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A comparative study of both bone forearm fractures treated with intramedullary nailing vs plating in adults

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Abstract
Background: The aim of this paper was to study the diaphyseal fractures of radius and ulna treated with nail/plate in adults and to choose the best modality of treatment.
Methods: From May 2017 to December 2018 in Department of Orthopaedics, Krishna institute of medical sciences, Karad, total of 30 patients of both bones forearm fractures were treated. 15 were treated with open reduction and internal fixation using DCP plating or 1/3rd tubular plate and 15 with intramedullary nailing with radius and ulna nail. 30 patients were available for the follow up. Follow up was done for one year. Functional results were assessed by using Anderson *et al* criteria.
Results: The time required for surgery in plating group was 62 minutes, and 42 minutes for nailing group. Average time of radiological union for radius & ulna was 13 weeks in nailing group and 16 weeks in plating group. There was one case of radiological non union with ulna nailing and there was no other associated complications.
Conclusion: We conclude that open reduction and internal fixation with plating is the gold standard procedure for the treatment of both bone forearm fractures in adults. Intramedullary nailing is a less attractive alternative compared to plating as the normal movements are hampered.

Keywords: intramedullary nailing, diaphyseal fractures, both bone forearm

Introduction
Fractures of both bone forearms are one of the most common fractures of upper extremity in adults. Aim of management is to regain length, axial alignment, opposition abnormal rotational alignment in order to gain good range of supination and pronation. Complications like mal union and non union occur because of difficulties in maintaining reduction of 2 parallel bones due to presence of supinating and pronating muscle which has rotatory action, so internal fixation is necessary. Open reduction and internal fixation with Plating is the most widely used technique for the treatment of diaphyseal forearm fractures in adults. However, application of a plate can disrupt the periosteal blood supply and may increase the probability of delayed fracture union. In an effort to reduce these problems, intramedullary nailing has been proposed as an alternative method for stabilization and maintaining the reduction of forearm fractures. Intramedullary nailing has not been widely used for fixation of forearm fractures because of its limited indications and need for additional immobilization [1].
The advantages of IM fixation over plating include small incisions, shorter duration of anesthesia, limited soft tissue dissection, rapid union, and excellent recovery of range of motion [2]. However, open reduction and plating allow a more anatomic repair for most fractures forearm rotation.
We conducted a randomized prospective comparative study to investigate whether the result of closed intramedullary nailing are comparable to plate osteosynthesis. The aim of our study was to evaluate the results of internal fixation of diaphyseal fractures of both bones forearm treated by plate osteosynthesis and closed intramedullary nailing and to compare the functional results of the two groups.

Materials and Methods
30 patients with diaphyseal fractures of both bones forearm who met the inclusion and

exclusion criteria were randomly chosen for a prospective study. 15 patients were treated by plate osteosyntheis and 15 patients were treated by closed intramedullary nailing.

The inclusion criteria for nailing were

1. Age more than 18 years
2. All open Grade 1 (Gustillo and Anderson) and closed fractures without neurovascular deficit.
3. Comminution < 25% of diameter of bone

The inclusion criteria for plating were

1. Age more than 18 years
2. All open Grade 1 (Gustillo and Anderson)and closed fractures without neurovascular deficit.
3. Comminution > 25% of diameter of bone

Exclusion criteria were

1. skeletal immaturity
2. narrow intramedullary canal
3. Isolated fracture of radius or ulna
4. presence of neurovascular deficit and
5. patient with head injuries.

All study participants were followed up for a minimum of 1 year. Cases with the closed fractures were immobilized in the above elbow POP slab as the initial management. In the open cases wound was examined for detailed injury and for the neurovascular status of the limb and washed with copious amount of normal saline and initial care was given in emergency including thorough debridement of wound. Prophylactic treatment against tetanus was given and broad spectrum antibiotic were given to prevent the infection.

Plating Group: There were 15 patients in this group. Out of these, 15 patients were available for follow up. Mean age was 32 years with age range from 20 to 54 years. 9 patients were male. Right extremity was involved in majority of the cases. RTA was most common mechanism of injury affecting 12 patients.

Average injury operation interval was 7.7 days.

Nailing group

There were 15 patients in this group. Out of these, 15 patients were available for the follow up. Mean age was 34 year with age range from 19 to 57 year. 9 patients were male. Right extremity was involved in 6 cases. RTA was most common mechanism of injury affecting 13 patients.

Average injury operation interval was 8.2 days (Table 1).

Surgical procedure

Brachial plexus block using the supraclavicular approach was the anaesthetic route for the patients.

Nailing: Square nails were used for intramedullary nailing. Nail size was determined before surgery. Required length was calculated by measuring the uninvolved limb directly. Ulna measurement was done with a measuring tape from tip of olecranon to the ulnar styloid process. One [1] cm was reduced from this value to obtain the nail size. Radius length was calculated by reducing 2.5 cm from the ulnar measurement. Preoperative diameter was determined by measuring narrowest diameter of intramedullary canal on antero-posterior and lateral view of the x-ray of the affected forearm. Intraoperatively, the required diameter was confirmed by trial. Nail to be chosen was of snug fit to avoid overriding of oblique and comminuted fractures. Patient's position was supine on the OT table with the affected limb positioned on the arm board.

Image intensifier i.e C-ARM was positioned over affected limb. For ulnar nailing 1 cm longitudinal incision was made over the tip of olecranon, triceps insertion was incised. Entry point was made using a straight awl at a point 5 to 8 mm from dorsal cortex and 5 mm from lateral cortex over olecranon. Reaming was not done. The fracture was reduced by traction, counter traction and manipulation under C- arm, a nail of the appropriate size was selected and inserted in the canal and hammered after reducing the fracture. Fracture site was observed under C-arm during hammering to avoid distraction of the fracture site. Skin suturing was done with Ethilon.

For radius nailing 1 to 1.5 cm incision was used, extending from dorsal margin of joint surface at a point lateral to Lister's tubercle. Careful dissection was done between extensor carpi radialis longus and extensor carpi brevis tendons. Entry point was made with straight awl in line along the medullary canal. At dorsal margin of joint a straight awl was introduced at an angle of 45° to joint surface. After entering bone for uptil 1 to 1.5 cm, the angle of awl was dropped to axis of bone and continued for another 1 cm in line with the medullary canal. The fracture was reduced by traction, counter traction and manipulation under C- arm, a nail of the appropriate size was selected and inserted in the canal and hammered after reducing the fracture. Fracture site was observed under C-arm during hammering to avoid distraction of the fracture site. Rest of the technique was same as used for the ulnar nailing except that the nail was bent regularly to approximate the bow of the radius prior to the insertion.

Skin suturing was done with Ethilon. Nailing group was given above elbow cast after suture removal after 4 to 6 weeks and the cast was removed when signs of union were noted, and active movement at elbow and wrist were started.

Plating: Both fractures were reduced before fixation and fracture with less comminution was fixed first. [5] Fracture fixation was done using Henry's approach. Ulna was exposed by subcutaneous approach. AO principle was used for fixation (Small fragment DCP/1/3 Tubular plate and 3.5 mm cortical screws).

Post-operative: Above elbow slab was given till suture removal for a minimum of 4 weeks. Cast was given if after suture removal, the fixation was not rigid. Heavy and the strenuous activities were avoided till solid union occurred in all cases and the cast/slab was removed when signs of union were noted, and active movement at elbow and wrist were started.

Patients were regularly followed up at 6,12,18,24 weeks. At every follow up clinical and the radiological examination was done and the movements of the elbow and the wrist recorded.

Clinical union was considered when on palpation there was no tenderness at the fracture site and Radiological union was found to be present when on x-ray, the fracture line was obliterated along with presence of bridging callus. Those which failed to unite without any other operative procedure were categorized as non-unions.

Anderson *et al* criteria was used for assessment of functional results [6] (Table 2).

Statistical Analysis: The t test was used to compare 2 groups for age at time of injury, mechanism of injury, sex, side of fracture, level of fracture, pattern of fracture, associated injuries, and time interval for surgery. Fisher exact test and unpaired t test was used to calculate and for comparison of groups. A $P>0.05$ was considered significant for analysis. The results are tabulated in Table 1.

Results

Average surgery time in plating group was 68 minutes, with range from 48 to 85 minutes. In nailing group average surgery time was 43 minutes with range from 42 to 64 minutes (p>0.05). All the plating group patients were immobilized for 6 weeks. In nailing group all patients were immobilized for a period of 4 to 6 weeks after suture removal. Follow-up was for 1 year.

In nailing group radius showed union in 15 (100%) patients and ulna in 14(93.3%) of patients. In one patient radius was united but ulna had non-union due to implant failure (TABLE 3). Average union time was 13weeks.

In plating group both radius and ulna showed union in 15(100%) of patients. Average radiological union time was 16 weeks (p>0.05).

Functional results were assessed by Anderson *et al* criteria. Functional results in plating group were excellent in 12 (80%) of patient, satisfactory in 3(20%). There was no unsatisfactory result in plating group.

In nailing group result were excellent in 9 (60%), satisfactory in 5 (33%), unsatisfactory in 1 (7%).

Table 1:

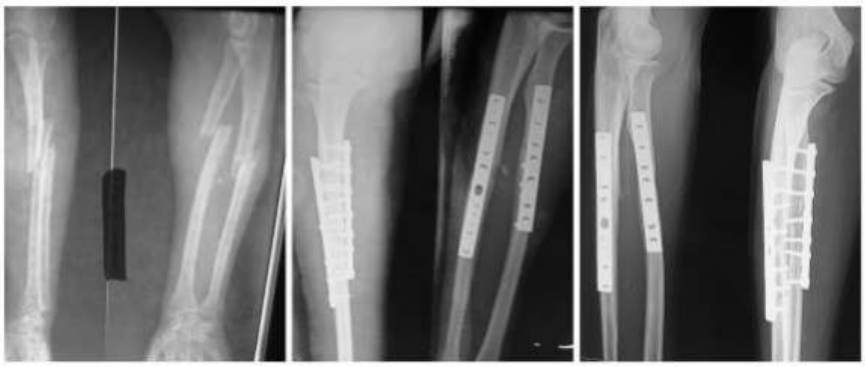
S. No	Parameter		Plating group (15)	Nailing group (15)	P value	Significance
1	Mean age		32	34	p>0.05	Not significant
2	Sex	Male	10	9	p>0.05	Not significant
		Female	5	6		
3	Side	Right	9	8	p>0.05	Not significant
		Left	6	7		
4	Mechanism of injury	RTA	12	13	p>0.05	Not significant
		Self-fall	3	2		
5	Closed or open	Closed	12	10	p>0.05	Not significant
		Open	3	5		
6	Time for operation (days)		7.8	8.5	P<0.05	Significant

Table 2: Anderson *et al* (3) Criteria was used in grading the functional outcome.

Results	Union	Flexion And Extension At Elbow Joint	Supination And Pronation
Excellent	Present	<10 degrees loss	<25% loss
Satisfactory	Present	<20 degrees loss	<50% loss
Unsatisfactory	Present	<20 degrees loss	>50% loss
Failure	Non-union or unresolved chronic osteomyelitis		

Table 3: Complications in both the groups

Complications	Plating group	Nailing group
Delayed union	0	1(ulna)

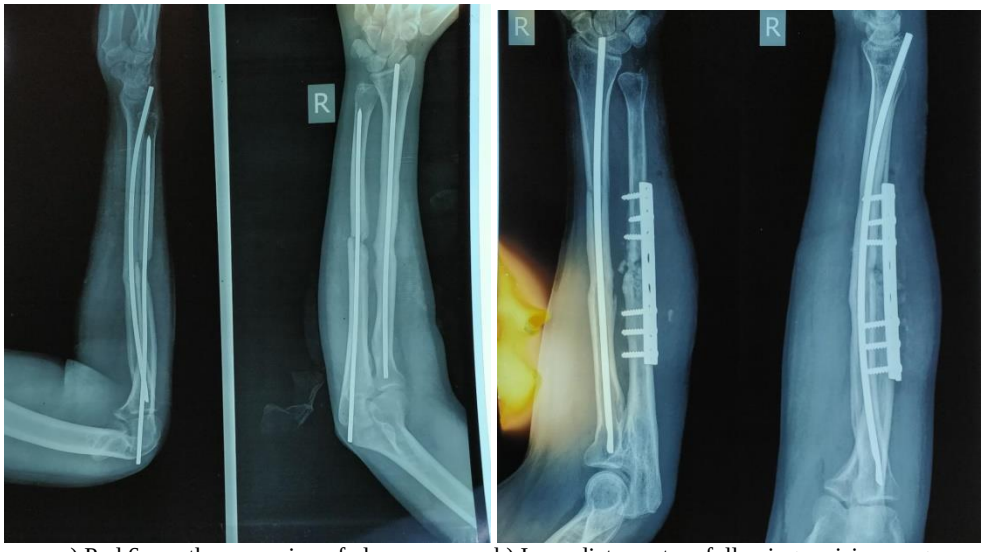


A) pre-op B) immediate post op C) 6 months follow up

Fig 1: Pre and post op Xrays along with fracture union-plating group

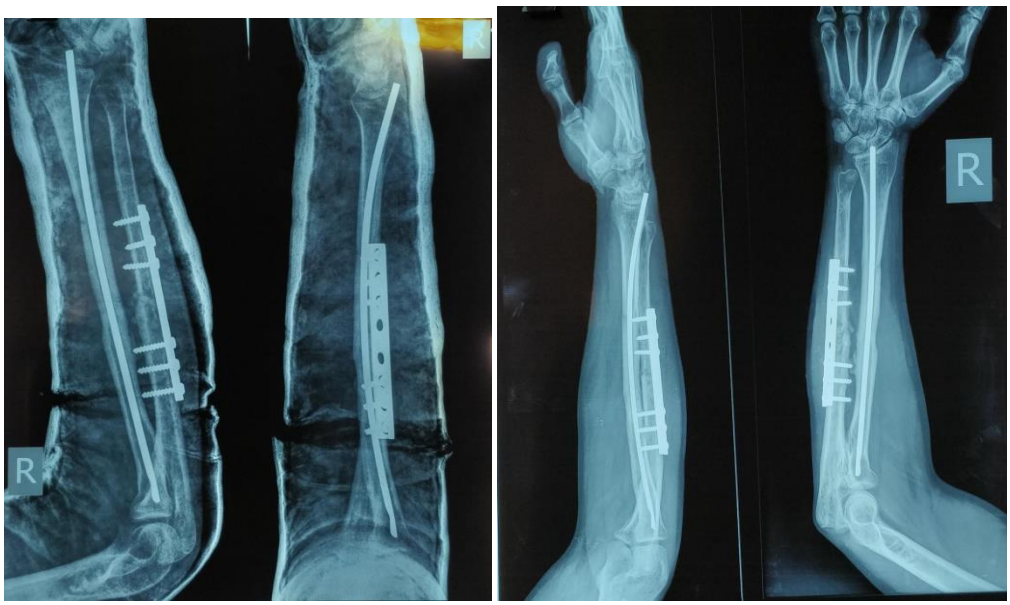
A) Pre Op B) Immediate Post Op C) 6 Months Follow Up

Fig 2: Pre and post op x-rays along with fracture union-nailing group



a) Pod 6 months non union of ulna b) Immediate post op following revision surgery

Fig 3: Non union of ulna treated with open reduction with plating and bone grafting



a) Post suture removal with cast b) Pod 10 weeks following revision surgery

Discussion

Fracture of both bones of the forearm are one of the most common injuries. Mal-union occurs after treatment with conservative management which furthermore results in decreased rotation of the forearm which is associated with poor outcome. Loss of rotation results in a hinderance to the function of the upper limb and activities of daily living [7]. Compression plate fixation has become the modality of choice for both bone forearm fractures. Many studies have shown good results [8] Droll *et al* compared injured arms with that of uninjured arms after internal fixation, he found out that injured arms had reduced strength of forearm pronation (70%) and supination (68%), wrist flexion (84%) and extension (63%), and also the grip strength (75%). Moreover, the injured arms had quite a significant reduced active range of forearm supination (90%) and pronation (91%) and wrist flexion (82%) [9]. Possible complications might include delayed union or non-union, compartmental syndrome, and refractures which might happen after extraction of the plate [10, 11]. Intraoperatively nerve injuries has also been reported quite frequently. The incidence of transient dorsal nerve palsy is around 7 to 10% of all patients with fracture of radius treated by plating. Treatment of diaphyseal fractures with closed intramedullary nail can achieve good results. In 1913 Schone [12] first used the silver nails for radial and ulnar medullary fixation, and subsequently various nails were developed to stabilize forearm fractures. Vom Saal (1954) developed the first square nail [13] Talwalkar (1967) treated 72 cases of both bone forearm fractures by square nail and resulted in 100% union rate [14]. Surgical duration was significantly longer in plating group as compared to the nailing group because operative technique is more demanding due to delicate and skill full soft tissue dissection required for exposure ($p>0.05$). Nailing group was provided with external bracing with cast or slab for a minimum duration of 4-6 weeks because the fixation is not as rigid as plating. 1 Patient in nailing group showed non-union of ulna. Duration of surgery in both these cases was 43 and 68 minutes. Plating had higher percentage of excellent results with respect to nailing group according to Anderson *et al*. criteria. Restoration of pronation and supination movements depends on the anatomical realignment and restoration of the normal bow of bone. As nailing was performed in closed reduction, it was difficult to restore the normal radial bow and this might be the reason for less percentage of excellent results in the nailing group. Regaining of the normal flexion and extension

at elbow and wrist joint was not a problem in either case. Surgical treatment of diaphyseal fractures with plating which requires an extensive and delicate soft tissue dissection, can compromise the blood supply of healing fracture [15] and atrophy of the cortical bone beneath the plate and placement of drill holes for the screw can weaken forearm bones. These factors might contribute to refracture of bones after removal of plate. Advantages of using intramedullary device is that periosteal stripping is avoided and the skin incisions are smaller, soft tissue damage is less, which results in preservation of blood supply, helping in fracture union. With respect to plating which are stress shielding devices, the intramedullary nails are stress shearing devices, which leads to formation of callus and may facilitate stronger union at the fracture site. Despite abundant callus formation, a mechanical block to forearm rotation has not been reported [10]. The disadvantage with intramedullary nailing is that it requires a longer duration of immobilization compared to plate osteosynthesis. Even with the disadvantage of longer duration of immobilization of the forearm, we think that intramedullary nailing is an alternative approach with exceptional results for both bone forearm fractures.

Conclusion

Open reduction and internal fixation with plating can be considered as the treatment of choice as it helps in maintaining length, opposition, axial alignment and good range of motion can be restored and better functional outcome can be achieved early with plating as compared to nailing. This has been proven in our study.

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