

Comparative Study of Intramedullary Nailing Versus Locking Compression Plating In Adult Diaphyseal Fractures of Forearm Bones

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Abstract

Background: “Natural forces within us are true healers of disease” Hippocrates Diaphyseal fractures of forearm bones are very common orthopaedic injury. A range of products are available for its internal fixation. This study was conducted with an aim to determine whether ORIF with plates or intramedullary nailing, is able to produce better clinical outcome. The outcome was assessed on the basis of operating time, union time, functional recovery, complication and cost to patient. **Subjects and Methods:** The study was conducted in Muzaffar Nagar medical college, Shyamal Trauma & child care and Vedanti Hospital Muzaffar Nagar (U.P.), from 2009 to June 2017. **Results:** In all 117 patients were treated with intramedullary nailing or plating of adult diaphyseal fracture of fore arm both bone and single bone. Of this 17 were discarded for various reasons and 100 were considered for the present study. Biomechanically, unlocked intramedullary nail (IM) attain stability by a curvature mismatch between bone and the nail, inducing a longitudinal interference fit. If curvature misfit is large reaming is required. **Conclusion:** Open reduction and internal fixation (ORIF) at present is thought to be superior method to treat such fractures. We have used commonly available locking compression plates and square intramedullary nail of various diameters.

Keywords: Fore arm fractures, skeletally mature, intramedullary nail, plate osteosynthesis.

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Introduction

“As to the disease make a habit of two things: to help or to do at least no harm.”

Hippocrates

Recent advances in fracture management in fracture BBFA (both bone forearm) have focused on minimally invasive fracture stabilization techniques. As forearm supination and pronation movements are initiated from the proximal and distal radioulnar joints, therefore Radius and Ulna have an important role in the movement of not only forearm but whole upper extremity.^[1] Over the last 40 years, anatomical reduction with plate stabilisation has become the standard in adult patients with diaphyseal fractures of Radius and Ulna. When operative fixation has been indicated in skeletally mature patients with these fractures a variety of techniques have been reported with Intramedullary Nail (IM) fixation becoming increasingly acceptable.^[2]

There is currently significant variability in treatment of adolescent with fore arm fracture.^[2]

Fracture of forearm are classified according to level of fracture, the pattern of fracture, the presence or absence of comminution or segmental, and whether they are open or

close. Each of these factors may have some bearing on the type of treatment to be selected and ultimate prognosis.^[3]

For descriptive purposes, it is useful to divide forearm into thirds, based on linear dimension of Radius and Ulna. Disruption of proximal and distal radioulnar joints with diaphyseal is of greater significance to treatment and prognosis but were not taken into consideration in present study and were discarded.

Conservative methods are not recommended for these fractures. The deforming effect of muscle strength, continuity of Radial incline and interosseous membrane damage are significant factors that affect the stabilization and maintenance of reduction.^[4] It is almost impossible to achieve sustainable and stable fixed reduction in conservative treatment. If there is rotatory malalignment it restricts forearm rotation, simultaneously wrist and elbow joint movement are affected negatively. So due to functional and anatomic features, forearm diaphyseal fractures are different from diaphyseal fracture of other long bones, and must be evaluated as intra articular fracture with treatment planned accordingly.^[5]

Open reduction and internal fixation is a widely used and accepted treatment method that is associated with high rate of union and satisfactory functional results. However, ORIF

has some pitfalls. Problems of incision scar mark has cosmetic issues, drainage of haematoma, risk of soft tissue and periosteal damage, skin irritation of implant specially in Ulna due to its subcutaneous nature have been reported. The criticized aspect of ORIF has made it controversial as a standard treatment method. Generally nonspecific Intramedullary nail (IM) implant have been used as an alternative method, but they do not have locking and compression features.^[6,7]

In this study we conducted a comparison between effectiveness of locking compression plating versus intramedullary nail in treating adult diphyseal fracture of both bones of forearm based on operating time, union time, functional recovery, complication and patients satisfaction as to cost.

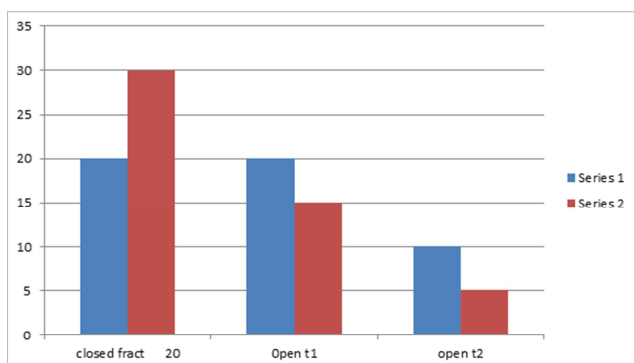
Subjects and Methods

“He Will Manage the Cure Best, Who Has Foreseen What Is To Happen From the Present State of Matters”

Hippocrates

Study was conducted from 2009 to June 2017 at three centres mentioned. 117 patients were operated out of which 17 patients did not turned up for adequate follow up hence were not included in study. One team operated for ORIF and one team performed IM nailing. Patient were selected for surgery randomly and due consent was taken.

Fractures with joint injuries were not taken up as were pathological fracture and skeletally immature patients also did not found place in our study. In adequate follow up were also not taken into account. Gustilo type 1 and type 2 fracture were admitted and sufficient irrigation was done before doing emergency surgery. Type 3 fractures were not taken into consideration. So a series of 100 patients was taken up for statistical purpose. 50 were of plating group and 50 were of IM nailing group.



Graph 1: Distribution of Cases by Fracture Type

Blue bar shows ORIF group and red IM group. IN ORIF group 20 (40%) patients were closed fracture BBFA (both bone forearm), 20 (40%) patients were open type 1, and 10 (20%) patient were open type 2 out of a total of 50 cases

and in IM nailing group 30 (60%) patients were closed fracture and 15 (30%) were open type 1 and 5 (10%) patients were open type 2 fracture of BBFA.

Dynamic compression locking plates were used in ORIF group and square nail were used in IM group. Union was evaluated radiologically as bridge callous formation or absence of fracture line and clinically as lack of pain on the fracture line. Nonunion was considered after 6 months of follow up if no bridge callous formation is seen. Functional results and union evaluation were made according to the Grace – Eversman criterion.^[8] Patients satisfaction was evaluated with the Disabilities of Arm, Shoulder and Hand (DASH) score.^[9] Questionnaire on the basis of physical activity in the previous week and satisfaction levels.

Joint range of movement was evaluated goniometrically, with elbow in 90 degree flexion, the forearm pronation and supination angles were measured.

Data related to operating time, amount of blood loss, fluoroscopic time and complication were duly noted. Radiological data were evaluated using radiographs taken at regular interval of 1 month in follow up examination up to 1 year. Union was evaluated on AP and LATERAL radiographs. Callus formation in four cortices were evaluated as union. The Grace – Eversman criterion, joint range of motion (ROM) measurement were obtained from all patients in 1 year follow up period.

Surgical Technique

All patients were treated with in 1-7 days of presentation (mean 4.5 days) in ORIF group and within 3 days (mean 2.1 days) in IM nail group. All patient received 1 gm. Ceftriaxone and Amikacin 500 mg. Intravenously preoperative. Patient was put supine for both types of surgery and tourniquet was not used in ORIF but was used in IM nailing group.

Closed reduction was attempted in IM nailing group on fluoroscopy compatible [Table]. With forearm in neutral position incision was made on Olecranon to introduce nail in it as Ulna was fixed first keeping elbow in 90 degree flexion. After making an opening in Olecranon with trocar, rimmer were introduced till fracture site. After obtaining reduction rimmer was passed in distal fragment till appropriate distance and measurement of length was taken and rimmer diameter as guide of marrow thickness. Appropriate square nail was taken and put inside Ulna. The same procedure was applied for Radius and entry was made through Radial styloid.

In ORIF group appropriate incision was made depending upon level of fracture. Care was taken not to strip periosteum excessively. Plate used as fixation material was 3.5 mm locking compression plate. A plate of appropriate size was selected according to fracture type and degree of fragmentation. We applied compression AO principle based on the fracture line. Fixation was made with a minimum of two screw holding four cortices proximal to fracture and

two screw distal to it. Following fixation and bleeding control an aspiration drain was placed in surgical area and wound closed. Drain was removed on 2-5th postoperative day. No graft was used in primary surgery in either ORIF or IM nailing group. In patients undergone IM nailing early stage ROM exercises started after keeping part in slab for 15 days. In ORIF group also exercises started in 15 days but arm was not supported in slab for any duration.

Table 1: Site Distribution of Cases

S. NO	Fixation	R Side	%	L side	%
1	ORIF	27	54%	27	46 %
2	IM	24	48 %	26	52 %

Table 2: Etiology of Fracture

S. No	Cause	No. Of Cases	%
1	Traffic Accident	52	52 %
2	Fall	24	24 %
3	Sporting Injury	7	7%
4	Industrial Accident	12	12 %
5	Impact	5	5 %

Table 3: Fracture Both Bone / Single Bone

S. No	Fixation	Fracture Bb	Fracture Radius	Fracture Ulna
1	ORIF	32	8	10
2	IM Nailing	36	7	7



Figure 1: Preoperative fracture both bone forearm

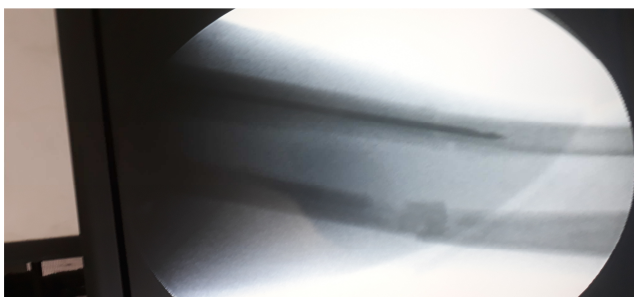


Figure 2: Rimmer Being Used Inulna



Figure 3: Intramedullary Nail In Ulna

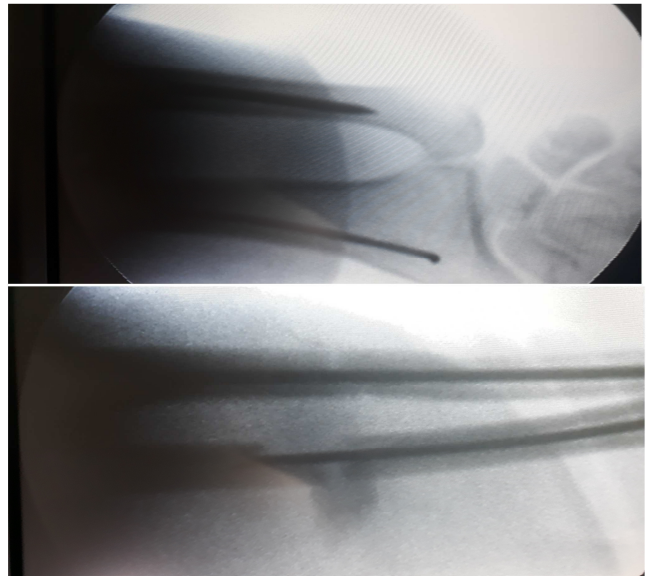


Figure 4 & 5: IM nail in both bone fore arm and lower end of both bone after nailing

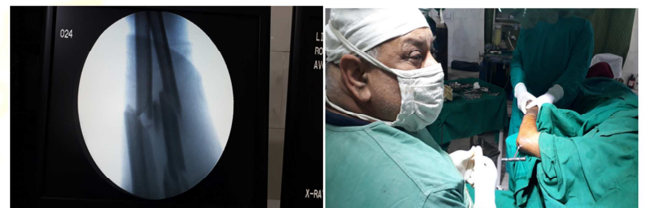


Figure 6 & 7: Another case of both bone fracture forearm with segmental radius and Nailing team with both bone forearm fracture

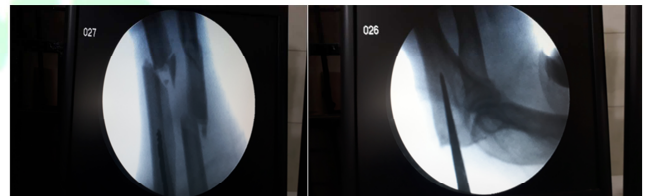


Figure 8 & 9: Rimmer IN Ulna and Trochar IN Ulna

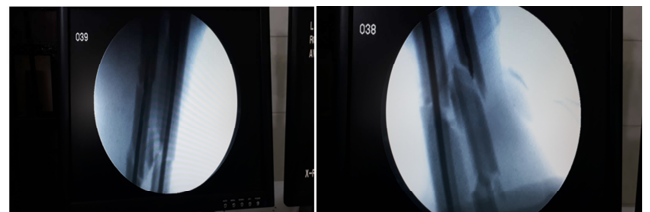


Figure 10 & 11: Nail in Ulna & Radius Marrow Being Opened UP

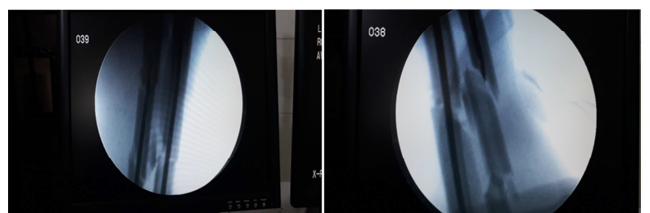


Figure 12 & 13: Rimmer in Radius & Nail In Both Bone

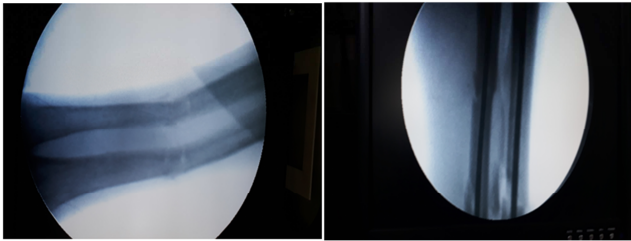


Figure 14 & 15: Nail In Both Bone, Both Bone Fracture

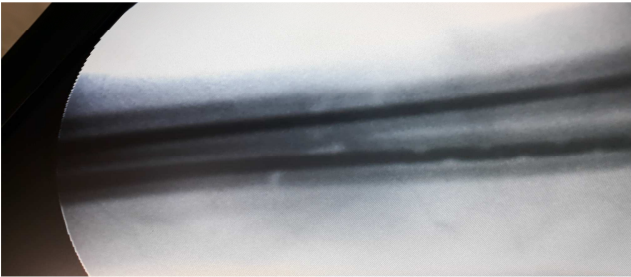


Figure 16: Nail in Ulna, Rimmer In Radius

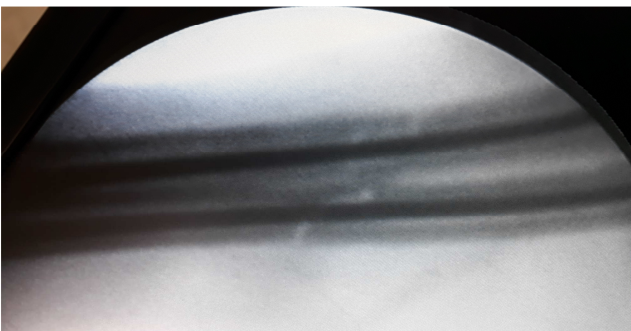


Figure 17: Nail in Both Bone

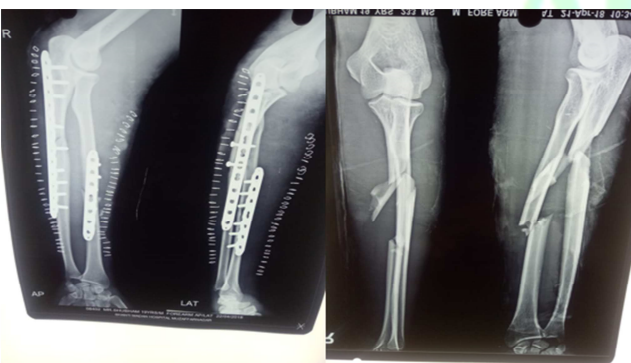


Figure 18: Preoperative and Post-Operative X-Ray of Case 2



Figure 19: Preoperative and Postoperative X-Rays of Fracture Both Bone Forearm

Results

“Cure Some Time, Treat Often, and Comfort Always”

HIPPOCRATES

According to Gustilo – Anderson, 10. Open fracture classification in ORIF group 20 patients were suffering from type 1 fracture and 10 were suffering from type 2 fractures and rest 20 patients were closed fracture and in IM nailing group 15 suffered from type 1 and 5 from type 2 fracture and rest 30 were closed fractures.

The mean time to union was 14.1 weeks ORIF group (range from 12 to 22 weeks) and 10.75 weeks (range 8 – 18 weeks) in IM nail group.

A statistically significant determined between two groups that bone union was achieved in 100 % patients in IM nailing group and 96 % in the ORIF group. Mean operating time was 66.34 minutes in ORIF group 39.08 minutes in IM nailing group.

Also DASH score were different in both group less in ORIF group (10.9) and 12.88 in IM nailing group. According to Grace – Eversman criteria results were excellent in 70 % patients (35) good in 14 % cases (7) and acceptable in 16 % cases (8). In IM nailing group excellent results were seen in 84 % cases (42) and good in 16 % cases (8).

No statistically significant difference was determine between DASH score in two groups at one year period. Data presented was after 6 months of follow up and no difference was observed between groups with respect to measurement of degree of supination and pronation and at one year were identical. Bleeding amount was significantly lower in IM nailing group (22.2 ml) than ORIF group (80.89 ml). The two group were not significantly different in terms of fracture type, open fracture, wrist ROM. In IM nailing group duration of hospitalisation was average 3 days (range 2- 7 days) and for ORIF group was average 5 days (range 3 – 12 days). Time spent under surgery was less in IM nailing group than ORIF group. Though it was not significant but all values were on the lesser side in IM nailing group.

Fluoroscopic guidance was used more in closed IM nailing and quite less in ORIF were it was done to check length of screws and bone plate relation. So nailing required more Fluoroscopic time.

No iatrogenic bone, tendon, vascular or nerve damage developed in any patient in either groups during operation. Post-operative superficial infection developed in two patient in ORIF group which subsided with antibiotic therapy guided by culture sensitivity .In the same group two cases of nonunion were seen at 6 and 9 months. So autogenous bone grafts taken from iliac wing were applied. Both united well but as they required second surgery so primary surgery union rate was taken as 96 % in Plate Osteosynthesis.

Table 4: Results on Different Parameters

S. No	Parameter	Orif Group	Im Nail Group
1	Flouroscopy	Less Than 2 Minutes	6.7 Minutes
2	Surgical time avg	66.34 Minutes	39.08 minutes
3	Union Time Avg.	14.1 WEEKS	10.75 Weeks
4	Bleeding During Surgery	80.89 ML	22.2 ML
5	Dash Score	10.90	12.88
6	Grace – Eversman Ratio (%) A-Perfect B-Good C-Acceptable D – Unacceptable	35 CASE (70 %) 7 CASE (14 %) 8 CASE (16 %) NO CASE	42 CASE (84 %) 8 CASE (16%) NO CASE NO CASE
7	Post-Operative Rom Supination Pronation	76.18 86.02	78.09 87.92
8	Elbow Joint Rom Flexion Extension	144.17 Degree Avg. 82 Degree Avg.	148.63 Degree Avg. 1.58 Degree Avg.
9	Wrist Joint Rom Dorsiflexion Palmar Flexion	80.08 Degree Avg. 73.07 Degree Avg.	79.7 Degree Avg. 75.64 Degree Avg.

In IM nailing group one case developed superficial infection which healed without any further untoward complication. At least 4 cases in this group took more than 4 months but bone eventually united without surgical intervention so union rate was 100 %.At the final follow up the patients had no subjective complaints.

No mechanical irritation, implant failure, synostosis or compartmental syndrome developed in any patient in either group .In 6 patient in ORIF group and 2 patients in IM nailing group implant was removed at patients request after a period of more than 1 and ½ year.

Discussion

“I Have Clearly Recorded This ; For One Can Learn Good Lesson Also From What Has Been Tried But Clearly Not Succeeded , When It Is Clear Why It Has Not Succeeded “

HIPPOCRATES

The current treatment for adult diaphyseal fracture is surgery as conservative management did not yielded good results. Many aspects of ORIF have been criticized and there are complication so this is also not a preferred method to treat always.^[11] The search for alternative method to ORIF has been in the due process .

Plate fixation or ORIF can achieve recovery of anatomic relationships such as length of both bones, rotational alignment , radial bowing and interosseous space between Radius and Ulna as it gives chance to reduce fracture in most precise manner. Also because fractures are fixed rigidly early motion of the forearm can be allowed. Which

is helpful in recovery of the function of forearm. Disadvantage are large skin incision, disruption of blood supply caused by extensive soft tissue dissection or refracture after plate removal.

Although IM implant have been attempted from time to time as an alternate treatment .Intramedullary nail was first reported in 1913.^[12] Using nonspecific material (first generation) such as k wire , Rush pin, and Steinman pin . Sufficient rotational stability could not be achieved with these materials. Intramedullary treatment caused high rate of non-union. The first nail design which took the forearm anatomy into account (second generation) was by Sage in 1959.^[13] The nail was design with anatomic features that enable it to maintain rotational stability . How ever there was no locking or compressive features. As fracture stability could not be achieved so additional fixation material were required and nonunion were seen. This IM implant did not find a place of sufficient use in treatment. Just as it is today ORIF has always been an acceptable method for treating adult fracture both bone forearm. However this did not prevented researchers from developing new IM implants with anatomic and biomechanical analysis of the forearm bones as reference (third generation). The possibility of stronger rotational stability is provided with anatomic design of third generation nails.^[14,15] We have used square ulna nail and bevelled square Radius nail. Which was moulded to provide 3 point fixation .More over interest in IM nailing renewed because of Image Intensifier which has added advantages of closed reduction with internal fixation.

The basic aim of surgical treatment of forearm diaphyseal fracture is to provide stable axial and rotational stability. To achieve excellent rotational results, the acceptable axial angulation must be > than 10 degree. 16. Even if radial bowing and interosseous gap are fully restored, it has been reported that rotational functional results could be limited.^[17] Anatomic reduction is obtained with open reduction which results in optimal repair of axial alignment , radial incline and interosseous gap . Forearm IM nailing treatment differs from all nail application in other long bones, as there are no anatomic land marks providing guidance for rotational alignment.

In fluoroscopic imaging of rotational reduction, the continuity of the cortical distance in the distal and proximal area of the fracture can be evaluated. There is little subcutaneous tissue support of the Ulna so while doing IM nailing axial and rotational alignment can be checked by palpation. However, in ORIF it may be necessary remove the implant because of mechanical irritation of plate and screws .Greater soft tissue support in the Radius makes correction of reduction and Radial bowing more difficult.^[18] There are two curvatures one in coronal plane and other in saggital plane.^[19]

It is necessary to take these curvatures into account when

preoperatively shaping the nails to appropriate intramedullary anatomy. In the current study Radius nails were shaped parabola. Elasticity of nail and 3 point fixation principle of parabolic shape rotational stability was achieved. In addition, by conforming to the Radial bowing the optimal intesosseous space was formed.

Few studies have compared ORIF and IM nailing treatment results in forearm diaphyseal fractures. These studies have compared, in particular, union status, time to union and functional evaluation criteria. Anatomic and close to anatomic reduction is obtained with ORIF. Axial and rotationally rigid stable fixation is obtained. However drainage of fracture haematoma has negative effect on union and it has been reported that excessive soft tissue and periosteal stripping could cause union problems .Osseous feeding is impaired due to super periosteal pressure of conventional plates and effects negatively on union. Risk of refracture is increased due to cortical atrophy which develops in the screw application areas. It is necessary to apply immobilisation, regardless of the stability of the fixation. Cosmetic problems may also develop with surgical approach.^[6,20] ORIF causes more bleeding but there is no fluoroscopic guidance required for open surgical intervention is an advantage. If used at all for checking length of screw and plate placement on bone it can be said that exposure to radiation is drastically less than IM group. Despite of these advantages / disadvantage of the method union rate of 96 % was achieved in this series (range 87 % to 98%).^[4,6,21] Time to union has been reported between 14 weeks to 33 weeks. We had average union time 14. 1 weeks taken radiologically. Functional evaluation results generally at satisfactory levels.^[22,23] Bleeding time in the plate group was measured 80.89 ml (range 38 ml to 252 ml). The mean operating time was 66.34 minutes (range 37 to 109 minutes).

Im nailing very little soft tissue damage in surgical application and provide cosmetic superiority and bleeding is much less 22.2 ml average. IM implant generally have property of stress distribution and stronger callus tissue is formed. An important cosmetic advantage is that the implant can be removed from the same incision. Length is protected in segmental forearm fracture. However exposure to radiation is a significant disadvantage. Immobilisation period is shorter due to more soft tissue support (because of less requirement of tissue dissection). Nailing treatment is contraindicated in patients who have open epiphyseal line, when there is infection and if marrow is less than 2.5 mm in diameter.

In IM nail application , union rate of 94 % - 100 % and time to union 10 weeks to 4.4 months have been reported.^[14,15,24] Good functional have been reported similar to plate osteosynthesis . In the present study 100 % union was achieved at a mean time period of 10.75 weeks (range 9 weeks to 22 weeks). The amount of bleeding in IM group was 22.2 ml (range 10 ml to 78 ml.) The mean operating

time was 38.08 minutes (range 25 minutes to 68 minutes). A statistically significant difference was determined between two groups with respect to time for surgery, time to union and amount of bleeding. No significant difference was determine with respect to radiological and functional outcome (Grace – Eversman criteria), DASH score, and functional joint range of movement [Table 4). The shorter time to union of IM group compared to ORIF could have been due to not draining the fracture haematoma and early mobilisation. As IM method is less invasive, the amount of bleeding is reduced. As no dissection of soft tissue is required body has less to heal. Controlled exposure in ORIF was thought to have prolonged the operating time.

The areas of application of both treatment methods carry potential risks. In the proximal Radial diaphyseal fractures the Posterior Intreosseous Nerve is at risk.^[25] There is risk of damage in open reduction during surgical exposure and in IM nailing during locking. But in current series as no locking was done and due to careful dissection no harm to nerve was done during ORIF. In the area of nail application in Radius Extensor Pollicis Longus tendon and superficial branch of Radial nerve are at risk.^[26] No such complication were seen in present study even in followup up to 5 years.

The removal of the internal fixation material used after union is controversial. In open or fragmented fractures or those that have resulted from high energy trauma, when there is insufficient compression or reduction in fragmented fracture and when there is another fracture in same extremity, the rate of refracture has been reported to increase.^[27] In current study implant were removed after at least one year after surgery on patient request. 4 patient in ORIF group and 1 patient in IM group implants were removed.

Conclusion

“The Life So Short; the Craft So Long To Learn”

HIPPOCRATES

The current treatment method for adult diaphyseal fracture is ORIF. The results of present study showed IM nailing treatment to be superior to ORIF with respect to less operating time, less blood loss, early union and good functional results. However no difference between the two methods was found at the end of one year. Due to shorter operating time, shorter time to union and cosmetic advantage IM nailing treatment can be considered good alternative method to ORIF in the treatment of adult forearm diaphyseal fracture.

As we had two surgical team separately for each of the two surgery their expertise lead to no iatrogenic complications. This also shows that one particular surgical team should devote itself to one type of surgery to excel in it thus providing much relief to patients.

Though cost did not matter in treatment but IM nailing costed much less than plating.

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