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**Dr. Hitesh Panchal**  
Assistant Professor, LG Hospital  
and AMC MET medial college,  
Ahmedabad, Gujarat, India

**Dr. Vinay Bhuria**  
Resident Doctor, LG Hospital  
and AMC MET Medial College,  
Ahmedabad, Gujarat, India

**Dr. Tapan Taviyad**  
Resident Doctor, LG Hospital  
and AMC MET Medial College,  
Ahmedabad, Gujarat, India

**Dr. Kuldeep Parmar**  
Resident Doctor, LG Hospital  
and AMC MET Medial College,  
Ahmedabad, Gujarat, India

### **Evaluation and outcomes of surgical management of radius Sulna diaphyseal fracture using titanium elastic nailing system (TENS)**

**Dr. Hitesh Panchal, Dr. Vinay Bhuria, Dr. Tapan Taviyad and Dr. Kuldeep Parmar**

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#### **Abstract**

**Introduction:** Management of radius ulna diaphyseal fracture in the age group of 3–17 years. The purpose of this study is to demonstrate the effectiveness of intramedullary fixation of radius ulna shaft fractures by using titanium elastic nailing system (TENS).

**Materials and methods:** 40 pediatric patients (31 boys, 9 girls) aged 3–17 years with diaphyseal radius ulna fractures were treated by TENS fixation. The final results were evaluated by using criteria.

**Results:** 100% Pediatric patients had excellent to good results radiological results and 95% Pediatric patients had excellent to good functional results.

**Conclusion:** TENS is a safe and effective method for the treatment of pediatric radius ulna shaft fractures, because it is minimally invasive, relatively easy to use and shows very good functional and cosmetic results.

**Keywords:** Evaluation, outcomes, management, elastic, TENS

#### **Introduction**

Forearm fractures represent one of the most common fractures in children; a distinction is made between fractures of the radius or the ulna only, and fractures of both the radius and ulna. Furthermore, a differentiation is made between incomplete fractures typical for children (torus, greenstick and bowing) and complete fractures that occur in children as well as in adults. The treatment of these both-bone forearm fractures depends on anatomical location (proximal metaphysis, distal metaphysis or diaphysis) and fracture displacement (minimally displaced or severely displaced).

Various techniques of internal fixation of these fractures had been reported in the literatures. Current understanding of bone biology led to a new approach that is the "biological fixation of fractures". The later considers the importance of soft tissue preservation and careful protection of viable bone as main targets. Intramedullary nailing of forearm fractures was successfully used long time ago. The advantages of the closed nailing technique include early union, low incidence of infection, small scars, less blood loss, and, frequently, relatively short operating time with minimal surgical trauma.

#### **Methods and Materials**

We have done a study of 40 patients with FRACTURES OF BOTH FOREARM BONES operated with Intramedullary Nailing In Paediatric Patients At Our Institute with follow up of 6- 24 months.

#### **Methods of collection of data**

- By interview
- By regular follow up at monthly intervals
- By clinical examination
- By analyzing case papers
- Inclusion and Exclusion Criteria:

**Corresponding Author:**  
**Dr. Vinay Bhuria**  
Resident Doctor, LG Hospital  
and AMC MET Medial College,  
Ahmedabad, Gujarat, India

**Inclusion Criteria**

- Patients with fractures of the shaft of radius and ulna.
- Both male and female
- 3 year to 17 year of age
- Unilateral or bilateral forearm bones

**Exclusion Criteria**

- Associated Neurovascular injury
- Pathological fractures
- Monteggia and Galeazzi Fractures
- Fractures with extensive comminution

**Design of implant used**

Titanium elastic nail (TENS NAIL) were used for most patients for both radius and ulnar repair. TENS Nail (Titanium Elastic Nail) are intended for fixation of diaphyseal fractures where the canal is narrow or flexibility of the implant is paramount. Nail diameters were 1.5mm, 2.0mm, 2.5mm, 3.0mm, or 3.5mm, 4mm with nail lengths 440mm for all surgical procedures.

**Operative procedure**

Under General or regional anesthesia, the relaxation obtained with general anesthesia improves the chances of achieving a closed reduction.

The patient is placed supine on an operating table, and a radiolucent arm table is used to support the extremity. The shoulder is abducted and internally rotated, and the elbow is flexed to 90 degrees. The elbow is "bumped" with a stack of towels for easier access to the olecranon. Fracture reduction can be accomplished by a closed or open method. Closed nailing is preferable because it preserves blood supply and enhances fracture healing. Closed reduction is achieved by longitudinal traction or direct pressure at the fracture site. Traction devices with finger traps have not been successful. When the fracture fragments are locked in bayonet apposition, a mini-open technique through a 2- to 4-cm incision may be used to reduce the fragments.

- **Entry Portal**

A tourniquet is used whenever possible to minimize blood loss. If both bones are fractured, the radius is approached first. However, both bones are prepared for nailing before nailing is initiated in either bone.

**Radius nailing**

The radius is approached through the Lister tubercle or radial styloid

**Lister Tubercle Entry**

Pros:

- a. Curve of nail can be easily adjusted.
- b. Nail impingement is less.
- c. Superficial branch of Radial Nerve not endangered.

**Cons**

- a. Damage to extensor tendons of second and third compartments is possible.
- b. Dorsal Scar might be cosmetic problem.

A 2cm incision is made just lateral to Lister's tubercle at the

distal radius. The extensor retinaculum is divided to expose and identify the extensor pollicis longus (EPL) tendon which is then released from its sheath around Lister's tubercle. The interval between the short and long wrist extensors is identified. The interval between the extensor carpi radialis longus (ECRL) is developed. The EPL is retracted radially with the ECRL. The distal edge of the radius must be identified to avoid inadvertent insertion through the scaphoid. The medullary canal is entered obliquely through dorsal margin of the radius. The awl is introduced at a point 5 mm from the distal edge of the radius. The awl is started vertically so entry into the bone can be gained. The wrist is flexed and placed over a stack of towels to prevent inadvertent perforation of the volar cortex. The wrist is flexed, and the awl is brought into a more horizontal direction to avoid penetration of the volar cortex.

A radius nail of appropriate size is selected and pre-bent to match the radial contour. The radius nail is loaded over the T-handle with a Jacob's chuck and pushed with the bevelled edge of the radius nail sliding over the volar surface of the radius. The assistant hold and assists in reduction of the fracture. The position of the nail is checked repeatedly under C-arm in both planes during the procedure. The radial nail is inserted up to the proximal border of the bicipital tuberosity of the radius. Distally the nail is buried flush with the bone.

**Ulna nailing**

An incision of 1cm over the olecranon tip was made deep down to the bone. (fig) Entry is made with an awl suited for the radius-ulnar nail diameter. The position of the awl is checked under C-arm image intensifier in the anteroposterior and lateral view. (fig) No reaming is generally required with insertion of the nails. An ulnar nail of appropriate size is selected and loaded over a T-handle. The nail is pushed free hand into the medullary canal of the ulna while the assistant applied traction in the position favouring reduction, depending on the type of fracture. If the nail did get jammed, it can be hammered lightly so that it made its way into the medullary canal. Because the ulna bows toward the radius in the proximal third, the point of insertion for the ulna is toward the radial side of the olecranon, and is made approximately 5 mm from the lateral cortex. The position was checked using the C-arm. The distal end of the nail is usually within 1 cm of the tip of ulna. The end of the nail is buried inside the olecranon.

- **Postoperative management**

All patients were immobilized with an above elbow slab and asked to perform active finger movements. Movement of the thumb was especially checked for any injury to the EPL tendon during surgery.

Patients were discharged on the 3rd to 4th day post-op with an above elbow plaster. Sutures were removed after 10-14 days and an above elbow cast was applied for further two to three weeks. Forearm was then immobilized in the sugar tong cast for a period of another 4 weeks. In most of cases elbow mobilization is started with sugar tong cast. And then wrist and forearm mobilization is started after removal of sugar tong cast. Patients were evaluated 4-weekly intervals till union and then at 3-monthly intervals.



**Fig 1:** Entry is made with an awl suited for the radius-ulnar nail diameter

### Observations

All the cases in our series were treated with Intramedullary fixation. The analysis of the patient data, intra operative data & post-operative outcome is as follow-: Youngest age was 3 and oldest was 17 with an average of 10.3 years. Maximum number of patients were from age group of 9-12 years [35%]. Majority of patients in our study were males (57.5%). Left side [55%] was most affected. In pediatric patients domestic

fall [75%] was most common cause of injury, follow by road traffic accident [22.5%] and assault [2.5%]. Most forearm shaft fractures were located in middle third [50%] Most patients in our study had closed fracture. There were 06 patients with open fractures with 04 patients having Grade I Open injury. 08 patients (20%) required mini open reduction after unsuccessful closed reduction. Average duration of surgery was 43 minutes. Average time of union was 8 weeks.

**Table 1:** Range of Movement

Range of Movement	Wrist Flexion		Range of Movement	Wrist Extension	
	Number of Patients	Percentage		Number of Patients	Percentage
Full to < 5 degree loss (Excellent)	34	85.00%	Full to < 5 degree loss (Excellent)	35	87.5%
5-10 degree loss (GOOD)	05	12.5%	5-10 degree loss (GOOD)	03	7.5%
10-15 degree loss (FAIR)	01	2.5%	10-15 degree loss (FAIR)	02	5%
> 15 degree loss (POOR)	00	0.00%	> 15 degree loss (POOR)	00	0.00%
Total	40		Total	40	
Range of Movement	Supination		Range of Movement	Pronation	
	Number of Patients	Percentage		Number of Patients	Percentage
Full Range to <10 degree loss	34	85%	Full Range to <10 degree loss	30	75%
10- 20 degree loss	04	10%	10- 20 degree loss	06	15%
20-30 degree loss	02	5%	20-30 degree loss	04	10%
30-40 degree loss	00	00%	30-40 degree loss	0	0.00%
>40 degrees loss	00	00%	>40 degrees loss	0	0.00%
Total	40		Total	40	
Range of Movement	Hand Radial Deviation		Range of Movement	Hand Ulnar Deviation	
	Number of Patients	Percentage		Number of Patients	Percentage
21-25 degrees (Excellent)	18	45%	35-40 degrees (Excellent)	25	62.5%
18-20 degrees (Good)	15	37.5%	31-35 degrees (Good)	15	37.5%
15-17 degrees (fair)	05	12.5%	<30 degrees (Poor)	00	0.00%
<15 degrees (Poor)	02	5%	Total	00	
Total	40				

Pediatric patients had better supination than pronation. There was 5% patients had more than 20 degree supination lose. There was more loss of pronation than supination in paediatric patients. The loss of pronation of more than 20 degrees was seen in 04 [10%] patients. No pediatric patient had >30 degrees loss of pronation or supination. Majority of pediatric patients had good to excellent wrist range of flexion and extension. Majority of pediatric patients had some loss of radial deviation. But all the pediatric patients showed excellent (62.50%) to good (37.50%) ulnar deviation. This might be due to the distal radial entry used for nail insertion.

### Complications

17.5% Patients had minor complications. No patient had non-union. Superficial Infection was seen in 2 patients (5%). Nail impingement was seen in 2 patients (5%). Backout of nail was seen in 1 patient and bursitis was seen in 2 patients (5%).

### Results

100% Pediatric patients had excellent to good results radiological results and 95% Pediatric patients had excellent to good functional results.

**Table 2:** Radiological and Functional Outcome Results

Results	<17 years			
	Radiological Outcome		Functional Outcome	
	No.	%	No.	%
Excellent	25	62.5%	34	85%
Good	15	37.5%	04	10%
Fair	00	0.00%	02	05%
Poor	00	0.00%	0	0.00%
Total	40		40	

### Discussion

The incidence of forearm shaft fractures was more in male

patients in all the studies. In our study it was 57.50%. Fall on out stretched hand were most common cause of forearm shaft fractures in our study followed by Road traffic accidents. Some studies reported assault by blunt trauma as significant cause of modality for forearm shaft fractures. In the present study most common level of fracture was found to be middle third, which is comparable to all the other series. In our study 20% cases required mini-open fracture reduction for irreducible fractures which was comparable to all other studies. The average period of POP immobilization was 5.75 weeks. Smith & Sage showed that 88% of their patients need immobilization for 10 weeks [7]. Talwalkar used cast for 10 days only, Moda *et al.* used POP cast for an average of 3 weeks while using TENS nails.

**Table 3: Radiological Union**

Series	Radiological Union
Moda S.K. [1]	12.52 weeks
Moerman <i>et al.</i> [2]	10.4 weeks
Rao <i>et al.</i> [3, 4]	6-8 weeks
N. Lil [5]	12.8 weeks
Present Study	8 weeks

Average union time in our study was 8 week, Pediatric patients showed union at around 6 weeks, which was comparable to Rao *et al.*, at 6-8 weeks.

**Table 4: Complications**

Series	Bursitis	Infection	Non Union
Talwalkar A.K. [6]	5.56%	2.78%	0.00%
Moda S.K.	None	10.00%	6.67%
Moerman <i>et al.</i>	None	1.43%	6.00%
Rao <i>et al.</i>	6.25%	6.25%	None
N. Lil	1.00%	5.88%	8.82%
Present Study	5%	5%	0.00%

Most common complications found were bursitis, infection and non-union. Rates of bursitis and infection were same as other series. Rates of non-union was significantly lower than that of other series.

**Table 5: Outcomes**

Series	Outcomes	
	Excellent + Good	Poor
Talwalkar A.K.		
Moda S.K.	93.40%	6.70%
Moerman <i>et al.</i>	80.00%	6.70%
Rao <i>et al.</i>	96.20%	3.80%
N. Lil	79.41%	5.88%
Present Study	95%	0.00%

The results of this study was similar and comparable to other series. The proportion of poor outcomes was lower than other series.

## Conclusions

Anatomical reduction and internal fixation of diaphyseal fractures of the forearm in paediatric patient is mandatory to achieve a satisfactory functional result. The use of intramedullary nailing particularly the closed technique is a preferred method for internal fixation because of: minimal surgical exposure, less scarring and disfigurement, lowered risk of infection, lower risk of soft tissue injury, less risk of refracture after implant removal and minimal period of convalescence. The use of intramedullary nailing in closed

and some open (Grade I, Grade II) diaphyseal fractures of the forearm is recommended as evidenced by the results of the present study.

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