	

**Based on Anderson *et al.* scoring system**

Results	Union	Flexion / Extension at elbow joint	Supination and pronation
Excellent	Present	<10* loss	<25* loss
Satisfactory	Present	<20* loss	< 50* loss
Unsatisfactory	Present	>20* loss	> 50* loss
Failure	Non union with / without loss of motion		

In our study, by using both criteria, all the 20 patients had excellent outcomes, with regards to radiological union and range of movements.

**Complications**

In our study 3 patients had infection at the ulnar entry site, because of leaving the implant protruding out of the skin, which were treated using oral antibiotics. In successful cases, this complication was avoided by burying the implant little deeper under the skin. No other complications such as osteomyelitis, non-union, malunion, implant failure, compartment syndrome was noted in our study.



**Fig 9: Complications**

**Discussion**

Initially all paediatric both bone forearm fractures are managed conservatively. But now there is a change in the management of these fractures, because of the higher complications following conservative management. These fractures have a higher tendency to go for malunion due to improper reduction and redisplacement following closed reduction and casting. In a study conducted by Kay *et al.* [13], children aged more than 10 years will have a remarkable decrease in forearm movements due to closed reduction manoeuvres resulting in angulation more than 10°. Treatment of these forearm fractures through non operative treatment had more complications than operative treatment [14]. Surgical treatment should be considered in patients with unstable forearm fractures, if acceptable alignment cannot be achieved with closed reduction manoeuvres. The remodelling potential particularly in older children will be limited, hence fractures with complete displacement are more commonly addressed by

surgical treatment [15]. Surgical intervention by classical fixation technique of open reduction and plating with physis sparing, provides anatomical reduction and stable fixation with earlier mobilisation of the joints [13]. The conventional plating methods has the disadvantage of surgical dissection to open the fracture site, loss of fracture hematoma, periosteal stripping, implant removal, higher chance of refracture due to stress shielding effect due to plating and possible neurovascular injury. Vainionpaa *et al.* [16]. Stated that out of 10 patients, 5 had restricted forearm movements with loss of functional outcome because of the soft tissue compromise, treated with plate fixation. There is a 42% rate of neurovascular complications following implant removal of plates and screws after osseous union in the forearm [17]. Radio-ulnar synostosis can also be found in some rare cases [18].

Recent studies regarding fractures of forearm fixation in paediatric population suggest intramedullary nailing has registered excellent outcomes and also has the advantage of nailing than plating in paediatric population [3, 19]. Intramedullary nailing helps in early union, decreases the infection risk and synostosis, and prevents making long incisions required for plating and its removal [5]. But the use of kirschner wire for fixation of these fractures intramedullary also had many disadvantages like penetration of k - wire, infection at the pin sites, restriction of movements in the involved forearm, delay in union of fractures [14]. To avoid these complications and to use the advantages of intramedullary fixation, titanium elastic nailing system is used. They act as internal splints, providing 3point fixation of fractures which helps in maintaining the alignment [20]. Reduction of fracture end to end is achieved, which helps in controlling rotational alignment and reduced motion at the fractured area promotes external callus formation by the conversion of shear stress into compression [4].

Study conducted by Furlan D *et al.* [21] in unstable both bone forearm fractures in paediatric age group, showed the advantages of intramedullary nailing. They concluded nailing using elastic nail is the preferred method in children as it is less invasive and gives excellent functional outcome, as well as cosmetic results. Wall L *et al.* [22] demonstrated a retrospective study on 32 cases of age group between 12- 18 years, who were treated using intramedullary nailing for fractures of both bone forearm and concluded flexible nailing in the treatment of forearm both bone fractures provides early union of fracture and shows excellent results in adolescents age group. Amit *et al.* [23] treated 20 adolescent patients using intramedullary nailing by closed method for unstable both bone fractures of forearm and all cases healed within 6 weeks without any complications. In his study of both bone forearm fractures, he recommended using intramedullary nailing over plate fixation, because of proper reduction, decreased complications, better cosmesis and easier implant removal under local anaesthesia. Chen CE *et al.* [24] suggested in his study that fractures of both bone forearm in paediatric age group requiring fixation should be attended with intramedullary nailing using titanium elastic nailing system. In a retrospective study of 75 paediatric patients conducted by salonen A *et al.* [25] recommended TENS nailing as implant of choice for the unstable forearm fractures, even though minor complications can be seen. Haoqi Cai *et al.* [26] in his study on 52 patients between 4- 14 years of age recommended the usage of prebent elastic nail by intramedullary fixation is a better technique for the management of distal radius fracture at the metaphyseal diaphyseal junction showing better

reduction of fracture, solid fixation and minimal migration.

## Conclusion

In paediatric patients with both bone forearm fractures, intramedullary nailing with titanium elastic nails provides excellent results in terms of both radiological union and functional outcomes. This technique has more merits than conventional plating methods as it is less invasive, simple and easily reproducible procedure with better cosmesis. As axial loading is negligible in forearm fractures, implant failure is also not commonly seen. Thus TENS can be advocated for its use in paediatric population due to its excellent objective and subjective results.

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