
RESULTS OF CLOSED INTRAMEDULLARY NAILING VS PLATE OSTEOSYNTHESIS IN DIAPHYSEAL FRACTURES OF BOTH BONES FOREARM IN ADULTSSuneet Tandon¹, Mohammad Zuber², Radheyshyam Dhiman³, S. Gaur⁴**HOW TO CITE THIS ARTICLE:**

Suneet Tandon, Mohammad Zuber, Radheyshyam Dhiman, S. Gaur. "Results of Closed Intramedullary Nailing vs Plate Osteosynthesis in Diaphyseal Fractures of Both Bones Forearm in Adults". Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4, Issue 15, February 19; Page: 2577-2585, DOI: 10.14260/jemds/2015/370

ABSTRACT: BACKGROUND: 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 necessitates skin incision that may be unsightly, and there is a risk of refracture if the implant is removed. The purpose of this study was to assess the early results of the use of closed intramedullary nail to stabilize diaphyseal fractures of both bones forearm.

AIMS OF STUDY: 1. To evaluate the results of internal fixation of diaphyseal fractures of both bones forearm treated by plate osteosynthesis and closed intramedullary nailing. 2. To compare the functional results of the two groups treated with plate osteosynthesis and closed intramedullary nailing. 3. To review the literature on the treatment of diaphyseal fractures of forearm bones.

METHODS: From September 2006 to October 2008 in the Department of Orthopaedics and Traumatology, Gandhi medical college and associated Hamidia Hospital, Bhopal, total of 38 patients of both bones forearm fractures were treated. Eighteen (18) patients were treated with plate osteosynthesis and 20 patients with closed intramedullary nailing using the square nails. Total 31 patients were available for the follow up. Average follow up in plate osteosynthesis group was 14.1 months and in closed intramedullary nailing group was 15 months, with range from 12 months to 21 months. Functional results were assessed by Anderson et al criteria (1975).

RESULTS: Average surgery time in plate osteosynthesis group was 68 minutes, and in closed nailing group was 43 minutes. In plate osteosynthesis group radius showed union in 14 (93.2%) patients and ulna in 13 (86.8%) of patients, in closed nailing group both radius and ulna resulted in 100% union rate. In plate osteosynthesis group there was 1 deep infection, 1 implant failure, and 3 nonunion. Functional results in plate osteosynthesis group were excellent in 12 (80%) of patient, satisfactory in 1(6.6%), failure in 2(13.2%). There was no unsatisfactory result in this group. In closed nailing group result were excellent in 11(68.7%), satisfactory in 4(24.8%), unsatisfactory in 1(6.2%) and no failure.

CONCLUSIONS: Our experience indicates that the advantage of closed intramedullary nailing for fractures of both bones forearm are that it is technically straightforward, it allows high rate of osseous union, and it requires less surgical exposure and operative time, less risk of infection than does plate osteosynthesis for diaphyseal fractures of both bones forearm in adults. The disadvantage of this system is that post-operative immobilization is required until bridging callus is observed at the fracture site and radiation hazard to patient and surgeon. We conclude that closed intramedullary nailing is not superior to plate fixation but can be considered as an alternative to that method for diaphyseal forearm fractures in adults.

KEYWORD: forearm nailing, forearm plating.

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INTRODUCTION: Fractures of the radius or ulna should be stabilized in order to ensure axial and rotational alignment,¹ and plate osteosynthesis is the procedure of choice for treating the forearm fractures. However, although this technique results in adequate reduction and satisfactory healing, it has been criticized because periosteal stripping may increase the probability of delayed fracture union.^{2,3} A 2.3% to 4% rate of non-union,^{4,5} a 1.9% to 30.4% rate of refracture⁶⁻¹⁰ and a 0.8% to 2.3% rate of infection¹¹⁻¹² have been reported as complication of plate fixation of forearm fractures. In addition, plate fixation can disrupt the blood supply and inhibit the periosteal revascularization. In an effort to circumvent these problems, intramedullary nailing has been proposed as an alternative method for stabilization and maintaining the reduction of forearm fractures.^{13,14}

This technique is commonly used for the femoral fixation and increasingly for fractures of tibia and humerus.¹⁵⁻¹⁷ However, intramedullary nailing has not been widely used for fixation of forearm fractures because of its limited indications, reportedly high rate of non-union, and need for additional immobilization.¹⁸ In these studies poor results may be because, nailing was performed in these studies by open reduction. Closed reduction theoretically seems to have advantage of preserving the fracture hematoma, preserving the periosteal blood supply, less infection, minimal surgical trauma and small scars. We conducted a randomized prospective study to investigate whether the result of closed intramedullary nailing are comparable to plate osteosynthesis.

AIMS OF STUDY:

1. To evaluate the results of internal fixation of diaphyseal fractures of both bones forearm treated by plate osteosynthesis and closed intramedullary nailing.
2. To compare the functional results of the two groups treated with plate osteosynthesis and closed intramedullary nailing.
3. To review the literature on the treatment of diaphyseal fractures of forearm bones.

MATERIAL AND METHODS: Thirty eight (38) patients with diaphyseal fractures of both bones forearm were randomly chosen for a prospective study from September 2006 to October 2008 in the Department of Orthopaedics and Traumatology, Gandhi medical college and associated Hamidia Hospital, Bhopal. Randomization was done using the sealed envelope technique. Fifteen (15) patients, group 1 were treated by plate osteosynthesis and 16 patients, group 2 were treated by closed intramedullary nailing. Square nails were used for intramedullary nailing. Adult patients with displaced diaphyseal fractures of both bones forearm were selected for the study. Closed fractures or grade 1 (Gustillo and Anderson¹⁹) open fractures less than 4 week old were included in the study. All the cases were thoroughly examined for head; chest and abdominal injuries and these injuries were treated as the priority.

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. Prophylactic treatment against TT was given and broad spectrum antibiotic were given to prevent the infections. Those cases, in which surgeries were performed within 6 hours of injury, were debrided in the OT at the time of surgery itself. Those cases which were not operated immediately, wound was washed with copious amount of normal saline and initial care was given in emergency including the thorough debridement of wound. After dressing limb was immobilized in the above elbow POP slab.

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Plating Group: There were 18 patients in this group. Out of these, 15 patients were available for follow up. Mean age was 32 years with age range from 22 to 54 years. Eleven patients (11) were male. Right extremity was involved in 8 cases. RTA was most common mechanism of injury affecting 7 patients. Twelve (12) patients had middle third fractures. One (1) patient had upper third fracture. Two patients had open fractures. Five (5) patients had another associated injury. Average injury operation interval was 7.7 days.

Nailing Group: There were 20 patients in this group. Out of these, 16 patients were available for the follow up. Mean age was 34 year with age range from 19 to 57 year. Twelve (12) patients were male. Right extremity was involved in 7 cases. RTA was most common mechanism of injury affecting 8 patients. Eleven (11) patients had middle third fractures. One (1) patient had upper third fracture. Three patients had open fractures. Five (5) patients had another associated injury. Average injury operation interval was 8.2 days.

Surgical Technique: Patients were given the brachial plexus block using the supraclavicular approach using the 20 – 30 ml. of 1 to 1.5 xylocaine mixed with the sensorcaine.

Nailing: Square nails were used for intramedullary nailing. Nail size was determined prior to surgery. The required length was determined by measuring the uninjured limb directly. Ulna was measured with a tape measure 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. Reaming was done with the reamer of successively increasing sizes after reducing the fracture by traction and manipulation under image intensifier. Distal fragment was reamed all the way to bone end. 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.

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Parameter		Group 1(n=15)		Group 2(n=16)	
		1. Mean Age		32	
2. Sex	Male	11		12	
	Female	4		4	
3. Side	Right	8		7	
	Left	7		9	
4. Mechanism	RTA	7		8	
	Fall	5		5	
	Assault	3		2	
5. Level of fracture	Upper third	1		2	
	Middle third	12		11	
	Lower third	2		3	
6. Closed or Open	Closed	13		13	
	Open	2		3	
7. Pattern of fracture		Radius	ulna	radius	ulna
	Transeverse	7	5	6	5
	Oblique	5	6	6	7
	Communitied	3	4	4	3
	Segmental	0	0	0	1
8. Associated injury	Clavicle	1		0	
		1		2	
	Humerus	1		1	
	Opposite forearm	1		0	
	Metacarpal	0		1	
	Patella	0		1	
	Tibia	1		0	
	Femur	1		0	
9. Trauma surgery interval (days)		7.7		8.2	

Table 1: Pre-operative Variables

Plating: Both fractures were exposed and reduced before fixation of either, fracture having less comminution was fixed first. Plates were applied using the AO²⁰ principles. When the radius fracture was in distal 3rd of bone Henry approach was used. For fracture of the proximal 3rd Thompson approach was used. For the fracture of the middle 3rd either approach was used depending on the surgeon's preference. Ulna was exposed by subcutaneous approach. Plate was applied on the either side of bone depending on the comminution. Plate was applied using the AO principles (Small fragment DCP 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 6 to 8 weeks and cast removed when early signs of union were noticed, and active movement of elbow and wrist started. Heavy and the strenuous

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activities were avoided till solid union occurred in all cases. Patients were regularly followed up at 2, 6, 8, 12, 14, 16, 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 trabeculae. 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.²¹

Duration (min)	Group I	Group II
<40	0	5
40 - 49	1	8(50%)
50 -59	3	2
60 - 69	7(46.6%)	1
70 - 79	2	0
80 - 89	2	0

Table 2: Duration of surgery

weeks	Group I		Group II	
	Radius	Ulna	Radius	Ulna
6	2(26.6%)	1(6.6%)	1(6.2%)	1(6.2%)
8	11(73.3%)	10(66.6%)	4(24.8%)	2(12.4%)
10	1(6.6%)	2(13.2%)	9(56.3%)	11(68.7%)
12	0	0	1(6.2%)	1(6.2%)
14	0	0	0	0
Delayed union	0	0	1(6.2%)	1(6.2%)
Non union	1(6.6%)	2(13.2%)	0	0
Total	15(100%)	15(100%)	16(100%)	16(100%)

Table 3: Union

RESULTS: Average surgery time in group 1 was 68 minutes, with range from 48 to 85 minutes. In group 2 average surgery time was 43 minutes with age range from 42 to 64 minutes. In the group 1, twelve patients required no immobilization. Three patients were immobilized for 6 weeks. In group 2 all patients were immobilized for a period of 6 to 8 weeks after suture removal. Average follows up in group 1 was 14.1 months and in group 2 was 15 months, with range from 12 months to 21 months. Patients having the follow up of less than 1 year were not included in the study. In group 1 radius showed union in 14 (93.2%) patients and ulna in 13 (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. There was no delayed union in group 1. Average union time for radius was 7.8 weeks, for ulna 8 weeks. In group 2 both radius and ulna showed union in 16 (100%) of patients.

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There were 1 delayed union for both ulna and radius which were in same patient. There was no nonunion. Average union time for radius was 9.3 weeks and for ulna 9.6 weeks. There was 1 posterior introsseous nerve injury; 2 cases of tourniquet palsy, 1(6.8%) deep infections, 1 superficial infection, 1 implant failure and 3 non unions in group 1. In group 2 there was no infection; one delayed union and 2 (12.4%) cases of nail migration. There was no synostosis, malunion, implant failure, nail bending or cortical perforation by nail. Functional results were assessed by Anderson et al criteria. Functional results in group 1 were excellent in 12 (80%) of patient, satisfactory in 1(6.6%), failure in 2(13.2%). There was no unsatisfactory result in group 1. In group 2 result were excellent in 11 (68.7%), satisfactory in 4(24.8%), unsatisfactory in 1(6.2%) and no failure.

DISCUSSION: This study demonstrated that use of closed intramedullary nails for treatment of diaphyseal fractures of forearm can achieve good results. In 1913 Schone²² first used the silver nails for radial and ulnar medullary fixation, and subsequently various nails were developed to stabilize forearm fractures.^{13,14,23-28} Vom Saal²⁹ (1954) developed the first square nail. Talwalkar³⁰ (1967) treated 72 cases of both bone forearm fractures by square nail and resulted in 100% union rate.

Duration of surgery was longer in group 1 than group 2 because operative technique in group 1 is more demanding due to meticulous soft tissue dissection required for exposure. 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, but in present study post operatively slab was given to minimize pain and swelling in early post-operative period.

One (1) patient in group 1 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. Patient in group 2 who showed delayed union was 46 year female. Tourniquet palsy occurred in 2 cases which was transient and recovered after 3 months. Duration of surgery in both these cases was 56 and 74 minutes. Tourniquet palsy in these cases may be due to high pressure in the cuff. There was 1 posterior interosseous nerve palsy in group 1. This was 52 year male having fracture of both bone in upper third. Radius was exposed by Thompson approach, nerve injury may have occurred due to traction injury. Nerve injury was transient and recovered completely after 4 months. 1 patients had superficial infection which was treated by intravenous antibiotics and recovered completely. This fracture was not open initially and culture resulted in the Staph aureus as the organism. One (1) patient who resulted in deep infection was 54 year male and 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.

Patient was operated on 9th day in routine OT and wound was healthy so closed at the time of surgery. Patient was discharged from the hospital after stitch removal on 11th day. At follow up of 2 months patient presented with discharging sinus from incision site over radius. Culture sensitivity resulted in MDR Staph aureus as the organism. IV cefuroxime was given and debridement was carried out. Infection healed clinically in 1 month, but patient again had pus discharge at 6 months and plate over radius had loosened both ulna and radius was not united.

Due to infection it was decided to remove the plates and patient was given A/E cast. Till last follow up patient infection was settled down but bones had not united. Another patient in whom implant failure occurred was 46 year female having fracture of middle third of forearm by RTA. Radius had transverse fracture while ulna had oblique fracture. Patient was operated 13th day after

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injury. At follow up radius showed union at 10 weeks while screws in ulna loosened. Patient gave the history of lifting heavy objects at 6 weeks. Other probable reason for implant failure was screw in ulna too close to fracture site. Revision surgery was advised for ulna but patient refused. In group II there was one delayed union which united after 6 months.

There were two case of ulnar nail migration. Patient complaint of pain at elbow during movement and nail was palpable at olecranon tip. Nails were hammered back in both cases. There was no infection in group 2 this may be because all the surgeries in group 2 were performed without exposing the fracture site by closed reduction under image intensifier. Percentage of excellent results in group 1 was higher when compared to group 2. But when the excellent and satisfactory results were combined (Good results) there were no significant differences between two groups (p value 0.06). 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 group 2. Regaining of the normal flexion and extension of elbow and wrist joint was not a problem in either case. Two failures in group 1 was because, in 1 case patient was uncooperative or technical fault of surgeon and in 2nd case because of infection.

Standard surgical treatment of diaphyseal fractures with plate osteosynthesis requires an extensive soft tissue dissection, which can compromise the blood supply of the healing fracture². 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 knowledge²⁶. 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 with that required following the plate osteosynthesis. Even with the disadvantage of longer duration immobilization of the forearm, we believe that intramedullary nailing is a reasonable approach that has good results. We found that fixation of diaphyseal fractures of the forearm in adults with closed intramedullary nailing has several merits. It results in a union rate comparable to that following the plate fixation. In addition, it requires no periosteal stripping and the incisions are smaller than those required for plate fixation.

The disadvantages of this system are that post-operative immobilization is required until bridging callus is observed at the fracture site and radiation hazard to patient and surgeon.

CONCLUSION: Our experience indicates that closed intramedullary nailing is not superior to plate fixation but can be considered as an alternative to that method for diaphyseal forearm fractures in adults.

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