

FUNCTIONAL OUTCOME OF SURGICAL MANAGEMENT OF FRACTURE BOTH BONES FOREARM IN ADULTS USING LC-DCPShiva Naik R¹, K. G. Gunnaiah²**HOW TO CITE THIS ARTICLE:**

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ABSTRACT: BACKGROUND: Forearm represent 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 conservative reduction of fracture BBFA results in a poor functional outcome, non-union, mal-union rotational deformity. Hence perfect reduction is essential in maintaining the rotation (supination and pronation). This is achieved by ORIF using LC-DCP. The term LC-DCP stands for a new approach to plate fixation, reduced trauma to bone, preservation of blood supply, avoidance of stress raisers produced at implant removal and improved healing. This study is undertaken to assess the results of diaphyseal fractures of BBFA using LCDCP to study the advantages and its complications. **MATERIALS AND METHODS:** Patients who are admitted tin Victoria and Bowring & Lady Curzon Hospitals (Bangalore Medical College) taken for study after obtaining their consent. This is prospective study from January 2004 to February 2006. **RESULTS:** This study consists of 20 cases of fracture BBFA. All cases were openly reduced and internally fixed with 3.5 mm LCDCP. Age distribution ranged from 18-65 years with fracture being most common in 2nd and 3rd decade (Average 34.6). Sex distribution out of 20 patients, 17 patients (85%) was male and 3 (15%) female. Side affected 13 (65%) left side and 7 patients (35%) right side. Mode of injury RTA 10 (50%), 8 (40%) with fall 2 (10%) assault. 18 (90%) patient s had sound union in less than 6 months, 2 (10%) patients had delayed union. Results were evaluated by Andersons scoring system. Using this scoring system we had 17 (85%) patients with excellent results. 2 (10%) patients with satisfactory results and 1 (5%) with unsatisfactory result (radioulnar synostosis). Superficial infection 2 (10%) posterior interosseous nerve injury 1 (5%) Radioulnar synostosis 1(5%). **CONCLUSION:** LC-DCP facilitates biological, rigid fixation and early bone union with excellent radiological and functional outcome in majority of the patients. Until newer implants are devised and extensively assessed as the versatile LC-DCP these should be used as the implant of choice for all closed displaced diaphyseal fractures of both bones.

KEYWORDS: Both bones forearm; Limited contact dynamic compression plate.

INTRODUCTION: The forearm fractures are increasing faster than the predicted rate due to increase in population, increasing number of vehicles rapid industrialization, increased incidence of violence and various sports. Activities have contributed to the increased incidence of fracture shaft of both bones. Forearm. The forearm represents the critical anatomic unit of upper limb, permitting the effector organ of the upper limb, the hand, to perform multi axial daily activities of living.¹

These bones take part in the Formation of five joints, which are ulnohumeral, radiohumeral, proximal radioulnar, distal radioulnar and the radiocarpal articulations. The reasons for high rate of non-union and malunion as well as poor functional outcome, due to complex anatomical structure with a coordination between muscles, tendon, bones and joints which is responsible for the multifold

ORIGINAL ARTICLE

functions of the arm and hand including pronation and supination where the radius rotates around the ulna. The radial bow should be maintained for the good functional outcome. It is important to regain the length of the bones, good opposition and alignment without any malrotation.

Conservative treatment has resulted in malunion, non-union, synostosis and ultimately poor functional outcome. Hence perfect fracture reduction and rigid fixation is mandatory and achieved by plating. With conventional plating, the screw acts as an anchor, with its axial force press the plate against bone, which produces large frictional force at the bone plate interface and this force has been shown to cause vascular disturbance, especially in the periosteum.

This observation has led to the development of LIMITED CONTACT DYNAMIC COMPRESSION PLATE, which decreases the bone contact area to approximately 50% of the total area of the under surface of the plate. So does not hinder the periosteal circulation. So, fracture healing is good and re fracture is less.² The present study is undertaken to provide satisfactory functional outcome and know the advantages and complication of the newer plate design the LC-DCP.

Twenty case of fracture BBFA were selected after inclusion and exclusion criteria, and treated with LC-DCP in Victoria and Bowring and Lady Curzon Hospitals, attached to Bangalore Medical College, Bangalore. So, this study has been taken up to evaluate the results of open reduction and internal fixation of the Diaphyseal fracture of BBFA with LC-DCP in adults.

The functional outcome was certified using Andersons et al scoring system. The variables taken into considerations are:

- Union of the fracture.
- Range of elbow and wrist movement.

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.

MATERIALS & 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 LC-DCP between January 2004 to February 2006 at Bowring and Lady Curzon Hospitals and Victoria Hospital attached to Bangalore Medical College, Bangalore. Follow-up was done up to February 2006.

- This is a prospective time bound study. Sample size is 20 patients.
- Inclusion criteria.
- Patients with closed diaphyseal fractures of both bones of forearm, age above 18 years.

EXCLUSION CRITERIA: open fractures.

- **Evaluation**
- The results are evaluated with Anderson's criteria for evaluation of forearm bones fracture.
- The results are compared with previous studies.
- Ethical clearance has been obtained from the Ethical Committee of Bangalore Medical College, Bangalore.

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,

ORIGINAL ARTICLE

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.

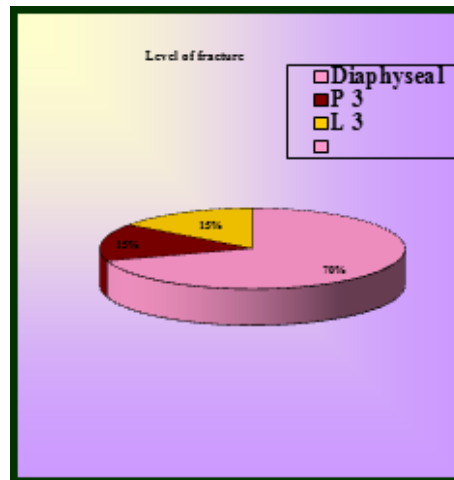
The patient was taken for surgery after routine investigations and after obtaining fitness towards surgery. The investigations are as follows: Hb%, Urine for sugar, FBS, Blood urea, Serum creatinine, ECG and chest x-ray. Radius was approached by Dorsal Thompson incision and Volar Henry approach was used for middle and distal radius. A narrow 3.5 mm LC-DCP was used and a minimum of 5 cortices were engaged with screw fixation in each fragment.

RESULTS: FRACTURE CHARACTERISTIC:

Majority of the fractures were seen in the mid diaphysis of both bones. 14 (70%) patients had diaphyseal fractures, 3 (15%) had proximal third fractures and 3 (15%) patients had lower third fractures both bones forearm.

Level of injury	No. of Patient's	Percentage
Diaphyseal fractures	14	70
Proximal third fractures	3	15
Lower third fractures	3	15
Total	20	100

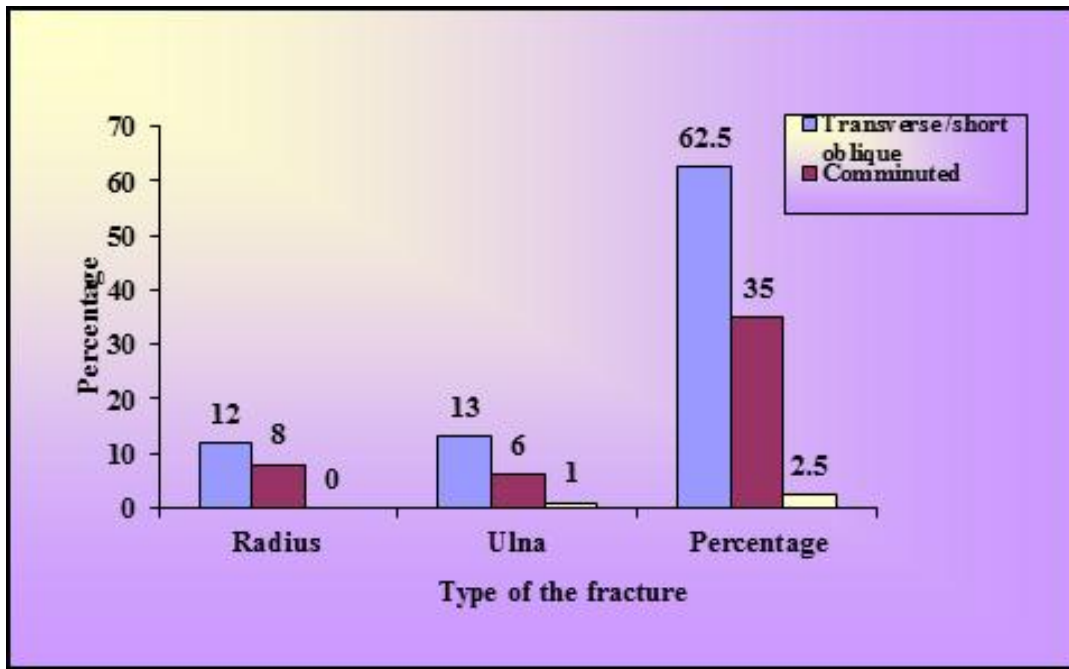
Table 1: Level of fracture



Type of fracture	Radius	Ulna	Percentage
Transverse /short oblique	12	13	62.5
Comminuted	8	6	35
Segmental	0	1	2.5
Total	20	20	100

Table 2: Type of the fracture

ORIGINAL ARTICLE



Majority (62.5%) of the fractures were transverse / short oblique. About 35% of fractures were comminuted and only 2.5% of segmental fractures were present.

STATISTICS OF SURGERY: 11 of the 20 cases were operated under general anesthesia and in other 9 patients brachial block was used. Dorsal Thompson approach for radius was used in 17 patients and volar Henrys approach for radius was used in 3 patients. Ulna was approached subcutaneously. Pneumatic tourniquet was used in all the cases. Follow-up ranged from 5 months to 24 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: 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.

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	10.0
Total	20	100

Table 3: Duration of fracture union

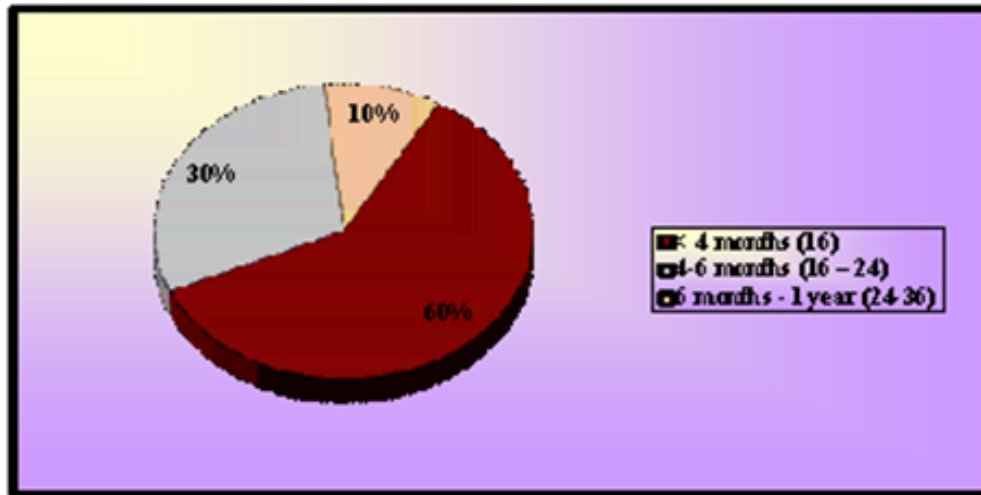


Table 3: 18 (90%) patients had sound union in less than 6 months, 2 (10%) patients had delayed union.

COMPLICATIONS:

- Intraoperative complications.
 - There were no cases of intraoperative complications.
 - Postoperative complications.
1. **Superficial Infections:** Two patients developed superficial infection. Infection was controlled with appropriate antibiotics after culture and sensitivity report.
 2. **Posterior inter osseous nerve Injury:** Immediate postoperative (Proximal radius fracture fixation), patient developed transient posterior inter osseous nerve injury. Patients was treated with static cockup splint, which recovered in a span of about 6 weeks
 3. **Radioulnar Synostosis:** One patients developed proximal radioulnar synostosis and resulted in poor functional outcome.

Complications	No. of cases	Percentage
Superficial infection	2	10
Posterior interosseous nerve injury	1	5
Radioulnar synostosis	1	5
Total	4	20

Table 4: Complications

CRITERIA FOR EVALUATION OF RESULTS

“Anderson” et al scoring system (1975).³

ORIGINAL ARTICLE

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		

Table 5: Criteria for evaluation of Results

Using the Anderson et al scoring system we had 17 (85%) patients with excellent results, 2 (10%) patients with satisfactory results and 1 (5%) patients with unsatisfactory result (radioulnar synostosis).

Results	No. of cases	Percentage
Excellent	17	85
Satisfactory	2	10
Unsatisfactory	1	5
Total	20	100

Table 6: Functional Results

CLINICAL PHOTOGRAPHS:



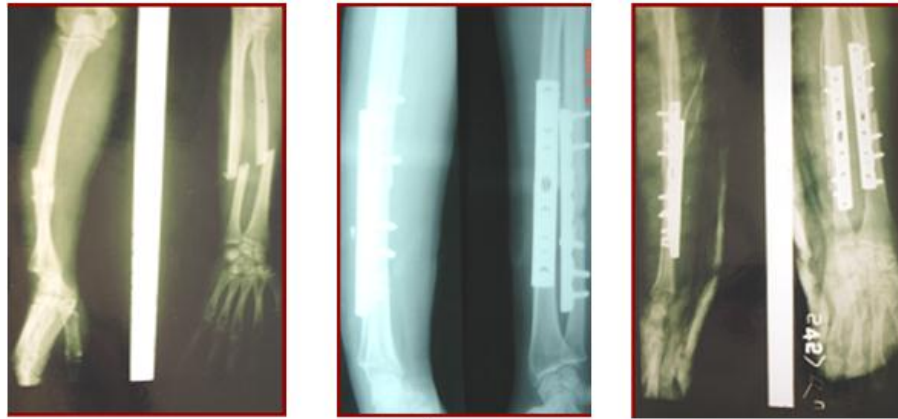
Preoperative X-ray





Postoperative X-ray

EXCELLENT RESULTS



Preoperative

After 10 Weeks

Postoperative

DISCUSSION: Fracture bones of forearm are commonly encountered in day-to-day orthopedic 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.

As reported by Knight and Purvis closed reduction and its maintenance is difficult.⁴ Intra medullary 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 (DCPs) give good results, but there are few disadvantages. Since these plates interfere with periosteal circulation, osteoporosis and re fracture are very common after plate removal. Much work had not been done on PC-fixators and as reported by Frankie Leung et al. they have no added advantage over the LC-DCPs.²

So, the LC-DCPs are the best implants for diaphyseal fracture of both bones forearm at present. LC-DCPs have got multiple advantages since their interference with the periosteal circulation is less. They give good results. The rate of union is high osteoporosis and re fracture after removal is very low. The present study was undertaken to determine the efficacy of LC-DCP in the treatment of fractures of both bones of the forearm.

ORIGINAL ARTICLE

A total of 20 patients of fracture both bones of forearm were treated with open reduction and internal fixation using 3.5 mm LC-DCP. We evaluated our results and compared with those obtained by various other studies utilizing different modalities of treatment.

OUR ANALYSIS IS AS FOLLOWS: EXTREMITY AFFECTED: Burwell HN and Charnley AD reported about 50% incidence of fracture both bones in right forearm.⁵ Chapman MW reported about 5.5% incidences of fractures of both bones in right extremity.⁶ We accounted about 35% incidence of fracture of both bones in right extremity, which is comparable to the previous studies.

This may be because in case of assaults the person tries to protect himself/herself with the left limb, also in falls the person may land with the left hand first as he/she would be holding something in the right hand or would use the right hand to hold something. 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.

Series	Right (%)	Left (%)
Burwell HN ⁵	49.33	50.67
Michael Chapman ⁶	55	45
Schemitsch et al ⁷	43.63	56.37
Present study	35	65

Table 7

FRACTURE ANATOMY:

TYPE OF FRACTURE: Chapman et al series noted about 53% of fractures as comminuted and 47% were transverse/short oblique.⁶ In present study accounted 62.5% of fractures as transverse/short oblique and 35% were comminuted and 2.5% segmental fracture. The results were not comparable to the previous studies, which can be attributed to low velocity trauma in our country.

Series	Transverse/ short oblique (%)	Comminuted (%)	Segmental fracture (%)
Chapman ⁶	47	53	-
Present study	62.5	35	2.5

Table 8

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.⁸ 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.⁹ 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.⁶ In our series, we had 70% of fracture in middle third, 15% proximal and 15% in lower third.

ORIGINAL ARTICLE

Series	Proximal third (%)	Middle third (%)	Distal third (%)
Herbert Dodge ⁵	7.14	71.42	21.44
Sarmiento ⁸	-	84.6	15.4
Chapman ⁶	13	59	28
Present study	15	70	15

Table 9

Complications: In the present study, there were two cases of superficial infection. They were treated with appropriate antibiotics and the wound healed without any problem. There was one case of posterior inter osseous nerve palsy. This case was treated conservatively and there was spontaneous resolution of the nerve injury. 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.

Complications	Anderson ¹⁰	Chapman ⁶	Frankie ²	Present study
Superficial infection	2.9%	2.5%	2%	10%
Non-union	2.9%	2.3%	-	-
Post-inter osseous nerve injury	2%	1.5%	3%	5%
Radio-ulnar synostosis	1.2%	2.3%	-	5%

Table 10

TIME FOR UNION: In most of the reported series, it is usually around 12 weeks except in the series of Anderson et al,¹⁰ 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 14.2 weeks, with the range of 8 to 28 weeks. We had 100% union of both radius and ulna. The results of our present study are comparable to the previous studies.

Series	Union times (weeks)	Range (Weeks)	Union (%)
Anderson ¹⁰	7.4	5 - 10	97
Chapman ⁶	12	6 - 14	98
Frankie ²	17	8 - 36	100
Mc Knee ¹¹	10.7	5 - 18	97.3
Present study	14.2	8 - 28	100

Table 11

ORIGINAL ARTICLE

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's et al scoring system was used as a measure for the functional outcome.¹⁰Anderson et al reported about 54 (50.9%) cases as excellent, 37 (34.3%) satisfactory, 12 (11.3%) unsatisfactory and 2 (2.9%) as failure.¹⁰Chapman et al reported about 36 (86%) cases as excellent, 3 (7%) satisfactory, 1 (2%) as unsatisfactory and 2 (5%) as failure.⁶Frankie Leung reported 98% cases as excellent and 2% as satisfactory results.²In present study, we had 17 (85%) with excellent results, 2 (10%) as satisfactory and 1 (5%) cases of unsatisfactory results.

Series	Excellent (%)	Satisfactory (%)	Unsatisfactory (%)	Failure (%)
Anderson ¹⁰	50.9	34.9	11.3	2.9
Chapman ⁶	86	7	12	5
Frankie ²	98	2	-	-
Burwell ⁵	77	23.8	10.8	1.4
Present study	85	10	5	-

Table 12

DURATION OF FOLLOW-UP: We had a follow-up, which ranged from 5 months to 24 months with an average mean of 12 months, which is comparable to Chapman series but other series had longer follow-up.

Series	Range	Average
Anderson ¹⁰	4 – 9 years	3 years
Chapman ⁶	6 – 48 months	12 months
Moed ¹²	12 months – 9 years	3 years
Frankie ²	14 – 40 months	22 months
Present study	5 – 24 months	12 months

Table 13

DURATION OF SURGERY AND TOURNIQUET TIME: The duration of surgery ranged between 50 to 90 minutes, with an average 74.5 minutes. The tourniquet time ranged from 40 to 60 minute, with an average of 49.75 minute. These findings could not be compared to the previous studies, as there was no data available.

CONCLUSION:

- Advantages of LC-DCP it facilitates biological fixation of the bone and early bone union. It is easier to apply in comminuted and segmental fracture 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 LC-DCP and screws allows immediate 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.

ORIGINAL ARTICLE

- It minimizes vascular damage to the plated bone segment. It should lead to more versatile and efficient application of internal fixation.
- The special design of the plate does not interfere with periosteal circulation to the extent the DCP does so, early union takes place and postoperative osteoporosis does not occur.
- 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 is minor and easily correctable.

Until newer implants are devised and extensively assessed as the versatile LC-DCP these should be used as the implant of choice for all closed displaced diaphyseal fractures of both bones forearm.

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ORIGINAL ARTICLE

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