



Original Research Article

SURGICAL MANAGEMENT OF DIAPHYSEAL FRACTURES OF BOTH BONES OF FORE ARM IN ADULTS WITH DYNAMIC COMPRESSION PLATE

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ABSTRACT

Background: The forearm represents a critical anatomical unit of the upper limb, permitting the hand to perform complex multidirectional activities essential for daily living. Conservative management of diaphyseal fractures of both bones of the forearm in adults often results in poor functional outcomes, including malunion, nonunion, and rotational deformities. Restoration of normal radial bow and anatomical alignment is essential for maintaining pronation and supination movements. Open reduction and internal fixation (ORIF) with Dynamic Compression Plate (DCP) provides rigid fixation, preservation of blood supply, early mobilization, and improved fracture healing. The present study was undertaken to evaluate the functional and radiological outcomes of diaphyseal fractures of both bones of the forearm in adults treated with DCP and to assess the associated complications.

Materials and Methods: This prospective study was conducted in the Department of Orthopaedics at Navodaya Medical College Hospital and Research Center from October 2010 to September 2012. Twenty adult patients with diaphyseal fractures of both bones of the forearm were included after obtaining informed consent. All patients underwent open reduction and internal fixation using 3.5 mm Dynamic Compression Plates. Patients were followed clinically and radiologically, and the functional outcome was assessed using Anderson's scoring system and the Disabilities of the Arm, Shoulder and Hand (DASH) score.

Results: A total of 20 patients with fractures of both bones of the forearm were studied. The age of patients ranged from 15 to 45 years, with the highest incidence observed in the third and fourth decades of life. The mean age was 32 years. There were 16 males (80%) and 4 females (20%). The right side was involved in 12 patients (60%) and the left side in 8 patients (40%). The most common mode of injury was road traffic accident in 12 patients (60%), followed by fall in 6 patients (30%) and assault in 2 patients (10%). Eighteen patients (90%) achieved fracture union within 6 months, while 2 patients (10%) had delayed union. According to Anderson's scoring system, 17 patients (86.7%) had excellent results, 2 patients (10%) had satisfactory results, and 1 patient (3.3%) had an unsatisfactory result due to radioulnar synostosis. Complications encountered included superficial infection in 1 patient (5%), posterior interosseous nerve injury in 1 patient (5%), and radioulnar synostosis in 1 patient (5%).

Conclusion: Dynamic Compression Plate fixation provides biological and rigid fixation with early fracture union and excellent functional and radiological outcomes in the majority of patients with diaphyseal fractures of both bones of the forearm. DCP remains the implant of choice for the management of closed displaced diaphyseal fractures of both bones of the forearm in adults until newer implants are proven to provide superior results.

Keywords: Both bone forearm fracture; Dynamic Compression Plate; Open reduction and internal fixation; Adult forearm fractures.

INTRODUCTION

The supporting skeleton and articulations of the upper extremity serve to position the hand in space and enable complex activities of daily living. In adults, precise management of diaphyseal fractures of the radius and ulna is essential to restore forearm function and preserve pronation and supination movements. These fractures may be considered functionally intra-articular injuries because the radius rotates around the ulna to facilitate forearm rotation. Improper treatment may result in restricted forearm motion, muscle imbalance, and significant disability of hand function.^[1]

The incidence of forearm fractures has increased substantially due to rapid urbanization, increased vehicular traffic, industrialization, interpersonal violence, and sports-related injuries. Fractures of both bones of the forearm are among the common orthopedic injuries encountered in adults.^[2]

The higher incidence of malunion, nonunion, and poor functional outcomes in forearm fractures is attributed to the complex anatomy and biomechanics of the forearm. Proper coordination between bones, joints, interosseous membrane, muscles, and tendons is necessary for effective upper limb function. The radius rotates around the ulna during pronation and supination, making restoration of the normal radial bow essential for optimal functional recovery.^[3,4]

Successful treatment of diaphyseal fractures of both bones of the forearm depends on accurate restoration of bone length, alignment, apposition, and rotational stability. Conservative treatment in adults has been associated with high rates of malunion, nonunion, radioulnar synostosis, stiffness, and poor functional outcome.^[5]

Open reduction and internal fixation with Dynamic Compression Plate (DCP) has become the standard treatment modality for displaced diaphyseal forearm fractures in adults. Dynamic compression plating provides rigid fixation, anatomical reduction, preservation of blood supply, rotational stability, and early mobilization, thereby facilitating early restoration of function.^[6,7]

In the present study, twenty cases of diaphyseal fractures of both bones of the forearm were treated with open reduction and internal fixation using 3.5 mm Dynamic Compression Plates after satisfying the inclusion and exclusion criteria.

This study was undertaken to evaluate the functional and radiological outcomes of open reduction and internal fixation of diaphyseal fractures of both bones of the forearm using Dynamic Compression Plate in adults and to assess its advantages and associated complications. The study also evaluated the rate and time of fracture union, complications, forearm rotation, and movements of the wrist and elbow joint following surgery.

Aims & objectives of the study

- To restore normal anatomy and achieve optimal functional outcome following treatment of diaphyseal fractures of both bones of the forearm.
- To preserve mobility of the hand, wrist, elbow, and shoulder joints through early rehabilitation.
- To study the efficacy of Dynamic Compression Plate fixation in fractures of both bones of the forearm.
- To study the age and sex incidence of diaphyseal fractures of both bones of the forearm.
- To study the possible complications associated with surgical management using Dynamic Compression Plate.
- To evaluate the functional outcome of the upper limb following open reduction and internal fixation.

MATERIALS AND METHODS

This prospective study was conducted in the Department of Orthopaedics at Navodaya Medical College Hospital and Research Center from October 2010 to September 2012. A total of 20 patients with fractures of both bones of the forearm were treated by open reduction and internal fixation using 3.5 mm Dynamic Compression Plate (DCP).

Inclusion Criteria

- Simple fractures
- Gustilo and Anderson type I and II open fractures
- Nonunion cases
- Patients aged 15–45 years of both sexes

Exclusion Criteria

- Age below 15 years and above 45 years
- Segmental fractures and isolated forearm bone fractures
- Pathological fractures
- Fractures associated with intra-articular extension
- Gustilo and Anderson type III open fractures
- Patients unfit or unwilling for surgery

Ethical clearance was obtained from the Institutional Ethics Committee. Detailed history, clinical examination, and radiological evaluation with anteroposterior and lateral radiographs including the wrist and elbow joints were performed in all patients. The limb was initially immobilized in an above-elbow plaster slab.

Routine preoperative investigations including hemoglobin, blood sugar, blood urea, serum creatinine, ECG, chest X-ray, and urine examination were performed before surgery.

Operative Technique: Patients were operated under general anesthesia or brachial block anesthesia in supine position under tourniquet control. The radius was approached through either the dorsal Thompson approach for proximal and middle third fractures or the volar Henry approach for distal third fractures. The ulna was approached through the subcutaneous border.

After exposure, fracture ends were reduced anatomically and fixed using 3.5 mm narrow

Dynamic Compression Plates with at least five cortices engaged on either side of the fracture. Compression was achieved using AO principles. Wounds were closed in layers over suction drain and sterile dressing applied.

Postoperative Care and Rehabilitation: The operated limb was elevated for 24–48 hours. Intravenous antibiotics and analgesics were administered postoperatively. Suction drain was removed after 24–48 hours, and sutures were removed on the 10th postoperative day.

Active and assisted range-of-motion exercises of the shoulder, elbow, wrist, pronation, and supination were started as pain and swelling subsided, usually within 2–3 days postoperatively.

Follow-Up and Evaluation: Patients were followed monthly for the first three months and assessed clinically and radiologically for fracture union and

functional recovery. Functional outcome was evaluated using Anderson's scoring system and Quick DASH score.

Fracture union was defined radiologically by the presence of bridging callus and trabeculations across the fracture site. Wrist movements, elbow movements, and forearm rotation were documented during follow-up.

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 2010 to September 2012.

Table 1: Age Distribution

Age	No. of Patient's	Percentage
15 - 20	1	5
21 - 30	9	45
31 - 40	6	30
41 - 50	4	20
Total	20	100

The age of these patients ranged from 15- 50 years with fracture being most common in 3rd decade and an average age of 31 years.

Out of 20 patients, 16 patients (80%) were males and 4 patients (20%) were females, showing male

preponderance because of working in factories, fields, travelling and sports. Out of 20 patients, 12 (60%) with right forearm fracture and 8 (40%) patients with left forearm fracture.

Table 2: Mode of injury

Mode of injury	No. of Patient's	Percentage
RTA	12	60
Fall	6	30
Assault	2	10
Total	20	100

In present study, 18 (60%) patients with road traffic accidents, 9(30%) patients with fall and only 3 (10%) patients with assault.

Table 3: Level of fracture

Level of injury	No. of Patient's	Percentage
Middle third fractures	14	70
Proximal third fractures	4	20
Lower 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 4: Type of the 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 5: Associated injuries

Associated Injury	No. of cases	Percentage
Supracondylar Fracture femur (Rt)	1	3.3
Fracture BB (Rt) leg	1	6.7

Fracture shaft humerus (Lt)	1	6.7
Fracture shaft femur(Rt)	1	3.3
Total	4	20

Only 4 (20%) of the patients had associated injuries. 8 of the 20 cases were operated under general anaesthesia and in other 12 patients brachial block was used. Dorsal Thompson approach for proximal and middle third radius was used in 18 patients and volar Henrys approach for lower third radius 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.

Duration of surgery and tourniquet time: In our study, we noted the duration of surgery ranged from

60 to 95 minutes, with average time of 80 minutes. The tourniquet time ranged from 40 to 60 minutes, with average time of 49 minutes.

Duration of 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 as non-union.

Table 6: Duration of fracture union

Time of union	No. of cases	Percentage
< 4 months (16 weeks)	12	60
4-6 months (16 – 24 weeks)	6	30
6 months - 1 year (24-36 weeks)	2	10
Total	20	100

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

Table 7: Complications

Complications	No. of cases	Percentage
Superficial infection	1	5
Posterior interosseous nerve injury	1	5
Radioulnar stenosis	1	5
Total	3	15%

Criteria for evaluation of results: Using the Anderson et al scoring system and quick DASH scoring we had 17 (86.7%) patients with excellent

results, 2 (10%) patients with satisfactory results and 1 (3.3%) patients with unsatisfactory result (radioulnar synostosis).

Table 8: Functional Results

Results	No. of cases	Percentage
Excellent	26	86.7
Satisfactory	3	10
Unsatisfactory	1	3.3
Total	20	100



Figure 1: A. Preop X ray. B. 4 weeks follow up. C. 10 weeks follow up. D. Supination



Figure 2: A. Preop X ray. B. 4 weeks follow up. C. 12 weeks follow up X-ray. D. Supination

DISCUSSION

Fracture both bones of forearm are commonly encountered in day-to-day orthopaedic practice in our hospital and it presents a formidable challenge to the orthopaedicians, 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.^[7] As reported by Knight and Purvis closed reduction and its maintenance is difficult.^[7] 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 findings are comparable to the study made by Chapman et al in 1989 witnessed 70% of patients between third and fourth decade and an average of 33 years.^[8]

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.^[9]

In our study, male preponderance with 80% males and 20% female patients, which was comparable to previous studies.

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.^[10]

Thomas Grace et al 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.^[11]

Smith noted about 45% of his cases, which were due to RTA, 36% were due to fall and 19% were due to industrial accidents.^[12]

In the present study, RTA 12 (60%), fall 6(30%) and assault 2(10%) of patients.

Extremity affected: We accounted about 60% incidence of fracture of both bones in right extremity, which is comparable to the previous studies.

But it is always difficult to determine the exact sequence of events in RTA or fall.

However, the results of present study are comparable with the previous studies.

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.

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

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

In the present study, there was one case of superficial infection. It was treated with appropriate antibiotics and the wound healed without any problem.

There was one case of posterior interosseous nerve palsy. These case was treated conservatively and there was spontaneous resolution of the nerve injury.

In most of the reported series, it is usually around 12 weeks except in the series of Anderson et al,^[13] 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 interobserver 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 12.2 weeks, with the range of 9 to 28 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 prevent soft tissue contracture, muscular tethering and improves the vascularity.

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.

In present study, we had 17 (86.7%) with excellent results, 2 (10%) as satisfactory and 1 (3.3%) cases of unsatisfactory results.

Table 9: Functional Results

Series	Excellent (%)	Satisfactory(%)	Unsatisfactory (%)	Failure (%)
Anderson	50.9	34.9	11.3	2.9
Chapman ⁸	86	7	12	5
Leung ¹⁵	98	2	-	-
Burwell ¹⁶	77	23.8	10.8	1.4
Present study	86.7	10	3.3	-

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.

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.
- A postoperative plaster is seldom required for uncomplicated fractures and early return to light work is possible.
- 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 we 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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