



## A Study To Evaluate Clinical Outcome of Diaphyseal Fractures of Forearm Bones Treated With Intramedullary Nail or Plates in Adults.

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### ABSTRACT

1. **BACKGROUND:** Plate is the most commonly used technique for the treatment of diaphyseal forearm fractures in adults. Application of plate disrupts the periosteal blood supply and necessitates skin incision that may be unsightly. The purpose of this study was to assess the early results of the use of closed intramedullary nail to stabilize displaced diaphyseal fractures of forearm bones.

2. **AIM:** 1. To evaluate the results of internal fixation of diaphyseal fracture of forearm bones forearm treated by plate and intramedullary nailing. 2. To compare the functional results of plating and intramedullary nailing.

3. **METHODS:** In Department of Orthopaedics, C U SHAH medical college and Hospital, Surendranagar, total of 50 cases of forearm bone fractures were treated. 25 patients were treated with plate and 25 patients with intramedullary nailing. Total 50 patients were available for the follow up. Functional results were assessed by Anderson criteria in closed nailing group both radius and ulna resulted in 100% union rate. In plate group there was 1 deep infection, 0 implant failure, and 2 non-union. Functional results in plate group were excellent in 20 (80%) of patient, satisfactory in 4 (16%), failure in 1 (4%). There was no unsatisfactory result in this group. In closed nailing group result were excellent in 17 (68.7%), satisfactory in 6 (24.8%), unsatisfactory in 2 (6.2%) and no failure.

4. **CONCLUSIONS:** Closed intramedullary nailing is not superior to plate fixation but can be considered as an alternative to that method for diaphyseal fo.

5. **RESULTS:** Average surgery time in plate group was 68 minutes, and in nailing group was 43 minutes. Plate group showed union in 23 (93.2%) patients rearm fractures in adults.

**KEYWORDS :** Diaphyseal Fracture , Radius , Ulna , Nailing , Plating

**INTRODUCTION:** Currently in diaphyseal fractures of forearm bones we have two treatment options available first is Closed Reduction and Internal Fixation (Nailing) and the other is Open Reduction and Internal fixation (Plating). Both methods have their advantages and disadvantages. The advantages of intramedullary nailing include indirect reduction with less stripping of periosteal blood supply and preservation of soft tissues and the fracture hematoma with its bone-forming cells and factors. Soft-tissue protection increases the chance of union and decreases the chance of infection. On the contrary it offers less rotational stability and can impinge during fracture healing. Plates can be applied with indirect reduction techniques and designed as "biologic" implants, but they usually destroy at least some of the periosteal blood supply and disrupt the fracture hematoma.

Plating techniques allow direct fracture exposure, so they are considered more reliable and can therefore achieve a more exact anatomic reduction, which is crucial for intra-articular comminution to decrease the chance of posttraumatic arthritis. Plating techniques allow for interfragmentary compression, which provides a more rigid construct than do intramedullary rods, because rods function more as an internal splint. Plating also carries more chances of infection as compared to nailing. Plating allows primary healing of the fracture and nails allow secondary healing of the fractures. In nails an immobilization span of almost 1.5 months is essential while in plating a comparative early mobilization is achieved. The average span for forearm bones to unite is 12 weeks.<sup>(1)</sup> The aforementioned facts affect the process of bone healing and the functionality of forearm. Thus, a clinical study to evaluate the functional and radiological outcomes of nailing and plating in diaphyseal fractures of forearm bones.

**METHODOLGY:** This series consists of 50 cases of diaphyseal fracture of forearm bones fixed with open/closed reduction with intramedullary nailing or open reduction and dynamic compression plate, Limited contact dynamic compression plate or semi tubular plate at C U SHAH MEDICAL College and hospital.

1. All patients satisfying the inclusion criteria

were selected.

2. Informed consent from each patient was taken.
3. Fractures classified by AO classification.
4. Treatment plan formulated on the basis of classification without intervention of the investigator in deciding the plan of surgery.
5. Subsequent follow up X-Rays were taken for minimum period of six months to check alignment and fracture union.
6. Final results graded with Anderson Scoring System.

#### The inclusion criteria were as follows:

1. All radius and/or ulna diaphyseal fractures with no distal neurovascular deficit.
2. Patients above 16 years and below 80 years who are medically fit for the surgery.
3. Patients with no other ipsilateral upper limb fractures.
4. Bones fixed with either nail or plate.
5. Open or Closed fracture.
6. Fracture associated with co morbidities.

#### Exclusion Criterias Include :

1. Patients with pathological fractures.
2. Patients denying consent.

#### The Materials used were:

##### SEMI TUBULAR PLATES<sup>(2)</sup>

These plates have the form of one-half of the circumference of a cylinder. They have low rigidity since they are only 1mm thick. The plate is used mainly for the fixation of fractures in lateral malleolus, the distal ulna, the olecranon, and the

metatarsals. The oval holes permit eccentric positioning of the screws, which can be used for axial compression of a fracture. To achieve this, the wide middle section of the plate is placed over the fracture. The screws nearest the fracture in each fragment are inserted eccentrically away from the fracture. The plate is fixed with 3.5mm cortex screws

in diaphyseal bone, and 4.0mm cancellous bone screws in the metaphyses.

The plate offers good longitudinal stability if in complete contact with the bone, either by the edges along the plate or by the "collar" on the undersurface of each plate hold. The following must be considered: Because of the "one-half of a

tube" cross section, the screw head is almost flush with the plate surface when inserted through the plate hole. As a consequence the undersurface of the screw head protrudes through the undersurface of the plate. If used on a bone with a small circumference the screw head may be in contact with the bone, blocking the plate from being securely fixed. To overcome this problem some plates (titanium plates at present) have a collar around the holes on the underside. These collars prevent the screw head from protruding and secure the plate/bone contact. The plate are available in lengths from 25mm to 145mm, with 2 to 12 holes.

#### **DYNAMIC COMPRESSION PLATE<sup>(2)</sup>**

These plates are used with cortex screws 3.5mm hence the name. It is the implant of choice for the fixation of fractures in the forearm. It may also be used for distal humerus fractures and the clavicle. The DCP hole design and working principle are analogous to those of the DCP, 4.5mm.

The holes allow for 1 mm displacement, if a load screw is used. The 3.5mm. DCP drill guide must be used with this plate to ensure the load effect of the screw. The plate can also be used with the articulated tension device. If necessary, 4.0mm cancellous bone screws can be inserted in the end holes. The plates are available in lengths from 25mm to 145mm, with 2 to 12 holes.

#### **LIMITED CONTACT DYNAMIC COMPRESSION PLATE<sup>(2)</sup>**

The design features of the LC-DCP, 3.5mm are analogous to those of the LC-DCP, 4.5mm. The plate is smaller in size, and is applied with 3.5mm Stainless Steel cortex screws and 3.5mm Stainless Steel shaft screws in the diaphysis. The 3.5mm screws can be inserted in three different positions: neutral, load, or buttress. For this purpose, special drill guides have to be used, either the LC-DCP drill guide, 3.5mm, or the LC-DCP universal drill guide, 3.5mm. Before applying a LC-DCP, the plate must be contoured. The bending templates are used as models. The LC-DCP is used for the same indications as the DCP : forearm fractures, fractures of the distal humerus, the clavicle and the pelvis. It can be applied for any desired function as neutralization, tension band or buttress plate.

#### **TREATMENT PROTOCOL**

After thorough clinical evaluation x-ray of the affected forearm was taken in both anteroposterior and lateral view including wrist and elbow joints. The limb was immobilized in above elbow slab with positioning the forearm according to the site of fracture with sling.

The patient was taken up for surgery after routine investigations. Medical fitness was obtained prior to surgery for geriatrics.

#### **Preoperative planning for intramedullary nailing**

Preoperative implant assessment was done. Nail size was determined. The required nail was determined by measuring the normal limb. The ulna was measured with a tape from the tip of the olecranon to the ulnar styloid. The radius nail size was difficult to measure clinically, it is approximately 2.5 cm shorter than the ulna. One

cm is subtracted from the measurement to avoid the risk of driving the nail through the end of bone. Nail diameter was determined by measuring the medullary canal size using X-ray. All sizes were kept available at the time of surgery.

#### **Preoperative planning for compression plating**

The plates size was determined depending on the type of fracture assessed with the help of radiography usually 5, 6 and 7 holed plates were kept for surgery. The cortical screw sizes were also assessed radiologically and made available at the

**time of surgery. A dose of tetanus toxoid and antibiotic were given preoperatively.**

Preparation of the part was done a day before surgery and slab was reapplied. Instrument to be used were checked before hand and sterilized. Surgery was performed within 3 days in 70% of cases, while rest were operated within a week from the day of admission. Surgery was performed under brachial block. All the cases were operated under tourniquet control.

For Henry's approach<sup>3</sup> – the arms placed on an arm board with elbow straight and forearm in supination. In Thompson's Approach<sup>3</sup> the arm is kept on the arm board with elbow in flexion and forearm in mid pronation.

#### **Incision**

Ulnar shaft<sup>3</sup> : Parallel and slightly volar to the subcutaneous crest of the ulna.

Radial shaft<sup>3</sup> : Proximal radius either dorsal Thompson / Volar Henry's approach is preferred; mid shaft fractures dorsal Thompson approach was preferred, distal radius fractures volar Henry's approach was preferred. Most forearm fracture was fixed using six holed DCP/ LCDCP or Semitubular plate and in some, five holed, In more comminuted fractures seven holed plates were used.

Positioning of patient in intramedullary Nailing The patient in supine position with forearm rested on the chest. Manual traction and counter traction with elbow flexed to right angle and manipulation at fracture site was done under C-arm guidance before positioning.

#### **Surgical technique for intramedullary nailing<sup>4</sup>**

Under aseptic precaution radial nail was inserted from the distal end, either through radial styloid or lateral to lister's tubercle. Entry portal was made over radial styloid about 5mm from its articular surface on its lateral aspect with the help of bone awl. Bone awl inserted at 45 degree angle to the distal radius, after entering the bone for 1-1.5 cm taking care not go through the volar cortex. The nail was driven from distal to proximal fragment after reducing the fracture by manual traction and manipulation at the fracture site under C-arm guidance. The nail was driven until the tip of the nail impinges against the bone.

The nail for ulna was inserted from the olecranon process at a point 5-8 mm from the dorsal cortex (to avoid entering to trochlear notch) and 5mm from the lateral cortex (to compensate for the lateral bow).

Nail was inserted into the proximal fragment after making entry portal with bone awl. Ulnar fracture was reduced by manual traction, counter traction and manipulation at the fracture site under C-arm guidance and the nail was passed.

After thorough wash, gap at the fracture site was over come by thumping at olecranon, incision was closed with interrupted silk sutures.

We applied above elbow slab in all cases.

#### **Post-operative care**

Patients either fixed by compression plates or intramedullary nail are immobilized in the above elbow pop slab immediately after surgery.

The limb is elevated by using drip stand in the ward and the neurological status checked. Postoperative check dressing is done on 2<sup>nd</sup> day and check X-ray is done without slab and slab reapplied. Both group of patients were discharged by 6th day and advised to review on 10th day for suture removal. The patient was advised at the time of discharge to continue the slab, arm pouch, oral antibiotics and shoulder mobilization.

#### **Follow up**

The patient comes for follow up on 10th postoperative day. The sutures were removed. In patients with rigid fixation of compression plate the plaster slab was discontinued and active gentle exercises were advised for the elbow, shoulder, wrist to the limit of tolerance and cautioned to avoid lifting weight and other strenuous activity.

Above elbow POP slab was applied in other patients for 4 weeks. The patients were followed up at regular interval of four weeks at our hospital till union occurred and evaluation was done based on "Anderson

et al.<sup>6</sup> scoring system<sup>5</sup>. Elbow movements and wrist movements were noted and the union was assessed radiologically and clinically.

**Anderson Scoring System TABLE - 1**

Result	Union (weeks)	Flexion / Extension (Degrees)	Supination/ Pronation (Degrees)
Excellent	<13	<25	<10
Satisfactory	13-17	<50	<20
Unsatisfactory	>17	>50	>20
Failure	Non-union with / without loss of motion		

**RESULT**



**Presentation In OPD**



**Immediate Post -op**



**6 Month Follow UP**



**70 Y M Presentation**



**5 month Follow Up**

Present study consists of 50 cases of diaphyseal fractures of forearm, treated surgically with follow up ranging from 4 months to 10 months.

The age group ranged between 15 to 75 years commonest being 15-25 years.

Predominance of males were seen in 30 cases out of 50 cases studied (60%).

Right side was more common (64.8%) than left side (35.2%).

Road traffic accident was the commonest mode of trauma (55.6%), followed by fall on out stretched hand (37.0%) followed by assault (7.4%). Direct trauma was the main mechanism of injury in these cases.

Middle 3rd was the commonest fracture site of both bones (42.6%) followed by junction of middle and lower 3rd (31.5%), followed by lower 3rd (14.8%), and middle and upper 3rd (11.1%).

Transverse fracture was the commonest (50%) followed by oblique fracture (25.9%) followed by comminuted fracture (24.1%).

Average surgery time in plate group was 68 minutes, and in nailing group was 43 minutes. Plate group showed union in 23 (93.2%) patients, in closed nailing group both radius and ulna resulted in 100% union rate. In plate group there was 1 deep infection, 0 implant failure, and 2 non-union. Functional results in plate group were excellent in 20 (80%) of patient, satisfactory in 4 (16%), failure in 1 (4%). There was no unsatisfactory result in this group. In closed nailing group result were excellent in 17 (68.7%), satisfactory in 6 (24.8%), unsatisfactory in 2 (6.2%) and no failure.

## DISCUSSION

In our series 50 patients of forearm bone fractures all are treated by various surgical modalities as results of non operative treatment for displaced adult diaphyseal fractures of forearm is not acceptable.

### The control of rotation is necessary

for fracture union. In our study, 25 patients were treated with open reduction and internal fixation

with DCP or LCDCP or semitubular plating, 25 patients were treated with intramedullary nailing.

In case of DCP and LCDCP the value of compression in obtaining union is noted. In dynamic compression plating the union occurred before 17 weeks in all patients, in limited contact dynamic compression plating all the patients had union before 17 weeks except one patient who had union but it was a delayed union, in

patients with semitubular plating also, all the patient had union except one patient

who had union but it was a delayed union.

By compression the fracture united by primary

bone healing if the fragments were rigidly fixed with their blood supply disturbed as little as possible, under these conditions resorption and bone formation occurred simultaneously in fractures treated by rigid fixation.

Whether the fracture gap obliterated or greatly diminished by a compression plate the capillaries are able to grow into the medullary callus at an early stage in the healing process. Their integrity is protected by the rigidity of the fixation and thus the mesenchymal cells in a well oxygenated environment may readily differentiate directly into osteoblasts.

Functional results were of more importance than anatomical results, functional recovery was rapid and complete in relatively fresh cases in our series is by:

#### (i) Absolute stability<sup>(6) (7)</sup>

As long as sufficient compression acts upon the surfaces there will be no displacement of the fracture surfaces in relation to each other, provided the dynamic load super imposed does not reach the level of preload or friction.

#### (ii) Bone healing

(a) Contact Healing<sup>(6)(7)</sup> : The direct union of fragments in close contact and under compression is achieved through remodeling of the Haversian canals. The osteocytes are connected among themselves and to the vascular supply in Haversian canal is by a network of canaliculi. Haversian remodeling is necessary in all fracture healing to achieve restoration of original integrity and it is the only step in fracture healing under absolute stability.

(b) Gap Healing<sup>(6)(7)</sup> : In diaphyseal fractures of forearm not all parts of fracture are in contact. If there is no proper reduction then final healing is therefore achieved through 2 stage procedure, first formation of lamellar bone in the gap is seen and then this bone is remodeled along the axis of bone through Haversian remodeling starting from the gap into the fragment and from the fragment into the gap.

#### Removal of plate after healing

After effects on bones following the use of DCP, LCDCP or semitubular plate and on its removal.

We have not removed any plate so far. This is required only in patients who have symptoms associated with plate, removal otherwise is not indicated<sup>(8)</sup>. Although the long term effects of these retained plates are not known and there is no need to remove plates as such. The unsatisfactory results often we encountered in medullary nailing of the forearm are primarily due to either lack of fixation of the radius in anatomical position and maintenance of radial bow. Which emphasized the need to preserve pronation and

supination, the normal rotational alignment. The failure of maintaining the alignment leads to distraction of the fragments of fracture of ulna and radius leading to non union<sup>9, 10</sup>. The nails we used were square nails (2 and 2.5 mm for radius and 2.5 and 3mm for ulna) though they approach the contour of the canal some nails which were small enough to be accommodated in the canal of the radius were not sufficiently rigid to withhold bending in the plane of their short diameters.

In our study we found that the square nails could not be rigid enough to withstand the torsional, rotational and angulating forces of the muscles of the forearm. It is difficult to determine the proper curves and length of the nail, because a thorough knowledge of the radial medullary canal in all its dimensions were necessary.

### We had non union in our series because

- (i) Distraction at the fracture site after healing<sup>9</sup>.
- (ii) Decreased vascularity due to subcutaneous location of bones.

In few cases with a gap of 2-3 mm at fracture site after the surgery. The gap was over come by thumping at wrist during check dressing. These fractures united uneventfully.

### The main drawbacks we faced were :

- (i) Need for external support in the form of slab till signs of clinical union appear<sup>10, 11</sup>.

We used closed reduction and intramedullary fixation for 25 patients because minimal duration of surgery decrease the chances of infection and other tourniquet related problems.

Retaining fracture haematosis

Absence of periosteal stripping

Minimal blood loss

Avoiding communication of fracture haematoma between two bones

Cost effectiveness

The disadvantages of closed nailing was

- (a) Image intensifier was essential.
- (b) Exposure to radiation.

## CONCLUSION

Increased incidence of forearm fractures were probably due to increasing road traffic accidents and fall.

Forearm fractures occurred more common in second and third decade.

Predominance of males were seen in these fractures.

Open reduction and internal fixation can be considered as the treatment of choice if there were no contraindications for this because it is important to maintain length, opposition, axial alignment and rotational alignment if a good

range of movement of forearm is to be restored. This is achieved in the present study.

DCP system, LC DCP system or semitubular system gave optimum fixation and allowed immediate mobilization.

Excellent results were achieved with it in terms of mobility and union without deformity.

Prophylactic antibiotics before surgery helped in reduction of rate of infection.

To conclude DCP or LC DCP offers excellent results in displaced diaphyseal fractures of forearm bones in adults and to be considered as

first line of

**management.**

Under certain circumstances where patient is not fit for open reduction and internal fixation or where there is need for:

Least invasive procedure

- Technically easy procedure
- Short operating time
- Reduced risk of infection
- Decreased hospital stay
- Economic procedure

Intramedullary nail can be considered as first line of management.

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