

## Evaluation of the Functional, Clinical and Radiological Outcome and Complications of the Diaphyseal Fractures of Radius and Ulna in Adolescents Treated with Titanium Elastic Nail

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### Abstract

*Introduction:* Intramedullary fixation with Titanium Elastic nail has become a favored stabilization technique for adolescent's population as Shorter operative time, Decrease scarring and decreased operative dissection. *Objective :* Evaluate the functional clinical and radiological outcome and complications of the diaphyseal fractures of radius and ulna in adolescents treated with titanium elastic nail. *Methodology:* Hospital based Interventional, prospective study was conducted during March 2014 to Feb. 2015 at SMS Hospital Jaipur on patients 12-18years of age with 30 patients, with diaphyseal both forearm bone fractures. *Indication:* Open injury, unstable fracture pattern, Inability to achieve an acceptable reduction, loss of reduction. All fractures was be treated with flexible intramedullary nail fixation. *Observations:* In majority of cases no secondary procedure require, only 4 cases require SSG which was open injury Average blood loss was 51.66 % Out 30 patient 29 patient had radiological and clinical evidence of solid union& one ulna was completely undergo in nonunion. The minimum time taken for union was 8 to 12 weeks for radius in 83% and 10-14 weeks for ulna 68% of patients. *Conclusion:* The use of titanium elastic nail is the ideal implant in the management of Fractures both forearm bones in adolescents population.

**Keywords:** Diaphysis Fractures of Radius and Ulna; Adolescents; Titanium Elastic Nail; Outcome.

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### Introduction

Fractures of shaft of radius and ulna are among the challenging to orthopaedist because their treatment complexity and risk of complications. Most shaft injuries require nothing more than skillful close fracture care [1,2]. There is no definitive treatment guideline for treatment of forearm bones in adolescents.

Intramedullary fixation with Titanium Elastic nail has become a favored stabilization technique for adolescent's population as Shorter operative time, Decrease scarring and decreased operative dissection. Adaptability to wide range of fracture, high healing rate low complication rate [3,4].

It should be emphasized that for primary fixation in the compound fractures the amount of devitalized soft tissue and the level contamination that usually determines the outcome rather than the comminution or configuration of the fracture.

Because of good circulation and soft tissue coverage of the upper extremity and the fact that upper extremity wounds involves less energy than lower extremity wounds the incidence of complication is much lower.

In upper extremity internal fixation is more frequently employed than external device, because multiple pins tend to lie down the forearm musculature and interfere with hand rehabilitation& function.

Intramedullary nailing is a comparatively simple operation and inflicts minimal damage at site of fracture. Short period of hospitalization needed after this procedure by virtue of faster recovery from soft tissue injury further proves it to be advantageous on account of socioeconomic reasons. Therefore we contemplate this study to evaluate the functional clinical and radiological outcome and complications of the diaphyseal fractures of radius and ulna in adolescents treated with titanium elastic nail.

## Material and Methods

This Hospital based Interventional, prospective study was conducted during March 2014 to Feb. 2015 at SMS Hospital Jaipur. After approval of this study from review board at SMS Medical College & attached Hospital, Jaipur (Raj.). This study included patients 12-18 years of age with 30 patients, with diaphyseal both forearm bone fractures where reduction cannot be achieved or maintained in cast. All cases were followed up for a minimum period of 12 month. The sample size was calculated 23 at 95% confidence limit 10% absolute allowable error assuming the good excellent result in the nailing was 94% (as per the seed article) and assuming the 20% dropout or lost to follow up the study purpose. The sample of 30 patients was included. The management of the injury was based on the following protocol. Metaphyseal fracture. Monteggia fracture dislocation, Galeazzi fracture, Radial head and neck fracture, With Neurovascular injury, Medically or anaesthetically unfit patient.

### *Surgical Indication*

Open injury, unstable fracture pattern, Inability to achieve an acceptable reduction, loss of reduction. Patients were received in the department of accidental emergency and vital parameter were monitored. Any associated limb, chest abdominal and head injury were ruled out. An intravenous line was established, analgesic injection was administered and fluid replacement was done. All patients with open fractures were admitted on the day of injury and taken to operating room immediately for irrigation and debridement. Forearm slab was applied, limb elevation and active finger movement done. Radiograph of the fracture both forearm bones including elbow and wrist joint in AP and lateral view. Preoperative investigations including hemoglobin, TLC, DLC, blood sugar, serum urea, serum creatinine, chest x-ray and ECG were done as a part of pre anaesthetic evaluation.

The operative technique involved thorough irrigation and debridement as needed for open wounds. All fractures were treated with flexible intramedullary nail fixation. Different approach for radius and ulna for Radius—small distal incision (<3 cm) dorsolateral just proximal to physis with utmost care to prevent injury to superficial radial nerve in retrograde manner for ulna— approach proximally and distally

### *Proximal Approach have Two Ways*

(a). through the very distal tip of the olecranon or (b). through the lateral border of the olecranon just distal to the physis in the metaphysis. A distal approach was used proximal to the distal physis in a retrograde manner Reduction was attempted closed in all cases; however, if closed nailing would not be achieved, open reduction was performed Length was measured by placing the nail on draped forearm bone under fluoroscopic guidance. Width of the canal was measured at the narrowest point of the diaphysis in both AP and lateral view.

Nail diameter measured 33% of the narrowest diameter (Flynn et al) [5]. The radius of curvature must be about 50-60 times greater than diameter of the nail. The apex of the curvature must be located on fracture site. Nail contouring is most useful to control the corrective forces, and adjust them according to local stress. Varus/vulgus angulation can be addressed by directing the nail tip medially or laterally to counter the angulation forces. A varus angulation can be corrected by directing the nail tip laterally, whereas a vulgus angulation can be corrected by directing the nail tip medially. Similarly, in the sagittal plane, a recurvatum angulation can be corrected by directing the nail tip posteriorly, and a flexion angulation by directing the tip nail so that the concave side face anteriorly.

### *Postoperative Protocol*

In all cases prophylactic Broad spectrum Antibiotic were given: injection cefuroxime 500mg-750mg was given at 4pm, 12 midnight and 8am on the next day. Injection Diclofenac: 1-2cc IM SOS. Post reduction check skiagram was taken. Dressing was checked at 48 hours. Limb was kept elevated and patients were advised to move their fingers at Metacarpophalangeal, proximal and distal interphalangeal joints actively. The patients were asked to report immediately for check-up if there is fever, abnormal swelling and pain at the site of operation.

Immobilization of the fracture was kept till there was radiological and clinical evidence of union of fracture.

In cases where skiagram showed some callus formation Sermiento forearm cast brace was given to allow flexion and extension of elbow. active finger movement was started 24 hour after the operation. Patients were discharged after 48 hours and called after 2 weeks of postoperative day.

After 10 days stitches were removed patients were called for follow up after every 2 weeks, 6 week, 3 month, 6 month and subsequently at monthly interval. Patients were assessed on subjective ground clinically and radiologically at each follow-up. After union the cast was discontinued, and gradual movement of the elbow, wrist and forearm were allowed and patients especially warned not to massage the limb complication developed during the post operative period were treated by appropriate measures.

#### *Criteria for Assessment of Determination of Results*

The normal range of motion:-Wrist flexion 80°Wrist extension 70°Elbow flexion 0-150°, Pronation 80°. Supination 80°Symmetrical to contralateral side.

- Clinical and functional outcome was assessed on final follow-up on the basis of Anderson *et al.* criteria.
- The patients will be categorized using the classification described by Anderson
  - a. Excellent -bony union with less than 10 degree loss of flexion-extension and less than 25% loss of pronation-supination.
  - b. Satisfactory - bony union with less than 20 degree loss of flexion-extension and less than 50% loss of pronation-supination.
  - c. Unsatisfactory - bony union with more than 30degree loss of flexion-extension and greater than 50% loss of pronation-supination.
  - d. Failure - nonunion with or without loss of motion.

#### **Observations and Results**

The present series includes 30 cases of Fractures both forearm bones in adolescent population treated by Titanium Elastic Nailing System.The mean age was 14.23 years (12 to 18 years). Fractures both forearm bones were more common in males than in females. 56.66% (17 cases) sustained injury due to

RTA while 4 patients (13.33%) suffered from fall from height, 6.66% were injured by engine machine and 6.66% assault, 3.33% kuty machine, 3.33% fall & slip. In this study the Right side 63.33% (19 cases) is more frequently involved than left side 36.66% (11 cases). It was noticed that in 66.66% (20 cases) was lower third, 20% (6 cases) was middle third and 13.33% was in upper third. Only 6 cases (20%) had open fractures of forearm and the remaining had simple fractures 24 cases (80%). Majority of cases 22 (73.33%) had A3 type, 6 cases (20%) had B3 type and remaining 2cases (6.66%) had C3 type. In our study majority of cases (36.70%) had operated within two days of injury rest 8 cases within 4 days, 5 cases within 3 days. It clear that in this study most of patient immobilize for short duration and early mobilization start to prevent post-operative stiffness. In this post operative period minimum for 5 week and maximum for 10 week. It is also observed that open injury require more immobilization. Most common complication was infection in two patients (6.66 %) one was superficial and one was deep infection. One case develop compartment syndrome and other one going in non-union. Most of patients 25 case (83.33%) have 100 -140 degree of elbow flexion two patient 90 degree, and one patient 30 degree of elbow flexion. In majority of cases 27 (93%) forearm pronation ranges from 60-80 degree and only two patients have pronation less than 50 degree. In majority of cases 24 (83%) forearm supination ranges from 60-70 degree and only 4 patients have supination less than 55 degree. In majority of cases 26 (90%) dorsiflexion at wrist ranges from 65-75 degree and only 3 patients have dorsiflexion at wrist less than 50 degree. In majority of cases 26 (90%) palmer flexion at wrist ranges from 50-70 degree and only 3 patients have palmer flexion at wrist less than 40 degree. In our study majority of case have 3-8 degree of radial bowing. Majority (96.55%) patients have normal movement after fracture fixation with tens, only patient got stiffness

In our study majority of patients show bridging callus within 4-6 weeks (79.5%) earliest callus seen in 3 week and last one was 12 weeks. According this study open injury take longer duration in appearance in callus formation than closed one.

In majority of cases no secondary procedure require, only 4 cases require SSG which was open injury. In majority of cases duration 45-60 minutes and averages is 51.66 minutes while minimum duration of surgery was 35 minutes and longer was 65 minutes. Duration of surgery important risk factor in infection rate. In our study majority of cases 22 cases (73.30%) had 30-40ml blood loss. Average blood loss was 51.66 % while minimum blood loss

**Table 1:** Baseline characteristics of the study population

Age in years	Mean ± SD	Frequency	Percent
		<b>14.23±1.86</b>	
Sex	Male	21	70
	Female	9	30
Mode of injury	RTA	17	56.66
	FFH	4	13.33
	Kutty machine	1	3.33
	Engine machine	2	6.66
	Blunt	3	10
	Assault	2	6.66
	Fall & slip	1	3.33
Side involved	Right	19	63.33
	Left	11	36.66
Site of fracture	Middle	6	20
	Upper	4	13.33
	Lower	20	66.66
Type of Injury	Open	6	20
	Closed	24	80
Type of Fracture	A3	22	73.33
	B3	6	20
	C3	2	6.66
Interval b/w injury & surgery in days	2	11	36.7
	3	5	16.7
	4	8	26.7
	5	3	10
	6	1	3.3
	7	1	3.3
	10	1	3.3
	Mean ± SD	3.56 ± 1.81	

**Table 2:** Range of movement after operation

Post Operative Immobilization Period in Weeks	Mean ± SD	7.26±1.38
range of movement (elbow) Flexion in degree( ° )	10-120°	4 13.79
	10-130°	9 31.03
	10-140°	8 27.58
	10-150°	1 3.44
	20-110°	1 3.44
	20-120°	1 3.44
	20-140°	2 6.89
	30-110°	1 3.44
	30-120°	1 3.44
	60-90°	1 3.44
range of movement (pronation) at elbow joint Pronation in degree	20°	1 3.4
	50°	1 3.4
	60°	5 17.2
	65°	2 6.9
	70°	11 37.9
	75°	5 16.67
	80°	4 13.8
Supination in degree	40 °	1 3.4
	50°	1 3.4
	55°	2 6.9
	60°	7 24.1
	65°	5 17.2
	70°	13 44.8
	Mean ± SD	63.96±7.36
range of movement (dorsiflexion) at wrist Dorsiflexion in degree	Mean ± SD	62.41±10.82
Palmer flexion in degree (°)	Mean ± SD	57.41±11.77
Radial bow	Mean ± SD	5.103±1.205
appearance of Bridging callus Time ( weeks)	Mean ± SD	5±1.17

**Table 3:** Characteristics of the operative procedure

		Frequency	Percent
secondary procedure <sup>2</sup> procedure	No	26	86.66
	SSG	4	13.33
duration of surgery (minutes)	mean±SD	51.66±7.805	
Hospital stay	< 1 week	28	93.33
	>2 week	2	6.66
Blood loss Volume (ml)	mean±SD	51.66±7.805	
Time in weeks follow up	mean±SD	10.24±1.93	
time taken for radiological union in weeks	Radius (N=29)	10.68±2.49	
Union time in weeks	Ulna(N=29)	12.51±4.18	
		No. Of Cases	Percent
range of movement (function)	Normal	28	96.55
Movement	Stiff	1	3.44
Complication	Superficial Infection	1	3.33
	Compartment Syndrome	1	3.33
	Deep Infection	1	3.33
	Non Union	1	3.33
<b>Result</b>	Excellent	24	80
	Satisfactory	3	10
	Unsatisfactory	1	3
	Failure	1	3

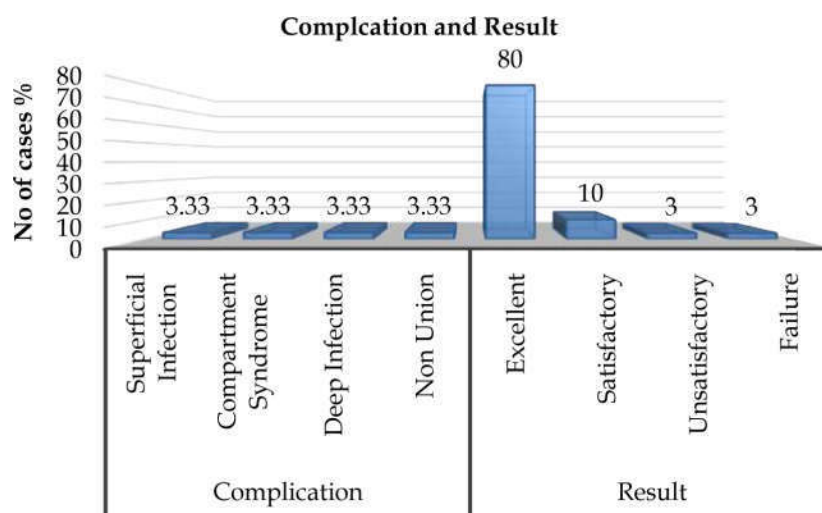
was 20ml in 16.7% cases and maximum blood loss was 90ml in 2 cases. It was observed that in closed cases blood loss was minimal while in open surgery more blood loss occurs. In our study majority of cases had isolated fracture both bone forearm, only 5 cases had associated injury which were crush injury of hand & foot, fracture shaft of tibia & humerus, injury around knee.

Out 30 patient 29 patient had radiological and clinical evidence of solid union & one ulna was completely undergo in nonunion. The minimum time taken for union was 8 to 12 weeks for radius in 83 % and 10-14 weeks for ulna 68% of patients. The average time of union for radius was 10.68 (8 to 18)

weeks and 12.51 (10 to 20) weeks for ulna. The results were graded according to the basis of Anderson *et al.* mentioned in “method & material” excellent results were obtained in 80% cases, satisfactory in 10%, unsatisfactory in 3% and poor in 3% case.

### Discussion

Intramedullary titanium elastic nail to treat fractures both forearm bones in adolescent. The reason behind it lies because these diaphyseal fractures of forearm arm bones present specific problems. Besides the necessity of regaining length,



**Fig. 1:**

apposition and axial alignment, normal rotation alignment must be restored to achieve an optimum range of pronation and supination.

The present study comprises of 30 cases of Fractures both forearm bones in adolescent (age ranges from 12-18 yrs), which were treated with TENS followed up in the department of orthopaedics, SMS Medical College & Hospital, Jaipur during the period of April 2014 to June 2015.

The commonest mode of injury in this series is due to RTA in 17 cases (56.68%) followed by blunt injury 3 cases (10%), assault 2 cases (6.66%), engine machine 2 cases (6.66%), kutty machine 1 case (3.33%). Smith [6] (1959) reported similar incidence of injury due to road traffic accidents (45%) and 36.22% due to fall. Grace et al [7] (1980) reported 45% due to road traffic accidents and fall. Burwell (1964) [8] reported, 69% due to road traffic accidents and industrial accidents.

Out of total 30 cases maximum 11 (36.7%) were operated within 2 days of injury. Out of 30 cases 8 (26.7) cases were operated within 4 days. 5 cases had associated injury. Murry (1941) believed that the best time to carry out of internal fixation is as soon as possible. A delay in surgery beyond 24-48 hrs is necessary because of condition of soft tissue, it is better to wait until the skin is free of fracture blebs, abrasion and laceration have healed edema subsides. Most of the fractures in the series of Smith (1959) [9] were subjected to early internal fixation and in about one-third of the total delayed operations were carried out, the results were surprising, it was found that every fracture with non-union and most of those with slow union occurred in patients operated upon early and non-union did not occur in any patients operated after sixth day.

Out of total of 30 cases only 4 cases (13.33%) had post-operative complication, out of these superficial and deep infection occurred in one each, compartment syndrome. Out of each cases of superficial infection had open fracture of forearm in road traffic accident while another case there was puncture wound. In both the cases infection occurred after two week shows some form of subclinical infection initially which was suppressed by antibiotics at time of operation.

Out of 30 cases, only one ulna shows non-union which treated surgically with bone grafting and union achieved. All fractures had radiological and clinical evidence of solid union. Minimum time for union was 8 to 10 weeks in 16 (53.33%). 11 to 16 weeks in 13 fractures (47.66%). Average time taken for union was 10.68 weeks for radius and 12.51

weeks for ulna. Almost in 24 fractures (80%), the time taken for union was below 12 weeks for radius and 20 fractures (66.66%), time taken for union was below 14 weeks for ulna.

Male patients dominated because of the nature of their outdoor activities. The male to female ratio was 7:3. This was very similar to the series studied by Lyons et al. [10].

The incidence of fracture was more in right side 19 cases (63.66%) compare to left side 11 cases (36.33%).

In our series, the most common site of fracture was lower third (66.6%) followed by middle third 20% and upper third 13.33%. The majority of forearm fractures are located in the distal part of the forearm [11,12].

In our series, road traffic accidents, accounted 17 cases (56.66%) for the highest incidence of these injuries followed by fall from height 4 cases (13.33%). The most common mechanism is a road traffic accidents (70%) while direct trauma is a distant second (10%) [11,12].

In our series, the average interval between injury and definitive management was 3.56 days and the delay in the definitive management was mainly due to large burden of patients.

The average hospitalization time was 5 days. (4 to 8 days). In our series average blood loss was 52ml (min 20 ml to max. 90ml)

Loss of pronation and supination is indicator of quality of result. In our series loss of motion in open fractures of forearm bones was more significant than it was in simple fracture. Similarly more loss of motion was observed with fractures of both bones, these injuries being more severe than single bone fractures. Grace and Evermann (1980) [13] had also reported on rotational movement similar to our findings.

In our present series the functional results were graded according to Anderson's criteria (1975). We have 24 patients (80%) excellent results, 4 patients (10%) patients have satisfactory, 1 patients had (3%) unsatisfactory result and 1 patients had (3%) failure result. Satisfactory results were observed in 4 cases of these 1 case had severe comminuted, one patients had severe soft tissue injury and was post-operatively immobilized for more than 20 weeks. Kang et al [14] evaluated 90 children treated with intramedullary nailing and reported *good results* and patient outcomes.

Both titanium and stainless steel flexible nails are available. In the clinical setting, titanium is being

used more often than stainless steel in most circumstances because of the elastic properties which allow for improved insertion and rotation while still providing adequate fracture stabilization.

Functional results in this series were much better in younger age group, close fracture than open fractures, co-operative patients than in non-cooperative patients, fractures not associated with injuries than those with associated injuries and non-comminuted than comminuted fractures.

### Conclusion

The use of titanium elastic nail is the ideal implant in the management of Fractures both forearm bones in adolescents population.

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