

A COMPARATIVE STUDY ON FIXATION TECHNIQUES AND FUNCTIONAL OUTCOMES IN BOTH BONES FOREARM FRACTURES (PLATE OSTEOSYNTHESIS VS INTRAMEDULLARY ELASTIC SCREW NAIL)

Orthopaedics

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ABSTRACT

Background and Objectives In the current era of industrialization, and with mechanized farming in India, fractures of forearm bones have become more common. The forearm serves an important role in the functioning of the upper extremity. Hence aggressive management becomes essential. The purpose of this study was to evaluate subjective and functional outcome after osteosynthesis of the forearm fractures with plates and screws (ORIF) or intramedullary elastic screw nailing (CRIF). **Methods** We evaluated 30 patients who underwent internal fixation of forearm fractures with CRIF (15 patients) or ORIF (15 Patients), concerning the Range of motion of forearm, elbow and a validated outcome measure. (Modified Grace Eversmann scoring system) and standardized radiographs of the forearm were evaluated. We used CHI square test to evaluate the results. **Results** There was a statistically significant difference in the final outcome in patients undergoing ORIF with Plate and CRIF with intramedullary elastic screw nail, with better functional outcome in the latter. **Conclusion** 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 intramedullary elastic screw nailing is a less invasive technique that allows restoring function more quickly with less pain and no increased risk of complications.

KEYWORDS

INTRODUCTION

Increasing incidence of motor vehicle accidents, assault, natural disasters, industrial accidents lead to numerous fractures and higher incidence of morbidity. Of these, the fractures involving both bones forearm form an important part⁽¹⁾. Even though these fractures can be treated successfully by surgical methods, the anatomical reduction of fracture fragments becomes essential for effective function postoperatively. Delayed hospitalisation, use of indigenous bandages and associated vascular and nerve injuries contribute to increased incidence of morbidity^(2,3).

Awareness about the various surgical fixation methods and their role in successful management of forearm fractures is essential for preventing complications.^(4,5)

Fracture of radius and ulna may result in significant functional loss unless they are treated adequately. So proper anatomical reduction and stable fixation of these fractures is of paramount importance to restore function.^(6,7)

For effective pronosupination to occur, the maintenance of interosseous space becomes mandatory while fixing the fractures of radius and ulna⁽⁸⁾. The anatomy of fracture pattern, presence of comminution, and presence of rotatory malalignment contribute to the postoperative morbidity in these fractures⁽⁹⁾.

Better understanding of the injury patterns, the concept of early surgical fixation, availability of better implants, and exact postoperative protocol all have convincingly improved the functional outcome of the patient to a larger extent⁽¹⁰⁾.

The successful management of these fractures demands the surgeon to be well familiar with the character of fracture, technical aspects of fracture fixation, the varieties of implants available for fixation and postoperative management protocol.

AIM OF STUDY

The aim of our study is to compare the functional outcome of fixation of both bones of forearm using plate osteosynthesis with that of intramedullary elastic screw nail.

Mechanism Of Injury

The most common is some form of motor vehicle collisions (MVC) resulting in direct blow to the forearm. Other causes of direct blow injuries include fights/assaults in which one of the person is struck in the forearm with a rod or stick. The person throws the forearm up, to protect her or his head, and the forearm is the recipient of the violence. Rotational deforming forces act leading to fracture of forearm bones following violent twisting of forearm^(11,12). Gunshot wounds causes fractures of both bones of forearm usually with significant bone loss. Such injuries are commonly associated with soft tissue defect and nerve injuries⁽¹³⁾. Most forearm diaphyseal fractures as a result of falls occur in fall from heights or in athletes^(14,15). The least common cause of diaphyseal fractures of both bone forearm is due to pathological fractures.

Investigations

Plain radiographs of forearm in two views – anteroposterior and lateral – are mandatory in all suspected forearm fractures⁽¹⁶⁾. If necessary, an additional oblique view may be required. The following features are noted in the X-rays:

- 1) Degree of offset
- 2) Amount of shortening
- 3) Degree of angulation
- 4) Presence of comminution

Additional visualization of adjacent joints is needed to rule out involvement of wrist, elbow and both radioulnar joints.

MATERIALS AND METHODS

Design of the study: Prospective study

Period of study: AUGUST 2019 to OCTOBER 2021

This is a prospective study of 30 cases of diaphyseal fractures of both bone of forearm in adults treated by surgical fixation with Plate and intramedullary elastic screw nails.

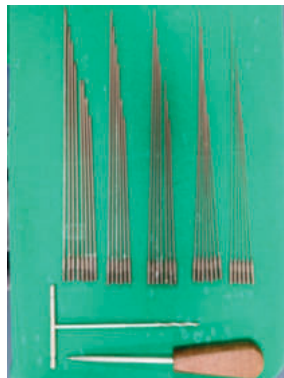
The patients were operated upon from August 2019 to February 2020 and they were followed up to October 2021.

Inclusion Criteria:

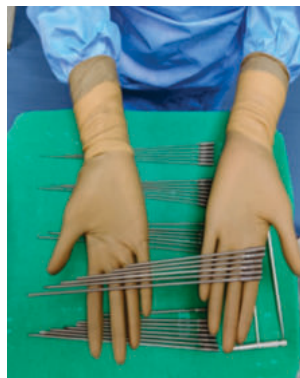
- Patients who are above 18 years old and willing to give written informed consent.
- Patients with both bone forearm fractures.
- Patients with isolated ulna fracture.
- Patients with isolated radius fracture.

Exclusion Criteria:

- Patients with intra articular fractures.
- Pathological fractures.
- Compound fractures.
- Patients who are not fit for surgery.



Intramedullary Elastic Screw Nail



Implants For Plating

Principles of plating^(10,11)

- Plate osteosynthesis provides static compression at the fracture site.
- Plates must be applied on the tension side of bones.
- For both ulna and radius, dorsal side is the tension side.
- Minimal stripping of periosteum from fracture ends
- Both the bones must be fixed with similar type of implant.
- Autologous bone grafting should be considered whenever there is comminution involving more than 1/3rd of circumference of bone.
- Larger comminuted fragments should be secured to the main fragments to produce interfragmentary compression before plate application.
- Fracture site should be exposed and reduced temporarily before a plate is applied.
- Plates must be accurately centered over the fractured site and there must be a minimal of six cortical purchases on either side of fracture.
- If autologous bone graft is added, they should not be placed in the interosseous border, to prevent cross union.

Principles of nailing:^(12,13)

- Fracture haematoma is preserved leading to early union and consolidation. Moreover, the chance of infection is minimized.
- The ulna is fixed first and radius automatically gets reduced.
- An appropriately sized nail so as to fit snugly inside the medullary canal is selected.
- Intramedullary elastic screw nails offers three point fixation thereby stabilizing the fracture fragments.

Post Operative Protocol For Plating:

In the immediate post-operative period the upper limb may be immobilized in an above elbow slab, and kept elevated till the oedema of fingers subsided. The wound was inspected on the 2nd postoperative day and then suture removal was done on 10th postoperative day. The upper limb was immobilized depending on the rigidity of fixation. Check X rays were taken at the end of 4th and 6th weeks to visualize callus response. The supination and pronation movements were started by the end of 6th week.

Post-operative Protocol For Nailing:

The upper limb was kept elevated. Wound inspection was done on 12nd POD. Suture removal was done on 10th POD, and above elbow cast was applied. After 3 weeks the cast was removed and a below elbow cast was applied, after obtaining check X rays. Active elbow mobilization exercises were started at the end of 3rd week. By the end of 6 weeks, the cast was discontinued and active pronation and supination exercises were started.

Observations

1) Age distribution:

The age group varied from 20 years to 70 years with the mean age of 45 years.

2) Sex distribution :

Among the 30 cases , males were 19 and 11 females.

3) Mode of injury was due to RTA in 21 cases and fall in 9 cases.

4) Time interval between injury and surgery :

Time interval	Number of cases	Percentage
<2 days	2	6
2 to 5 days	22	73
5 to 7 days	6	20

5) Associated injuries :

Humerus shaft fracture - 1
Femur fracture - 3
Tibia fracture - 1
Head injury - 3
Olecranon fracture – 1
Chest injury – 1

6) Duration of hospital stay postoperatively was 4-5 days and 3-4 days in patients treated with plating and nailing respectively.

Pitfalls And Their Management

1. Infection:

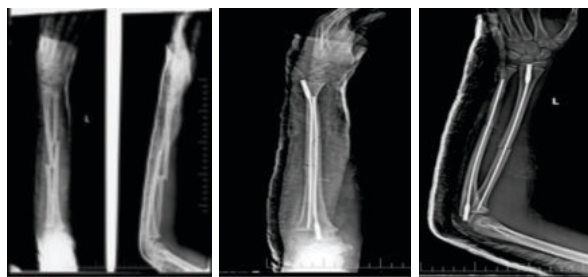
Three cases developed wound infection, all of them treated with plate osteosynthesis and all are superficial infections . Pus for culture and sensitivity was sent in all those cases and treated with appropriate antibiotics. The three superficial infections subsided with 3 weeks of antibiotic treatment.

2. Stiffness:

2 Patients who were treated with plate osteosynthesis and 3 patient treated with intramedullary elastic screw nail developed elbow stiffness at the end of 6th week while removing above elbow cast. The patients were put on strict physiotherapy protocol involving active mobilization exercises of elbow. Eventually all 5 patients had good range of motion of elbow.

3. Implant breakage:

Two case treated with intramedullary elastic screw nail had breakage of the nail at the junction between the screw part and the shaft while inserting into the radius. The broken part was removed in one case intraoperatively. In other case we could only notice it in the post operative X-ray. However both the patients had good evidence of union by the end of 8 weeks. CASE 1 –34 years old male patient treated with nailing of both bones



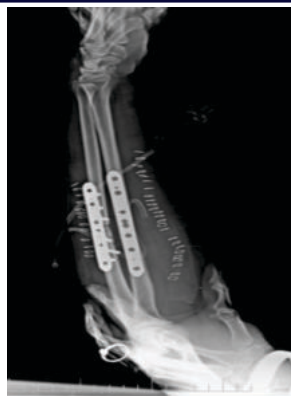
CASE 1 –34 years old male patient treated with nailing of both bones



CASE 2- 60 years old male patient treated with nailing of both bones



CASE 3 - 37 years old male patient treated with plating of both bones



CASE 7 - 39 years old male patient treated with plating of both bones



RESULTS

In our study the average time of fracture healing was 8 weeks. In patients who had undergone plate osteosynthesis, it was 7-8 weeks whereas in patients who had undergone nail fixation it was 8-9 weeks. Chapman in a study had 98% union with range of 6 to 14 weeks union the average union time was 12 weeks. Mc Knee study had average union time of 10.7 weeks with range of 5 to 17 weeks (19). He had 97.3% union rate.

4 patients had restricted supination and pronation. 2 patients were treated with plate osteosynthesis and 2 patients with intramedullary nailing had restricted supination pronation. Restoration of supination and pronation 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

5 patients developed post-operative stiffness of elbow joint. 2 patients were treated with plate osteosynthesis and 3 patients with intramedullary elastic screw nail. However, all these patients eventually had fair range of motion following intense physiotherapy by the end of 12 weeks. Chapman et al reported 36 (86%) cases as excellent, 3 (7%) Good, 1 (2%) Fair and 2 (5%) Poor results in his study.

Our series had 60% of excellent results and 16% of good results which is comparable to the previous studies.

However in a study by Sara et al, (20) there was no significant differences between the groups undergoing plate osteosynthesis or nailing. The risk of reintervention and non-union was not different between the groups.

Statistical Analysis

The mean value of Modified Grace and Eversmann score in Patients who underwent nailing is 9.6 and in plating is 8.8. Standard deviation being 1.18 and 1.63 for patients who underwent nailing and plating respectively. The t-value is 1.53 and the p-value was found to be 0.13, hence there is no statistically significant difference between average

pain score and functional outcome between the two groups. (t test of independent means is used to test the difference between scores)

DISCUSSION

The average age in our study was 41.9 years, males were 19 and females were 11. In a study by Kim et al, the average age was 47 years, males were 30 and female subjects were 17 (21). In a study by Sang et al the mean age was 41 years.

In a study by Tabet et al, they concluded that open reduction and internal fixation with compression plates with strict adherence to surgical technique is the gold standard method of treatment in both bones forearm fractures with excellent results than closed reduction, nailing which is also again a simple method with better results than conservative methods.

Ambhore et al compared plating vs square nails in 20 patients, 12 males and 8 females, the average age was 38.5 years. Mean operation time was 65 minutes (range 40 to 97 min) with plate-screw fixation, and 61 minutes (range 35 to 90 min) with intramedullary nailing. No patients showed non-union. On X-Ray radiological union of both radius and ulna took 12.33 weeks while radiological union of only radius bone was seen in 10.3 weeks and that of ulna was seen after 11.6 weeks (23).

MK Khateeb conducted the study on 30 patients comparing plating and nailing. He stated that average surgery time in plating group was 68 minutes and 43 minutes in nailing group. Average union time for radius & ulna was 7.8 and 8 weeks in nailing group and 9.3 and 9.6 weeks in plating group. There was 3 non-unions in plating group. In nailing group there were two delayed union cases. They concluded that plate osteosynthesis is the implant of choice for all diaphyseal fractures of both bones forearm. (24)

Upendra et al studied 72 patients treated with plating in 30 patients and nailing in 46 patients. The average union time for nail was 7.86 weeks and for the plate was 7.33 weeks. In both groups, there was a similar number of patients who have loss of forearm rotation. Four patients had some loss of pronation and supination in plating group whereas five patients had some loss of pronation and supination in IM nailing group. (25)

Nabeel conducted study on 50 patients, 24 with plating and 26 with K-wire fixation. (26)

Our study had showed that good to excellent union occurred with 90% of fractures fixed with intramedullary elastic screw nails.

We compared the results of plate fixation with that of intramedullary elastic screw nail. Apart from the incidence of infection at operated site we did not have any complications while treating forearm fractures with plate osteosynthesis. All the cases healed well after controlling the infection.

We had technical difficulties while using intramedullary elastic screw nails. While fixing fractures of radius involving distal 3rd shaft, the intramedullary elastic screw nails did not provide with adequate stability of fracture fragments because of wide medullary canal.

Earlier, intramedullary devices like square nails, K wires and Rush nails were used for fixing ulna and radius. These implants did not provide rotational stability at the fracture site leading to higher incidence of non-union. But intramedullary elastic screw nails provided with excellent rotational stability of fracture fragments.

Closed Intramedullary fixation has the following advantages when compared with plate osteosynthesis.

- Periosteal stripping is not required
- Smaller operative wound
- Bone grafting is not necessary
- No risk of refracture after implant exit.

In our study, the post operative rehabilitation time was much shorter for fractures fixed with screw nails 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 7 weeks when intramedullary elastic screw 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) with intramedullary fixation.

Intramedullary fixation provides for short operating time, early rehabilitation and short hospital stay. Intramedullary fixation excels better than plate osteosynthesis especially in cases of comminuted fractures and segmental fractures if closed reduction is possible.

CONCLUSION

The conclusions of our study are:

- Diaphyseal fractures of both bones of forearm in adults are one of the commonest fractures being reported to orthopaedic emergency room.
- Early fixation of fracture and intense physiotherapy produces excellent results.
- Excellent fixation.

The advantages of intramedullary fixation over plating are:

- Preservation of fracture hematoma
- Early mobilization.
- Less post-operative morbidity.
- Smaller incision – hence better cosmesis
- Since there is no axial loading (like weight bearing) after intramedullary fixation, the chances of implant failure is very less.
- Intramedullary elastic screw nails fixation is particularly useful in fractures involving middle third of radius and ulna. The 3 point fixation provided by these nails leads to stable fixation and proper alignment of fracture fragments.
- As it is a newer technique, these intramedullary devices require further evaluation and there is a steep learning curve.
- The presence of image intensifier (C arm) helps in easy reduction of fractures fragments, hence shortening intraoperative duration.

To conclude:

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 intramedullary elastic screw nailing is a less invasive technique that allows restoring function more quickly with less pain and less risk of complications

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