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## Management of fractures of radius and ulna using dynamic compression plating

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### Abstract

**Aim and Objective:** This study has been taken to determine the functional outcome of treating diaphyseal fractures of both bones, forearm with Dynamic compression plate at Medicti institute of medical sciences, Ghanpur from October 2018 to March 2020.

**Methodology:** This is a time-bound prospective study. Twenty cases of fractures of both bones forearm was treated by open reduction and internal fixation with 3.5 mm DCP. The follow-up ranged from 5 months to 18 months.

**Results:** Males predominant with right forearm affection more than left. Most of the fractures due to RTA and fall. The average age was 35 years with fracture being most common in third decade. Most of the fractures of both bones forearm were located in the middle third and the fracture pattern transverse/short oblique was commonest. 18 (90%) patients has sound union in less than 6 months, 2 (10%) patients had delayed union. The results were based on Dash scoring system and in our study, there were 18 (90%) patients with excellent results and 2 (10%) with satisfactory and no unsatisfactory results.

**Conclusion:** Hence the study was on par with the previous studies and DCP is proved to be the best mode of treatment for diaphyseal fractures of both bones forearm.

**Keywords:** DCP, diaphyseal fractures, dash scoring, bones forearm

### Introduction

The forearm represents a critical anatomic unit of the upper limb, permitting the effector organ of the upper limb, the hand, to perform multi axial daily activities of living. Historically, the closed management of forearm fractures has been met with poor functional outcome in adults, hence perfect fracture reduction and rigid fixation is mandatory and achieved by plating <sup>[1]</sup>.

Yet a number of problems exist with current plate designs. These include the inability to contour the plate to the unique anatomy of some regions of the upper limb, and a lack of versatility of screw placement of the skeleton directly underneath the plate <sup>[2-6]</sup>.

The number of forearm fractures is increasing faster than the predicted rate due to rapid industrialization, increased incidence of violence, road traffic accidents and various sports activities. Conservative treatment has resulted in malunion, nonunion, synostosis and ultimately poor functional outcome <sup>[7]</sup>.

It is essential to regain length, apposition, axial alignment and normal rotation while treating diaphyseal fracture of forearm. Open reduction and internal fixation with various types of plates and intramedullary nailing is the treatment of choice in displaced fractures of forearm in adults. Internal fixation with Dynamic Compression Plate (DCP) is a frequently carried out surgical procedure for these fractures.

With conventional plating, the screw acts as an anchor, with its axial force being exploited to press the plate against the bone, this produces large frictional force at the bone plate interface when the construct is loaded, and this force has been shown to cause vascular disturbances, especially in the periosteum.

Recent experiments focusing on the plate-bone interface have suggested that the most important factor influencing cortical porosity was the amount of plate-bone contact and that the use of the LCDC plate allows soft-tissue preservation and preserves the viability of bony fragments <sup>[8, 9]</sup>.

This observation has prompted the development of the limited contact dynamic compression plate (LC-DCP), which decreases the bone contact area to approximately 50% of the total area of the under surface of the plate <sup>[10]</sup>.

Hence the present study was undertaken to provide satisfactory functional outcome and to know the advantage and complications of the newer plate design, the LC-DCP applied to the skeleton of the upper limb. Unsatisfactory treatment can lead to loss of motion as well as muscle imbalance and disability of hand function.

This method helps in perfect reduction of fracture fragments in anatomical position by rigid fixation and early mobilization, the normal functions of the hand can be re achieved at the earliest. With this advantage of open reduction and internal fixation of the fractures of the both bone forearm, I have selected this topic

Twenty cases of fracture both bones forearm was selected after inclusion and exclusion criteria, and treated by open reduction and internal fixation with DCP in Mediciti institute of medical sciences, Ghanpur.

This study has been taken up to evaluate the results of open reduction and internal fixation of the Diaphyseal fracture of radius and ulna with DCP in adults and its advantages and complications.

In this study the rate of union, time taken for union, the complication, the functional results in terms of forearm rotation and wrist and elbow movements are studied.

### **Aim and Objectives**

- To evaluate the results of treatment of fractures of radius and ulna treated by internal fixation with Dynamic compression plating.
- The aim of the treatment is to return to normal function and this often but not always coincides with reestablishment of normal anatomy.
- To study the efficacy and outcome of dynamic compression plate in forearm bone fractures.
- To study the age and sex incidence of fracture both bones forearm.
- To study the possible complications of the surgery.
- To evaluate the function of the upper limb after open reduction and internal fixation.

### **Materials and Methods**

This study includes treatment of 20 cases of fracture of both bones of forearm by open reduction and internal fixation with 3.5 mm DCP between OCTOBER 2018 TO MARCH 2020 at Department of Orthopaedics at Mediciti institute of medical sciences, Ghanpur. Follow-up was done upto October 2020.

This is a prospective time bound study. Sample size is 20 patients.

### **Inclusion criteria**

Simple fractures.

Open fractures-Gustilo and Anderson type I

Non-union

Age criteria – above 14 years, both males and females

### **Exclusion Criteria**

Age criteria < 14 years.

Radiologically proven segmental fractures and isolated forearm bone fractures. Fracture shaft with intra articular fractures to be excluded.

Gustilo and Anderson type II and III are excluded Patient unfit for surgery.

### **Evaluation**

The results are evaluated with Anderson's criteria and for evaluation of forearm bones fracture. The results are

compared with previous studies.

Ethical clearance has been obtained from the Ethical committee at Mediciti institute of medical sciences, Ghanpur.

On admission of the patient, a careful history was elicited from the patient and/or attendants to reveal the mechanism of injury and the severity of trauma. The patients were then assessed clinically to evaluate their general condition and the local injury.

In general condition of the patient the vital signs were recorded. Methodical examination was done to rule out fractures at other sites. Local examination of injured forearm revealed swelling, deformity and loss of function. Any nerve injury was looked for and noted.

Palpation revealed, abnormal mobility, crepitus and shortening of the forearm, distal vascularity was assessed by radial artery pulsations, capillary filling, pallor and paraesthesia at finger tips.

Radiographs of the radius and ulna i.e., anteroposterior and lateral views, were obtained. The elbow and wrist joints were included in each view. The limb was then immobilized in above elbow Plaster of Paris slab with sling.

The patient was taken for surgery after routine investigations and after obtaining fitness towards surgery. The investigations are as follows: Hb%, Urine for sugar, FBS, Blood urea, Serum creatinine, ECG and chest x-ray.

Proximal radius was approached by Dorsal Thompson incision and Volar Henry approach was used for middle and distal radius. A narrow 3.5 mm LC-DCP was used and a minimum of 3 cortices were engaged with screw fixation in each fragment.

### **Preoperative Planning**

Consent of the patient or relative was taken prior to the surgery. A dose of tetanus toxoid and prophylactic antibiotic were given preoperatively. Soap water enema on the previous night and on the morning of the day of surgery was given.

After studying the x-ray, fracture was classified and pattern was assessed. After deciding the length of the plates, all instruments required, plate and screws were sterilized. Preparation of the part was done before a day of surgery.

### **Position**

Patient is supine on the operating table. Pneumatic tourniquet is recommended.

For Henry's approach - the arm is placed on an arm board with elbow straight and forearm in supination position.

For Thompson approach - the arm on the arm board, elbow flexion and forearm in mid pronation position.

### **Type of anesthesia**

General anesthesia was used in 15 cases and brachial block in 5 cases.

### **Operative procedure**

After anesthesia, part was painted and draped. The radius was approached by Dorsal Thomson/ Volar Henry's approach. For proximal radius and mid shaft fractures, Dorsal Thomson approach was preferred. The critical step in the dorsal approach is to identify and preserve the posterior interosseous nerve. The nerve is protected in the mass of supinator when the muscle is detached from the bone and retracted as it mainly travels within the substance of the muscle. For distal radius fractures, Volar Henry's approach was preferred. Henry's approach allows a wide exposure of the anterior surface of the radius and exposes the bone over its entire

length, if this is required. The approach can be extended across the elbow and into the hand. Ulna was approached directly over the subcutaneous border.

### Postoperative care

The limb was kept elevated for 24 hours and the patient was instructed to move their fingers and elbow joint. Check X-ray in anteroposterior and lateral views were obtained. Suction drain was removed after 24 hours. Wound was inspected after 2 days postoperatively. Antibiotics and analgesics were given to the patient till the time of suture removal. Suture removed on 10<sup>th</sup> postoperative day.

### Physiotherapy 11

Patient was encouraged to perform both active and active-assisted range of motion exercises of shoulder and hand.

Elbow range of motion, supination and pronation exercises were begun as soon as remission of pain and swelling of forearm permits, usually after 2 to 3 days. Because of rigidity of fixation, rapid return of motion was expected. These isotonic exercises are very much essential for the excellent outcome. Physiotherapy helps in fracture union, as there is increased blood supply and tethering of muscles to the bone and soft tissue contracture is avoided. Thus, physiotherapy with rigid fixation gives excellent results.

### Follow-up

All the patients were followed up as monthly intervals for first 3 months and evaluation was done based on "Anderson *et al.* scoring system". Elbow movements and wrist movements were noted and the union was assessed radiologically.

The fracture was designated as united, when there was presence of periosteal callus bridging the fracture site and trabeculations extending across the fracture line.

The patient rated outcome was assessed using the disabilities of the arm, shoulder and hand (Quick DASH) questionnaire, an 11-item questionnaire intended to assess the functional symptoms of patients with disorders of the upper limb [12].

The DASH score was seen to be higher in patients who did not regain their full range of motions at the wrist and forearm. The DASH scoring was performed from 6 months onward. The score at the latest follow up was considered [12].

### Results

The present study consists of 20 cases of diaphyseal fracture both bones of the forearm. All the cases were openly reduced and internally fixed with 3.5mm DCP. The study period was from October 2018 to March 2020.

**Table 1: Age Distribution**

Age	No. of Patient's	Percentage
18 – 30	10	50
31 – 40	3	15
41 – 50	4	20
51 – 60	2	10
61 – 70	1	5
Total	20	100

The age of these patients ranged from 18-70 years with fracture being most common in 3rd decade and an average age of 35 years.

**Table 2: Sex distribution**

Sex	No. of Patient	Percentage
Male	15	75
Female	5	25
Total	20	100

Out of 20 patients, 15 patients (75%) were males and 5 patients (25%) were females, showing male preponderance because of working in factories, fields, travelling and sports.

**Table 3: Side affected**

Side affected	No. of Patient's	Percentage
Right	6	30
Left	14	70
Total	20	100

Out of 20 patients, 14 (70%) with Left forearm fracture and 6 (30%) patients with Right forearm fracture.

**Table 4: Mode of injury**

Mode of injury	No. of Patient's	Percentage
RTA	13	65
Fall	6	30
Assault	1	5
Total	20	100

In present study, 13 (65%) patients with road traffic accidents, 6 (30%) patients with fall and only 1 (15%) patients with assault.

**Table 5: Level of fracture**

Level of injury	No. of Patient's	Percentage
Middle third fractures	14	70
Distal third fractures	4	20
Proximal third fractures	2	10
Total	20	100

Majority of the fractures were seen in the mid diaphysis of both bones. 14(70%) patients had middle third fractures, 4(20%) had proximal third fractures and 2 (10%) patients had lower third fractures both bones forearm. Table 6. Type of the fracture

**Table 6: Type of fracture**

Type of fracture	Radius	Ulna
Transverse /short oblique	16	14
Comminuted	4	6
Total	20	20

Majority of the fractures were transverse / short oblique. About 20% of radius and 30% of ulna fractures were comminuted.

**Table 7: Associated injuries**

Associated Injury	No. of cases	Percentage
Tibial Plateau Fracture	1	5%
Tibia and Fibula shaft Fracture	1	5%
Humerus shaft fracture	1	5%
Total	3	15%

Only 3 (15%) of the patients had associated injuries.

### Statistics of surgery

15 of the 20 cases were operated under general anaesthesia and in other 5 patients brachial block was used.

Volar Henry approach was used in 18 patients and Dorsal Thompson approach was used in 2 patients.

Ulna was approached subcutaneously. Pneumatic tourniquet was used in all the cases. Follow-up ranged from 5 months to 18 months.

**Table 8:** Statistics of surgery

Surgical approach	Number of patients	Percentage
Volar Henry's	18	90%
Dorsal Thompson's	2	10%

**Time for fracture union**

The fracture was considered as united when there were no subjective complaints, radiologically when the fracture line was not visible.

Those fractures, which healed after 6 months without an additional operative procedure was considered as delayed union. Fractures, which did not unite after six months or that needed an additional operative procedure to unite was considered.

**Table 9:** Time for fracture union

Time of union	No. of cases	Percentage
< 4 months (16 weeks)	10	50
4-6 months (16 – 24 weeks)	8	40
6 months - 1 year (24-36 weeks)	2	10
Total	20	100

18(90%) patients had excellent union in less than 6 months, 2(10%) patients had delayed union.

**Complications****Intraoperative complications**

There were no cases of intraoperative complications.

**Postoperative complications**

**Superficial Infections:** One patient developed superficial infection.

Infection was controlled with appropriate antibiotics after culture and sensitivity report.

**Radioulnar synostosis:** One patient developed proximal Radioulnar synostosis and resulted in poor functional outcome.

**Table 10:** Complications

Complications	No. of cases	Percentage
Superficial infection	1	5%
Non-union	-	-
Post-interosseous nerve injury	-	-
Radio-ulnar synostosis	1	5%
Total	2	10%

**Criteria for evaluation of results**

“Anderson” *et al.* scoring system (1975).<sup>18</sup> and after 6 months the assessment is DASH scoring system.<sup>37</sup> (Quick dash score method)

**Table 11:** Criteria for evaluation of functional Results

Results	Union	Flexion / 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	Nonunion with / without loss of motion		

Using the Anderson *et al.* scoring system and quick DASH scoring we had 18 (90%) patients with excellent results, 2 (10%) patients with satisfactory results and no patients with unsatisfactory result.

**Table 12:** Functional Results

Results	No. of cases	Percentage
Excellent	18	90
Satisfactory	2	10
Unsatisfactory	0	0
Total	20	100

**Discussion**

Fracture both bones of forearm are commonly encountered in day-to-day orthopedic practice in our hospital and it presents a formidable challenge to the orthopedicians, as the various muscle forces acting upon the fracture tend to displace it. Hence to provide the functional rehabilitation of the upper limb, anatomic reduction and rigid fixation is mandatory.

As reported by Knight 18 and Purvis closed reduction and its maintenance is difficult. Intramedullary nails have got high failure rate. Though there are few advantages like closed nailing, minimal tissue dissection and hospital stay. So, the best option is plating. Different types of plates are available. The dynamic compression plates (DCP) give good results.

So, the DCP are the best implants for diaphyseal fracture of both bones forearm for rigid fixation and early mobilization.

The present study was undertaken to determine the efficacy of DCP in the treatment of diaphyseal fracture of both bones of the forearm. A total of 20 patients of fracture both bones of forearm were treated with open reduction and internal fixation using 3.5 mm DCP.

We evaluated our results and compared with those obtained by various other studies utilizing different modalities of treatment.

**Our analysis is as follows****Age distribution**

Study made by Chapman *et al.* in 1989 witnessed 70% of patients between third and fourth decade and an average of 33 years<sup>[13]</sup>.

In 2003, Frankie Leung and Shew Ping chow accounted an average of 36 years (11-90 years)<sup>[14]</sup>.

In the present study, fracture was common in third decade with average age of 35years.

**Sex distribution**

In most of the series, males are affected more. In the series of Burwell *et al.* 69.33% were males and 30.67% were females.

Herbert Dodge in his study, noted about 89% males and 11% females.<sup>15</sup> Michael Chapman noted about 78% males and 22% females<sup>[13]</sup>.

In our study, male preponderance with 75% males and 25% female patients, which was comparable to previous studies.

**Mode of injury**

Moed BR *et al.* accounted 50% of his cases to RTA, 20% due to industrial accidents, 14% due to fall, 12% due to direct blow and 4% due to gunshot injuries.

Thomas Grace *et al.* 83 noted about 29(45%) patients with automobile/motorcycle accident 14 (22%) in fall 2 (3%) had gunshot wounds and remainder had other miscellaneous types of injuries.

Smith noted about 45% of his cases, which were due to RTA, 36% were due to fall and 19% were due to industrial accidents<sup>[16]</sup>.

**Extremity affected**

Burwell HN and Charnley AD reported about 50% incidence of fracture both bones in right forearm<sup>[17]</sup>.



We accounted about 70% incidence of fracture of both bones in left extremity.

### Fracture anatomy

#### Type of fracture

Chapman *et al.* series noted about 53% of fractures as comminuted and 47% were transverse/short oblique [13].

In present study accounted 75% of fractures as transverse/short oblique and 25% were comminuted. The results were not comparable to the previous studies, which can be attributed to low velocity trauma in our country.

#### Level of fracture

In all reported series, the incidence of fracture is highest in the middle third and least in the proximal third.

Sarmiento A *et al.* noted about 84.6% of fracture on both bones were in middle third and 15.4% of cases had lower third fracture of both bones [18].

Herbert Dodge and Cady GW documented 71.5% fracture on both bones in middle third, 21.5% in distal third and 7% in proximal third [15].

Chapman MW *et al.* noted about 59% and 40% of fractures in middle third of radius and ulna, 13% and 21% in proximal third of radius and ulna and 28% and 12% in lower third of radius and ulna respectively [13].

In our series, we had 70% of fracture in middle third, 20% distal and 10% in proximal third.

### Complications

In the present study, there was one case of superficial infection. It was treated with appropriate antibiotics and the wound healed without any problem. We had a case of proximal radio-ulnar synostosis. We do not believe that this complication is related to the method of fixation, but rather to level of fracture and the degree of comminution.

### Time for union

In most of the reported series, it is usually around 12 weeks except in the series of Anderson *et al.*, [30] where he reports a union time of 7.4 weeks (average). Time for union varies according to age, general condition, rigidity of fixation and presence of infection. Also, inter-observer variation is there, regarding time of union.

Absence of tenderness at the fracture site and disappearance of fracture line with callus formation is taken as union.

Anderson's criteria for evaluation of union were taken into account. In our series, we had an average union time of 15 weeks, with the range of 9 to 30 weeks. We had 100% union of both radius and ulna.

The results of our present study are comparable to the previous studies.

### Functional results

Fracture union and range of movements are the two factors, which affect the functional outcome. So early mobilization prevents soft tissue contracture, muscular tethering and improves the vascularity.

Dash scoring system was used as a measure for the functional outcome [19].

Anderson *et al.* reported about 54 (50.9%) cases as excellent, 37 (34.3%) satisfactory, 12 (11.3%) unsatisfactory and 2 (2.9%) as failure [19].

In present study (n=20), we had 18 (90%) with excellent results, 2 (10%) as satisfactory and 0 cases of unsatisfactory results.

### Duration of follow-up

We had a follow-up, which ranged from 5 months to 18 months with an average mean of 12 months, which is comparable to Chapman series but other series had longer follow-up.



Fig 1: Instruments



Fig 2: Volar approach for radius

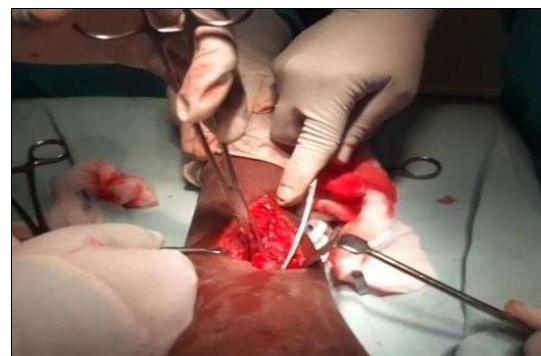


Fig 3: Deep dissection for radius



Fig 4: Fracture fragments exposed and reduced





**Fig 5:** Application of the plate



**Fig 9:** Exposure of fracture site



**Fig 6:** Drilling the cortices



**Fig 10:** Fixation of plate



**Fig 7:** Fixed with 3.5mm DCP



**Fig 11:** Wound closure

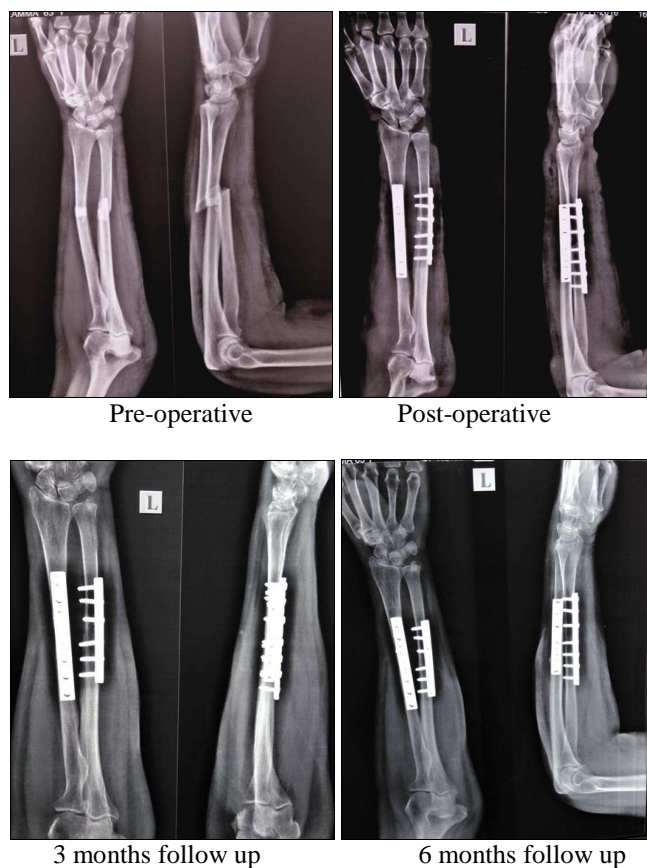


**Fig 8:** Incision for ulna



**Fig 12:** Sterile dressing



**Clinical and radiological photos****Fig 13: Radiography - 1****Fig 14: Radiography - 2****Conclusion**

Advantages of DCP, it facilitates biological fixation of the bone and early bone union. It is easier to apply in comminuted and short oblique fractures. Use of separate incisions for radius and ulna and preservation of the natural curves of radius will lessen the rate of complication.

Rigid fixation of fractures after perfect anatomical reduction with 3.5 mm DCP and screws allows early mobilization. A minimum of 5 cortices has to be fixed in each fracture fragment and the nearest screw to the fracture line should be at least 1 cm away. It minimizes vascular damage to the plated bone segment. It should lead to more versatile and efficient application of internal fixation. It gives excellent functional results in the majority of patients. Complication after a well-performed surgery are minor and easily correctable. Comparing the results, postoperative mobilization and going back to work as early as possible us after our study concluded that DCP is one of the best procedures for diaphyseal fracture both bones forearm these should be used as the implant of choice.

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**Conflict of Interest**

None

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