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Comparison of Intramedullary Nailing to Plating for Both-bone Forearm Fractures in Adult

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Abstract

Background: Plate osteosynthesis most commonly used technique for the treatment of both bone forearm fractures in adults. Plating can disrupt the periosteal blood supply. There are chances of refracture after implant removal. The purpose of this study was to assess early results of Nailing and Plating to stabilize the fractures and to compare the functional results of the two groups and to review the literature.

Methods: From May 2011 to September 2016 in the Department of Orthopaedics, MMCRI Mysore, Kamareddy Ortho & Trauma Care Hospital and ESIC MC Kalaburagi, total of 60 patients of both bones forearm fractures were treated. 30 were treated with plating and 30 with nailing.53 patients were available for the follow up. Follow up was for one year. Functional results were assessed by Anderson et al criteria.

Results: 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 1PIN palsy; 2 tourniquet palsy, 1 deep infection, 1 superficial infection, 1 implant failure, no delayed union and 3 non-unions in plating group. In nailing group no infection; two delayed union and no cases of nail migration. No synostosis, malunion, nail bending or cortical perforation.

Conclusion: We conclude that Plate osteosynthesis is the implant of choice for all diaphyseal fractures of both bones forearm. Intramedullary nailing is an attractive alternative. Complication rates are lower as compared to plating, application of above elbow cast after nailing is a drawback of the procedure.

Keywords: Plate osteosynthesis, Intramedullary Nailing**,** Diaphyseal Fractures, Bothbone Forearm.

Introduction

Both bone forearm fractures are not uncommon. Healing occurs reliably after closed treatment but malunion, with resultant decreased rotation of the forearm, is common and has been associated with poor results.[1,2] Rotation of the forearm is a complex interaction between the radius and ulna and the restoration of this movement depends on both an accurate reduction of the fractures and early initiation of post-operative movement.[3] Loss of rotation impedes function of the upper limb and activities of daily living. Most of the of fractures of both bones of the forearm in adults is treated operatively and there are various modes of internal fixations available, the choice of which depends on the treating surgeon.[4]

When treated conservatively forearm fractures is thick with complications of casting, compartment syndrome, malunion, and bayonet apposition.[5] Plate osteosynthesis is the most commonly 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.[6,7] Skin incisions that may be unsightly and also associated with risk of refracture after implant removal.[8] 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.[9,10]

The technique is commonly used in paediatric fractures of forearm. Intramedullary nailing has not been widely used for fixation of forearm fractures because of its limited indications and need for additional immobilization.[11] In these studies poor results may be because, nailing was performed by open reduction. 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.[12] However, open reduction and plating allow a more anatomic repair for most fractures.[13] This may result in more accurate restoration of the radial bow, which, although unproven, may more completely restore 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

60 patients with diaphyseal fractures of both bones forearm who met the inclusion and exclusion criteria were randomly chosen for a prospective study. Thirty (30) patients were treated by plate osteosyntheis and 30 patients were treated by closed intramedullary nailing. Square nails were used for intramedullary nailing.

The inclusion criteria were: 1) age more than 18 years 2) patient not subjected to any other form of treatment 3) all open Grade 1 (Gustillo and Anderson[14]) and closed fractures without neurovascular deficit. Exclusion criteria were: 1) skeletally immaturity 2)very narrow intramedullary canal 3) fractures older than 10 days before treatment 4) single bone fractures 5)presence of neurovascular deficit and 6) patient with head injuries. All study participants were followed up for a minimum of one 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 30 patients in this group. Out of these, 27 patients were available for follow up. Mean age was 32 years with age range from 20 to 54 years. Nineteen patients (19) were male. Right extremity was involved in majority of the cases. RTA was most common mechanism of injury affecting 15 patients. Eighteen (18) patients had middle third fractures. Four patients had open fractures. Five (5) patients had another associated injury. Average injury operation interval was 7.7 days.

Nailing Group: There were 30 patients in this group. Out of these, 26 patients were available for the follow up. Mean age was 34 year with age range from 19 to 57 year. Seventeen (17) patients were male. Right extremity was involved in 14 cases. RTA was most common mechanism of injury affecting 14 patients. Seventeen (17) patients had middle third fractures. Four patients had open fractures. Five (5) patients had another associated injury. Average injury operation interval was 8.2 days (Table 1).

Surgical Procedure: Patients were given the brachial plexus block using the supraclavicular approach. (Fig. 1)

Nailing: Square nails were used for intramedullary nailing. Nail size was determined prior to surgery. The required length was determined by measuring the uninvolved limb directly. Ulna was measured with a measuring tape from the tip of olecranon to ulnar styloid. One (1) cm was subtracted from this measurement. Radius length was determined by subtracting the 2.5 cm. from the ulnar measurement. Preoperatively diameter was determined by measuring the narrowest diameter of the intramedullary canal on either AP and lateral view of the x-ray of the fractured forearm. During the surgery diameter was confirmed by trial. Snug fitting nail was selected to avoid the overriding of the oblique and comminuted fractures. Patient was laid supine on the OT table with the affected limb positioned on the arm board. Image intensifier was positioned over the affected limb. For ulnar nailing 1 cm longitudinal incision was made over the tip of olecranon, triceps insertion was incised. Entry portal was made with the straight awl at a point 5 to 8 mm from the dorsal cortex and 5 mm from the lateral cortex over the olecranon. No reaming was done. After reduction of the fracture by traction and manipulation under image intensifier a nail of the proper size was selected and inserted in the canal and hammered after reducing the fracture, leaving only 5 mm outside the bone end. Fracture site was seen under image intensifier during hammering to avoid the distraction at the fracture site. Skin sutures were applied.

For radius nailing 1 to 1.5 cm incision was given extending distally from the dorsal margin of joint surface at a point just lateral to Lister's tubercle. The dissection was carried out between the extensor carpi radialis longus and extensor carpi brevis tendon. The entry portal was made with the straight awl directly in line with the medullary canal. At the dorsal margin of joint a straight awl was introduced at an angle of 45° to joint surface. After entering the bone 1 to 1.5 cm, the angle of the awl was dropped to the axis of bone and continued another 1 cm in line with the medullary canal of bone. 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.

Plating: Both fractures were exposed and reduced before fixation of either, fracture having less comminution was fixed first. Plates were applied using the AO principles.[15] Henry approach was used for fracture fixation. Ulna was exposed by subcutaneous approach. Plate was applied using the AO principles (Small fragment DCP/1/3 Tubular plate and 3.5 mm cortical screws).

Post-operative: In both methods above elbow slab was applied till suture removal. In plating group slab was discarded after suture removal and the active movement of the elbow and the wrist started. In the plating group above elbow cast was applied after suture removal if internal fixation was not rigid which was decided by the operating surgeon during the surgery. In the nailing group above elbow cast were applied after suture removal for 4 to 6 weeks and cast removed when early signs of union were noticed, and active movement of elbow and wrist started. Heavy and the strenuous activities were avoided till solid union occurred in all cases. Patients were regularly followed up at 6,12,18,24 weeks and finally at 1 year. At every follow up clinical and the radiological examination was done and the movements of the elbow and the wrist recorded. Clinically union was considered when there was no tenderness at the fracture site on stressing. Radiological union of fracture was judged to be present when on x-ray there was obliteration of fracture line with the evidence of bridging callus. (Fig. 2 & 3) Those fractures which required more than 6 months to unite and had no additional operative procedure performed were classified as delayed union. Those fractures which failed to unite without another operative procedure were

classified as non-unions. Functional results were assessed by Anderson et al (1975) criteria.[16](Table 2)

Statistical Analysis: The t test for independent samples was used to compare the 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. The Fisher exact test and unpaired *t* test were used to calculate and compare the groups. For all analyses, a P>0.05 was considered significant. Statistical analyses were performed using SPSS 24.0 (SPSS Inc., Chicago, Ill). 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). In the plating group 21patients required no immobilization. Six patients were immobilized for 6 weeks. In nailing group all patients were immobilized for a period of 4 to 6 weeks after suture removal. Average follow-up was from 12 months to 18months. Patients having the follow up of less than one year were not included in the study. In nailing group radius showed union in 24(93.2%) patients and ulna in 22(86.8%) of patients. In one patient both ulna and radius resulted in non-union. In another patient radius was united but ulna resulted in non-union due to implant failure. Average union time for radius was 7.8 weeks, for ulna 8 weeks. In plating group both radius and ulna showed union in 26(96.29%) of patients. There were 1 non-union for both ulna and radius which were in same patient. Average union time for radius was 9.3 weeks and for ulna 9.6 weeks (p>0.05). There was 1posterior interosseous nerve injury; 2 cases of tourniquet palsy, 1 deep infection, 1 superficial infection, 1 implant failure, no delayed union and 3nonunion in plating group. In nailing group there was1 implant failure, no infection; two delayed union and no cases of nail migration. (Table 3)(Fig. 6) There was no synostosis, malunion, nail bending or cortical perforation by nail. Functional results were assessed by Anderson et al criteria. Functional results in plating group were excellent in 22 (80%) of patient, satisfactory in 2(6.6%), failure in 3(13.2%). There was no unsatisfactory result in plating group. In nailing group result were excellent in 18 (68.7%), satisfactory in 7(24.8%), unsatisfactory in 1(6.2%) and no failure. (Fig. 4)

Table 1: Patient profile

S.no.	Parameter		Plating group(27)	Nailing group(26)	P value	Significance
1.	Mean age		32	34	p>0.05	Not significant
2.	Sex	Male	19	17	p>0.05	Not significant
		Female	08	09		
3.	Side	Right	15	14	p>0.05	Not significant
		Left	12	12		
4.	Mechanism of injury	RTA	15	14	p>0.05	Not significant
		Self-fall	09	08		
		Assault	03	04		
5.	Level of fracture	Upper/3	03	04	p>0.05	Not significant
		Middle/3	18	17		
		Lower/3	06	05		
6.	Closed or open	Closed	23	22	p>0.05	Not significant
		Open	04	04		
7.	Pattern of fracture	Transverse	14	16	p>0.05	Not significant
		Oblique	09	07		
		Spiral	02	02		
		Communited	02	0		
		Segmental	0	1		
8.	Associated injury	Clavicle	02	02	p>0.05	Not significant
		Humerus	01	02		
		Contralateral forearm	0	0		
		Hand	2	1		
		Others	0	0		
9.	Time for operation(days)		7.7	8.4	P<0.05	significant

Table 2: Anderson et al[13] Criteria was used in grading the functional outcome

Results	Union	Flexion and extension at elbow joint	Supination and pronation
Excellent	Present	<10° loss	< 25% loss
Satisfactory	Present	<20° loss	< 50% loss
Unsatisfactory	Present	>20° loss	>50% loss
Failure	Non – union or unresolved chronic osteomyelitis		

Table 3: Complications in both the groups

Complications	Plating group	Nailing group
Superficial infection	1	0
Deep infection	1	0
Delayed union	0	2
Nonunion	3	1
Implant failure	1	1
Nerve palsy(PIN)	1	0
Tourniquet palsy	2	0

Fig. 1: Operative steps both the groups

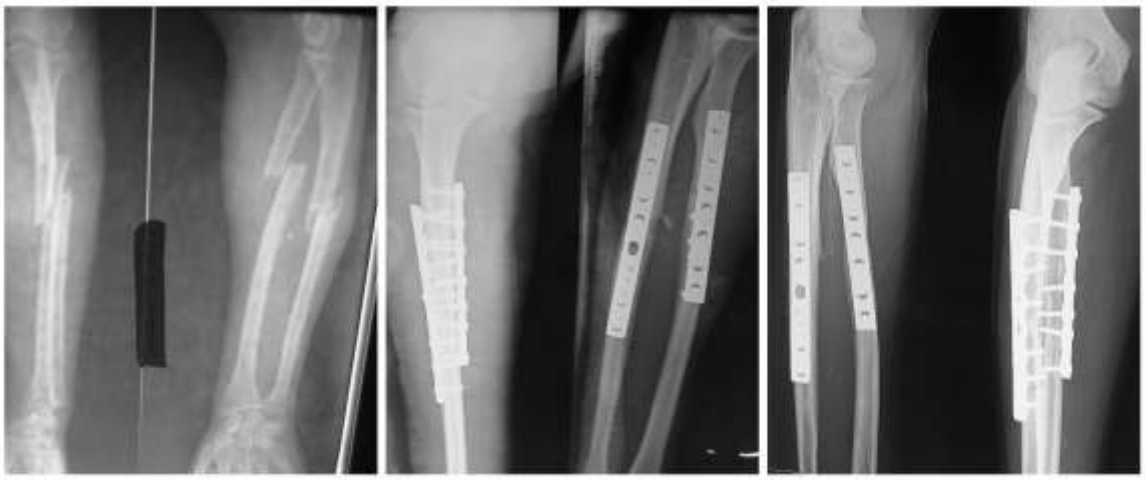

Fig. 2: Pre and post up x-rays along with fracture union-plating group

Fig. 3: Pre and post up x-rays along with fracture union-nailing group

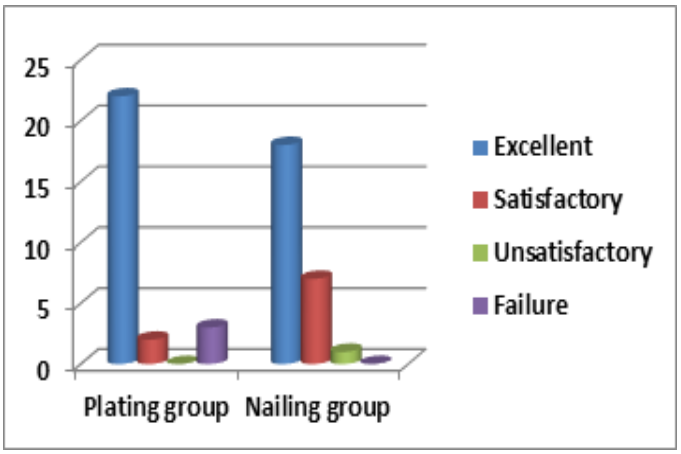

Fig. 4: Functional results in plating and nailing groups

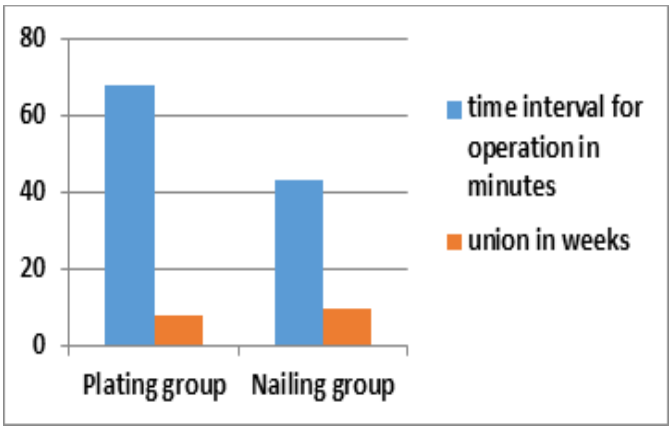

Fig. 5: Duration of fracture union and time interval for operation in both groups

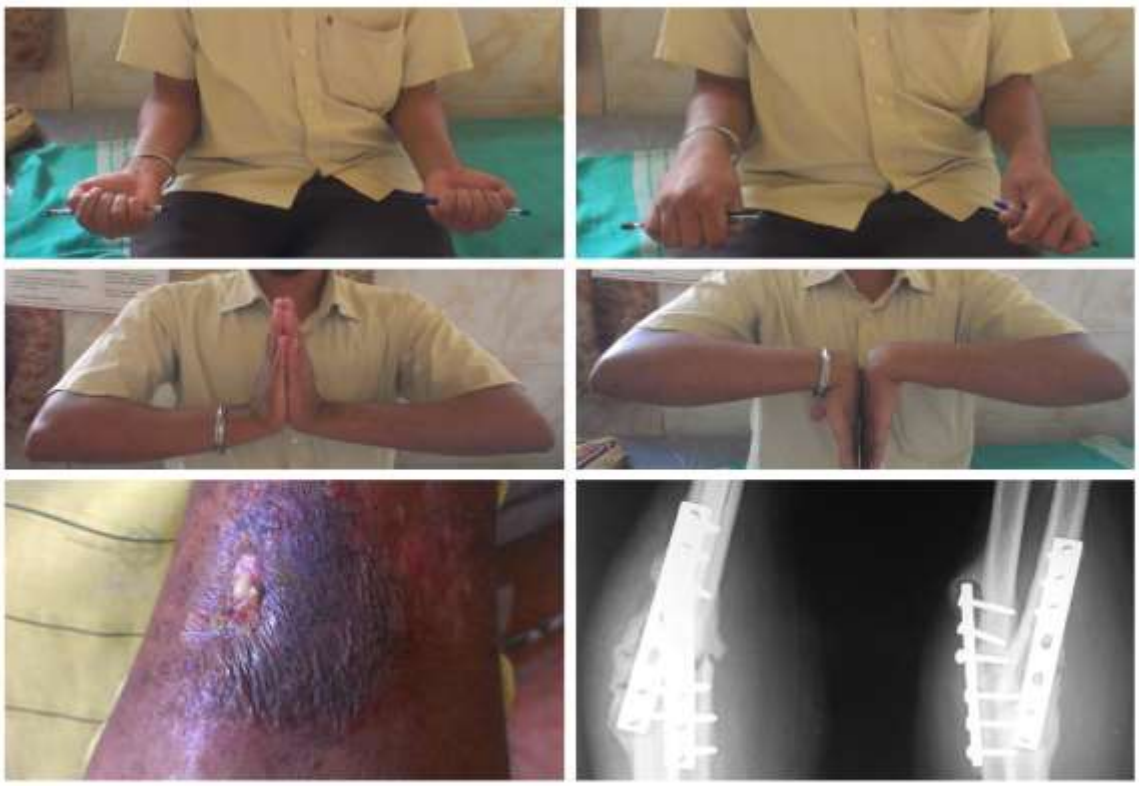

Fig. 6: Patient with range of motion and complications

Discussion

Fracture of both bones of the forearm is relatively common injuries which can challenge the treating surgeon. Healing occurs relatively after closed treatment but malunion with resultant decreased rotation of the forearm is common and has been associated with poor outcomes. Loss of rotation impedes function of the upper limb and activities of daily living.[17] Compression plate fixation has become the treatment of choice for fractures of both bone forearm. Several studies have shown good results.[18] Droll et al compared injured arms to uninjured arms, following internal fixation of the forearm fractures, and found that injured arms had reduced strength of forearm pronation (70%) of that of the normal arm, forearm supination (68%), wrist flexion (84%), wrist extension (63%), and grip (75%). In addition, the injured arms had a significantly reduced active range of forearm supination (90%), forearm pronation (91%) and wrist flexion (82%).[19] Possible complications include compartmental syndrome, delayed union or nonunion and refractures after extraction of the plate.[20,21] A high frequency of intraoperative nerve injuries has also been reported. The reported incidence of transient dorsal nerve palsy is 7 to 10% of all patients with radius fracture treated by plating .Incidence of radioulnar synostosis of the plate fixation is reported in the literature is 2% to 9%. Though plating for both forearm bones fracture is a sound practice and adheres to the principles of

osteosynthesis, a straight plate is unable to maintain and preserve the radial bow, essential for normal rotational movements of the forearm. Use of closed intramedullary nails for treatment of diaphyseal fractures of forearm in nailing group can achieve good results. In 1913 Schone[22] 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.[23] Talwalkar(1967) treated 72 cases of both bone forearm fractures by square nail and resulted in 100% union rate.[24]

Duration of surgery was longer in plating group than nailing group because operative technique is more demanding due to meticulous soft tissue dissection required for exposure ($p>0.05$). Nailing does not provide rigid fixation and some form of bracing is required for initial 6 to 8 weeks. Plating in general does not require external bracing. One patient in plating group who showed nonunion had open fracture and developed the deep infection 1 month after surgery. Another patient who had nonunion of ulna had loosening of screws. 2 Patients in nailing group showed delayed union. Tourniquet palsy occurred in 2 cases which was transient and recovered after 3 months. Duration of surgery in both these cases was 43 and 68 minutes.(Fig. 5) Tourniquet palsy in these cases may be due to high pressure in the cuff. Two patients had superficial infection which was treated by intravenous antibiotics and recovered completely. One patient who had deep infection had open fracture of middle third by fall. Radius was comminuted and ulna had transverse fracture. Wound was debrided at the day of injury and intravenous antibiotics were started. Another patient had implant failure having fracture of middle third of forearm by RTA.

There was no infection in nailing group this may be because all the surgeries in this group were performed by closed reduction under image intensifier. Percentage of excellent results was higher in plating when compared to nailing group. Restoration of pronation and supination depends upon the anatomical alignment and restoration of normal bow. As the nailing was performed after closed reduction so normal radial bow could not be restored this may be the probable reason for less percentage of excellent results in nailing group. Regaining of the normal flexion and extension of elbow and wrist joint was not a problem in either case. (Fig. 6) Standard surgical treatment of diaphyseal fractures with plate osteosynthesis requires an extensive soft tissue dissection, which can compromise the blood supply of the healing fracture.[25]

Moreover, atrophy of the cortical bone underlying the plate and placement of drill holes for the screw can weaken the forearm bones. These factors contribute to refracture of bones after the plate removal.

The advantages of using an intramedullary device is that periosteal stripping is unnecessary, the skin incisions are smaller, and there is less soft tissue dissection, resulting in preservation of osseous blood supply, which aids in fracture union. Also unlike compression plating, intramedullary devices are stress sharing rather than stress shielding, which leads to peripheral periosteal callus that may facilitate the stronger fracture union. Despite this abundant callus a mechanical block to the forearm rotation had not been reported to our knowledge.[20] In our study there was no case of radioulnar synostosis. The disadvantage of intramedullary nailing procedure is that it requires a longer duration of immobilization (until bridging callus is observed) compared to plate osteosynthesis. Even with the disadvantage of longer duration of immobilization of the forearm and radiation hazard to patient and surgeon. We believe that intramedullary nailing is a reasonable approach with good results.

Conclusion

From our comparative study we conclude that anatomical reduction and stable internal fixation should continue to be the standard method of treatment for fracture of both bones of the forearm in adults. Plate osteosynthesis is the implant of choice. Intramedullary nailing is an attractive alternative for the treatment of shaft fractures involving both forearm bones in adults. Complication rates are lower as compared to plate osteosynthesis, although application of above elbow cast after nailing is a drawback of the procedure.

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