

# Diaphyseal Fractures of Both Bones Forearm - A Comparative Study on Fixation Techniques and Functional Outcome between Intramedullary Nailing and Plate Osteosynthesis

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**Abstract:** Introduction: Diaphyseal forearm fracture is one of the most commonly encountered fractures of the upper extremity. The literatures comparing the outcome of plate fixation and intramedullary nailing in adults are scarce and therefore the consensus on superiority of one over the other is lacking. This study was undertaken to compare the outcome of these operative techniques in adults with diaphyseal fracture of both bone forearm. Aim & Objectives: This study was undertaken to compare the outcome of plate fixation and intramedullary nailing in adults with diaphyseal fracture of both bone forearm. Methods: Patients of 18–70 years of age, with diaphyseal fractures of both bones of the forearm <7 days old, were selected. Patients were randomly allocated to two treatment groups: intramedullary nailing and plate osteosynthesis. Patients were followed up at 4th week, 12th week, and 24th week post-operative period. Functional outcome was measured at the end of 24th week based on Grace-Eversman Score. Result: Average time of fracture healing in our study was 8 weeks. In patients who had undergone plate osteosynthesis, it was 9 weeks whereas in patients who had undergone nail fixation it was 6 weeks. Muller's Type 22 C3 fracture united by 11 weeks. Other fracture patterns healed between 6 and 9 weeks. Patients had restricted Pronation and supination. Three patients were treated with plate osteosynthesis and one patient with intramedullary nailing had restricted supination Pronation due to cross union. 4 patients treated with plate osteosynthesis gave excellent results with regard to Pronation & supination. Patients developed post operative stiffness of elbow joint. 3 patients were treated with plate osteosynthesis and one patient with Titanium elastic nail. However, all these patients eventually had fair range of motion by the end of 12 weeks following intense physiotherapy. Our series had 90% (18 cases) of excellent /satisfactory results and 10% (2 cases) Poor results which is comparable to the previous studies. The patient who had sustained fracture of radial styloid process during titanium nail fixation following far lateral entry point developed stiffness of wrist joint. With active exercises, the ROM was increased. Restoration of Pronation & supination activities were possible by the end of 6th week using intramedullary nailing whereas they were possible by the end of 9th week using plate osteosynthesis.

**Keywords:** Both bone forearm; Diaphyseal fractures; Intramedullary nailing; Plate osteosynthesis; Internal fixation

## 1. Introduction

Increasing incidence of road traffic accidents, natural disasters and industrial accidents together with assault leads to multiple fractures and higher incidence of morbidity. They form the major epidemic of modern era. Of these, the fractures involving both the bones of forearm form an important part. Even though these fractures can be treated successfully by surgical methods, the anatomical reduction of fracture fragments becomes absolutely essential for effective postoperative function. Delayed hospitalization, use of indigenous bandages and associated vascular and nerve injuries contribute to increased incidence of morbidity. Traditionally majority of adult forearm fractures are treated by traditional bone setters leading to various complications. Awareness about the role of various types of surgical fixation and their role in successful management of forearm fractures is absolutely essential for preventing this practice. Fracture of the forearm bones may result in severe loss of function unless adequately treated. Hence good anatomical reduction and internal fixation of these fractures is necessary to restore function<sup>1</sup>. For effective Pronation and supination to occur, the maintenance of interosseous space becomes mandatory while fixing the fractures involving radius and ulna. Presence of comminution, the anatomy of fracture

pattern and presence of rotatory mal-alignment significantly contribute to the postoperative morbidity in these fractures. Better understanding of the injury patterns, availability of better implants, the concept of early surgical fixation and post operative protocol all have convincingly improved the functional outcome of the patient to a larger extent. The successful management of these fractures demands familiarity with the character of fracture, technical aspects of fracture fixation, the varieties of implants available for fixation and the art of postoperative management<sup>[2, 3, 4, 5]</sup>.

## 2. Methods

A prospective study was conducted for 18 months at Muzaffarnagar medical college and hospital, Muzaffarnagar. Patients of 18–70 years of age, with diaphyseal fractures of both bones of the forearm of < 7 days old, were selected. Those having pathological fractures, open fractures GA Type II and III, neurovascular injury or associated head, chest, or abdominal injuries arising out of polytrauma were excluded from the study. Subject recruitment commenced once written approval was obtained from Institutional Ethics Committee. During screening of the subjects, all potential subjects who fulfilled the study selection criteria were informed by the investigator, verbally, in vernacular, about the study in

details (including the rationale, aims and objective of the study, study related procedures, potential discomfort, and benefits of participation). Then a copy of informed consent form and patient information sheet was provided to the subjects and they were requested to go through them. After the above mentioned procedure, only those subjects who were willing to participate were included in study and informed was taken. Patients were randomly allocated to two treatment groups: Intramedullary nailing (Titanium Elastic Nailing System) and plate osteosynthesis. Laboratory investigations included plain X-ray of involved forearm (anteriorposterior view and lateral view) with wrist and elbow joint (to rule out associated fractures or dislocations), hemoglobin percentage (%), total count, differential count, erythrocyte sedimentation rate, fasting blood sugar, serum

urea, serum creatinine, chest X-ray (P.A. view), electrocardiogram, HIV I and II, hepatitis B surface antigen, anti-HCV, clotting time, bleeding time, prothrombin time, activated plasma thromboplastin time, international normalized ratio, and platelet count. Patients were followed up at 4th week, 12th week, and 24th week in the post-operative period. Pain at operation site, limb shortening, range of forearm rotation, range of elbow, and wrist motion were noted and X-ray forearm was obtained on each follow-up visit. Functional outcome was measured at the end of 24th week based on the clinical and radiological parameters by modified Grace Eversman Score<sup>[7, 8, 9, 10]</sup>.

**3. AO Classification**

Type	A	Simple fractures of one or both bones
	A1	Simple fracture of ulna
	A2 A3	Simple fracture of radius Simple fracture of both radius & ulna
Type	BB1	Wedge fractures of one or both bones
	B2	Wedge fracture of ulna Wedge fracture of radius
	B3	Wedge fracture of both radius & ulna
Type	C.	Complex fracture of one or both bones
	C1.	Grossly comminuted fracture of ulna with simple fracture of Radius
	C2.	Grossly comminuted/segmental fracture of Radius with Simple fracture of ulna
	C3.	Grossly comminuted fractures of both bones

**Modified Grace and Eversmann Scoring System.**

**Supination and Pronation** (Normal – Pronation & Supination 80 degrees

Rating	Range of Movement	Score
Excellent	> 80	4
Good	60 TO 80	3
Fair	40 TO 60	2
Poor	< 40	1

**Radiological Union**

Radiological Union	Score
Union Present	2
Non Union	1

**Range of Movement –Elbow**

Range	Result	Score
Flexion > 120	Excellent	4
Flexion 100 to 120	Good	3
Flexion 80 to 100	Fair	2
Flexion < 80	Poor	1

**Final Analysis**

Result	Score
Excellent	10 and
Good	8 to 9
Fair	6 to 7
Poor	Less than 5

**Final Analysis**

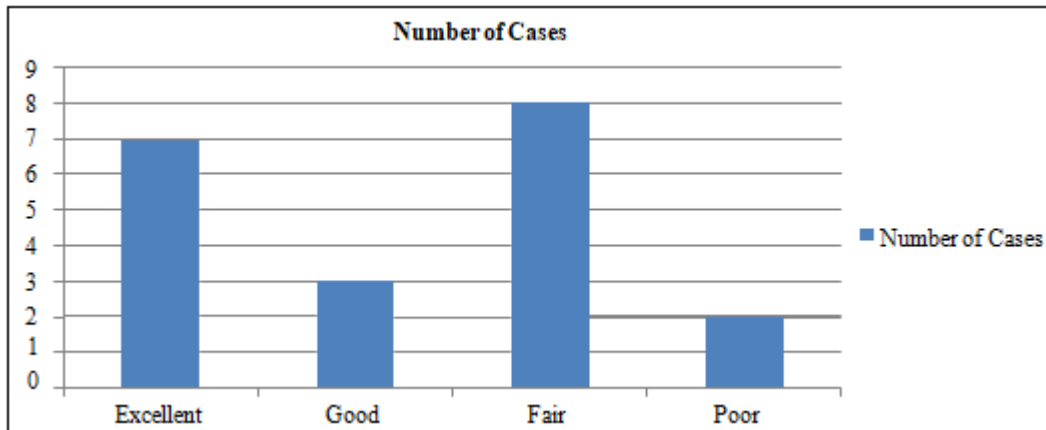
Result	Score
Excellent	10 and
Good	8 to 9
Fair	6 to 7
Poor	Less than 5

**4. Results**

Average time of fracture healing in our study was 8 weeks. In patients who had undergone plate osteosynthesis, it was 9 weeks whereas in patients who had undergone nail fixation it was 6 weeks. Muller’s Type 22 C3 fracture united by 11 weeks. Other fracture patterns healed between 6 and 9 weeks. 3 patients had restricted Pronation & supination. Three patients were treated with plate osteosynthesis and one patient with intramedullary nailing had restricted supination Pronation due to cross union. 4 patients treated with plate osteosynthesis gave excellent results with regard to Pronation & supination. Patients developed post operative stiffness of elbow joint. 3 patients were treated with plate osteosynthesis and one patient with Titanium elastic nail. However, all these patients eventually had fair range of motion by the end of 12 weeks following intense physiotherapy.

**5. Overall Results**

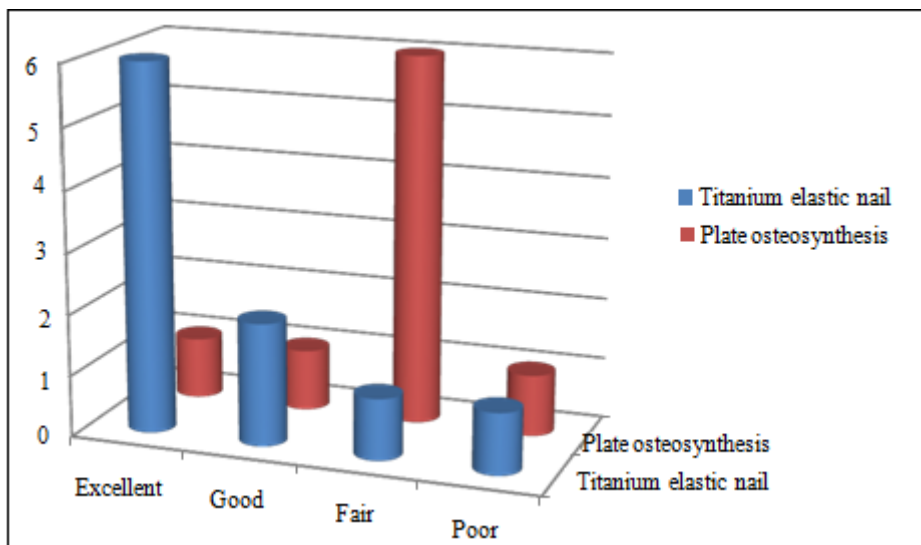
Grading	Number of	Percentage
Excellent	7	35
Good	3	15
Fair	8	40
Poor	2	10



Results according to implant used

Implant	Number of cases	Grading	Percentage
Plate Osteosynthesis	1	Excellent	10
	1	Good	10
	6	Fair	60
	1	Poor	10
	Number of cases	Grading	Percentage
Titanium Elasticnail	6	Excellent	60
	2	Good	20
	1	Fair	10
	1	Poor	10

Overall results by Implants used



Case 1





Case 2





## 6. Discussion

The aim of this study is to compare the results of treating diaphyseal fractures of both bones in adult forearm using plate osteosynthesis with that of titanium elastic nail fixation. We selected 20 cases of diaphyseal fractures involving both the bones in the forearm in adults. The period of study was between 1 January 2020 – 30 June 2021. Most of these patients fell into middle age, group with majority of them being males. The mode of violence is either due to RTA, assault or due to accidental fall. A satisfactory device for internal fixation must hold the fracture rigidly, eliminating as completely as possible angular and rotatory motion. This can be accomplished by either a strong intramedullary nail or dynamic compression plate or locking compression plate. During plate osteosynthesis, to minimize further injury to blood supply of the bone, the periosteum was stripped sparingly with a periosteal elevator and only sufficiently for applying a plate. The fragments were carefully reduced with inter digitating bone spicules being fitted properly. Comminuted fragments were fitted accurately in place. The plates were selected such that at least there were six bi-cortical purchases on either side of fracture fragments. The plates were contoured before they were applied to the bone. Our study has showed good fracture union occurred in 80% of cases. Earlier studies have reported an alarming re-fracture rate of 40% when the plates were removed before 1 year<sup>[11, 12]</sup>. It is well established that the cortex beneath a rigid plate weakens because of stress shielding, becoming thin, atrophic and almost cancellous in nature. If soft tissue stripping has been extensive, osteonecrosis and revascularization weakens the cortex further. In our series involving 10 cases treated with plate osteosynthesis, we did not have re-fractured in any of our patients. While using intramedullary device for fixing the adult forearm fractures involving both bones, rotational control in fractures near the metaphyseal- diaphyseal junction was difficult because of wide medullary canal. Interference fit nails do not maintain bone length if associated with bone loss. When an

intramedullary fixation is used, errors in selecting the proper diameter or length of the nail and operative technique contributed to poor results. In case of the titanium elastic nail, the distal end of nail must abut subchondral bone to prevent shortening. The lower modulus of elasticity of titanium nails allow easier insertion and provide more load sharing with the bone. Titanium elastic nails produced interference fit which was responsible for the return of forearm rotation and grip strength<sup>[13, 14]</sup>. Our study had showed that good to excellent union occurred with 90% of fractures fixed with titanium elastic nail. We compared the results of plate fixation with that of intramedullary fixation. Apart from the incidence of infection we did not have any complications while treating forearm fractures with plate osteosynthesis. All the cases healed well on controlling the infection. We had technical difficulties while using both titanium elastic nail. While fixing fractures of radius involving distal 3<sup>rd</sup> shaft, the titanium elastic nail did not provide with adequate stability of fracture fragments because of wide medullary canal. While using titanium elastic nail we had entry point fracture at radius, since the entry point was shifted far laterally that led to the fracture of styloid process of radius which was treated conservatively. In another case, there was avulsion of tendon of extensor pollicis longus by a drill bit. This occurred following failure of separation of soft tissue up to the bone with a curved artery forceps after skin incision was made. Earlier, intramedullary devices like K wires, square nails and Rush nails were used for fixing radius and ulna. These implants did not provide with rotational stability at the fracture site. This lead to higher incidence of non-union. But titanium elastic nail, provided with excellent rotational stability of fracture fragments. We used tourniquet in fractures fixed with plate osteosynthesis. One case of tourniquet palsy occurred but recovered eventually. Since tourniquet was not used during intramedullary fixation, the chance for occurrence of this neurological complication was totally eliminated.

Closed Intramedullary fixation offers the following

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advantages when compared with plate osteosynthesis.(1)No periosteal stripping is required(2)Smaller operative wound(3)Bone grafting not necessary(4)No potential for diaphyseal re-fracture after implant exit.

In our study, the rehabilitation time was much shorter for fractures fixed with intramedullary nail when compared with that of plate osteosynthesis. The average time required for functional recovery is more than 9 weeks when plates are used, and about 6 weeks when intramedullary nails are used. The duration of hospital stay post operatively was also less (on an average of 5 days for intramedullary devices and 12 days for plate osteosynthesis). Intramedullary fixation provides for short operating time, short hospital stay and early rehabilitation. Intramedullary fixation excels better than plate osteosynthesis especially in cases of segmental fractures and Comminuted fractures if closed reduction is possible.

The conclusion of this study is:-

Diaphyseal fractures of both bones of forearm in adults are one of the commonest fractures being reported to orthopedic emergency

Early fixation of fracture followed by intense physiotherapy produced excellent results.

Fixation with plate osteosynthesis has stood the test of time and provides excellent fixation.

- The advantages of intramedullary fixation are:-
- Preservation of fracture hematoma
- Early mobilization. Can be done as a day care procedure
- Less post operative morbidity.
- Smaller incision – hence better cosmesis

Last, but not the least; since there is no axial loading (like weight bearing) after intramedullary fixation, the chances of implant failure is very less.

Titanium elastic nail fixation is particularly useful in fractures involving middle third of radius and ulna. Providing for 3 point fixation leads to stable fixation and proper alignment of fracture fragments.

Being newer techniques, these intramedullary devices require further evaluation and there is a steep learning curve. Forearm bones fractures are associated with high rates of consolidation and satisfactory mobility of the forearm since we obtain an anatomic reduction of the fracture, as is most easily achieved by plate fixation. However elastic nailing is a less invasive technique that allows restoring function more quickly with less pain and less risk of complications.

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