ORIGINAL RESEARCH

Comparative study of Dynamic Compression Plating (DCP) and Limited Contact Dynamic Compression Plating (LCDCP) in forearm bone fractures

[1]Dr. Narayana Gowda BS, [2]Dr. Ajith Krishnamurthy, [3]Dr. Sandeep Patil V

[1]Assistant Professor, Department of Orthopaedics, Siddaganga Medical College and Research Institute, Tumakuru, Karnataka, India
[2]Associate Professor, Department of Orthopaedics, St. Peter's Medical College Hospital and Research Institute, Hosur, Tamil Nadu, India
[3]Assistant Professor, Orthopaedic Department, SMSIMSR (Sri Madhusudan Sai Institute of Medical Sciences and Research), Sathya Sai Grama, Karnataka, India

Corresponding Author
Dr. Narayana Gowda BS
Assistant Professor, Department of Orthopaedics, Siddaganga Medical College and Research Institute, Tumakuru, Karnataka, India

Received: 02Sept, 2023 Accepted: 25Sept, 2023

ABSTRACT
The goal of fracture treatment is to achieve union and to restore the anatomy and function of the injured part as near normal as possible. It is important to regain the length of the bones, good opposition and alignment without any malrotation. This was a prospective time bound study with sample size of 20 patients. Which include treatment of 10 cases of fracture both bones forearm by open reduction and internal fixation with 3.5 mm DCP (Group-A) and 10 cases with 3.5 mm LC-DCP (Group-B). Using the Anderson *et al*. scoring system we had 8 (80%) patients with excellent results, 1 (10%) patients with satisfactory and 1 (10%) patient with failure due to nonunion ulna in Group A and 9 (90%) patients with excellent results, 1 (10%) patients with satisfactory results in Group B.
Key words: Dynamic Compression Plating (DCP), Limited Contact Dynamic Compression Plating (LCDCP), Forearm bone fractures

INTRODUCTION

The earliest account regarding the management of fracture of bones dates back to the time of Hippocrates in 400 BC. From the beginning fracture treatment has sought to stabilize the fracture fragments. Splints were used and it was presumed that either the contraction of adjacent muscles or the force of gravity during weight bearing compress the fracture fragments together.[1]

Historically, the closed management of forearm bone fractures have been met with frustration in adults and resulted in malunion, non-union, synostosis and ultimately poor functional' outcome.

The reasons for high rate of malunion and non-union as well as poor functional outcome are due to complex anatomical structure with coordination between muscles, tendons, bones and joints which is responsible for the multi fold 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.[2]

Hence perfect fracture reduction is mandatory and is achieved by open reduction and rigid internal fixation with plating.

The goal of fracture treatment is to achieve union and to restore the anatomy and function of the injured part as near normal as possible. It is important to regain the length of the bones, good opposition and alignment without any malrotation.[3]

The use of metal device in the bone for mechanical stabilization of fracture was introduced by Malgagne in 1859. Later Lambotte in 1909 developed and promoted internal fixation methods. Sherman in 1912 introduced vandalium steel bone plates and self-tapping screws and later in 1916 Hey Groves introduced intramedullary nail.

Perren S.M. *et al*. who work for AO group introducedDynamic Compression plates (DCP) in 1969 and later they developed the Limited Contact Dynamic Compression Plate (LC-DCP) in 1990 to realize the new concept of Biological internal fixation.[4]

With conventional DYNAMIC COMPRESSION PLATE, 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 was uniquely contoured underneath to minimize the bone contact area to approximately 50% of the total area of the under surface of the plate, that minimizes vascular damage to the plated bone segment and in turn improves circulation under the plate which allow a narrow area of circumferential callus to regenerate at the fracture site[2]. The holes in the plate are uniformly positioned to optimize plate application about fracture. Under cutting of the holes allows a greater angular capacity of screw insertion up to 40°.[5,6]

METHODOLOGY

This was a prospective time bound study with sample size of 20 patients. Which include treatment of 10 cases of fracture both bones forearm by open reduction and internal fixation with 3.5 mm DCP (Group-A) and 10 cases with 3.5 mm LC-DCP (Group-B).

INCLUSION CRITERIA

- Patients with closed and type I open diaphyseal fractures of both bones of forearm.
- Patients fit for surgery.
- Age above 18 years.
- Patients willing for surgery.

EXCLUSION CRITERIA

- Open fractures other than type I.
- Children below 18 years of age.
- Patients medically unfit for surgery.
- Patients not willing for surgery.

EVALUATION

The results are evaluated using 'ANDERSON'S CRITERIA' for functional evaluation of forearm bones fracture.

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's approach and middle & distal radius were approached through Volar Henry's approach. Ulna was approached through subcutaneous incision. Alternate cases were selected and fixed with narrow3.5 mm DCP & LCDCP respectively and a minimum of 5 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.

RESULTS

In group A the average duration of surgery was 84 minutes with the majority (50%) ranging from 75-90 minutes. And in group B it was 89 minutes with the majority (70%) ranging from 75-90 minutes.

Table 1: Duration of Surgery

Duration (In min)	Group A		Group B	
	No of Cases	Percentage	No of Cases	Percentage
61-75	0	00	1	10
75-90	5	50	7	70
91-105	1	10	1	10
106-120	4	40	1	10
Total	10	100	10	100

In group A the average hospital stay was 12.1 days with majority of the cases (80%) ranging from 8- 14 days. In group B the average hospital stay was 13.1 days with majority of the cases (90%) ranging from 8-14 days

Table 2: Number of days of Hospital stay

Days	Group A		Group B	
	No of Cases	Percentage	No of Cases	Percentage
0-7	0	00	0	00
8-14	8	80	9	90
15-21	2	20	1	10
Total	10	100	10	100

In group A, the average tourniquet time was 63 minutes with the majority of the cases (60%) ranging from 71-80 minutes. In group B the average tourniquet time was 64 minutes with majority of the cases (40%) ranging from 61-70 minutes.

Table 3: Tourniquet time

Time (Minutes)	Group A		Group B	
	No of Cases	Percentage	No of Cases	Percentage
<60	1	10	3	30
61-70	3	30	4	40
71-80	6	60	3	30
Total	10	100	10	100

The present study includes treatment of 10 cases of fracture both bones forearm by open reduction and internal fixation with 3.5 mm DCP (Group-A) and 10 cases with 3.5 mm LC-DCP (Group-B).

All 20 cases were followed up at 6 weeks, 12 weeks & at the end of 6 months for functional and radiological evaluation.

In group A average follow up was 10.1 months (Range 6 to 17 months).

In group B average follow up was 10.2 months (Range 3-20 months).

CRITERIA FOR EVALUATION OF RESULTS

RADIOLOGICAL CRITERIA

Using the criteria of Anderson *et al*. (1975) a fracture was designated as healed radiologically when there was presence of periosteal callus bridging the fracture site or of trabeculation extending across it, and or when there was obliteration of fracture in rigidly compressed fractures.

DETERMINATION OF UNION

Using the criteria of Anderson *et al*. (1975).

1. Fractures which healed in less than 6 months were classified as unions.
2. Those which required more than 6 months to unite and had no additional operative procedure were classified as delayed unions.
3. Those which failed to unite without another operative procedure were classified as non-unions.

FUNCTIONAL RESULTS

Table 4:"Anderson" *et al.* Criteria for evaluation of Results

Results	Union	Flexion/Extension at elbow joint	Supination and pronation
Excellent	Present	$<10^0$ loss	<25% loss
Satisfactory	Present	$<20^0$ loss	<50% loss
Unsatisfactory	Present	$>20^0$ loss	>50% loss
Failure	Nonunion/Malunion/Unresolved Chronic Osteomyelitis, with/without loss of motion		

Using the Anderson *et al.* scoring system we had 8 (80%) patients with excellent results, 1 (10%) patients with satisfactory and 1 (10%) patient with failure due to nonunion ulna in Group A and 9 (90%) patients with excellent results, 1 (10%) patients with satisfactory results in Group B.

Table 5: Functional Results

Complications	Group A		Group B	
	No of Cases	Percentage	No of Cases	Percentage
Excellent	8	80	9	90
Satisfactory	1	10	1	10
Unsatisfactory	0	00	0	00
Failure	1	10	0	00

INTRAOPERATIVE COMPLICATIONS
There were no cases of intraoperative complications.

POSTOPERATIVE COMPLICATIONS

1) **SUPERFICIAL INFECTIONS:** Two patients from group A had developed superficial infection which was successfully treated with appropriate antibiotics after culture and sensitivity report.
2) **POSTERIOR INTEROSSEOUS NERVE INJURY:** In immediate postoperative period following Proximal radius fracture fixation, one patient from each group A and B developed transient posterior interosseous nerve neuropraxia. Patients were treated with static cockup splint, which recovered in a span of about 6 weeks.
3) **NONUNION:** One patient from group A developed non-union of Ulna which was treated with bone grafting. This was a case of wedge comminuted (Type B 1) fracture.

Table 6: COMPLICATIONS

Complications	Group A		Group B	
	No of Cases	Percentage	No of Cases	Percentage
Sup. Infection	2	20	0	00
Post Int. Neuropraxia	1	10	1	10
Non union	1	10	0	00
Total	4	40	1	10

DISCUSSION
In the present study, there were two cases of superficial infection in group A. They were treated with appropriate antibiotics and the wound healed without any problem.
There was one case of posterior interosseous nerve palsy in each group. This case was treated conservatively and there was spontaneous recovery of the nerve injury.
We had one case of non-union of Ulna in group A.

Table 7: Comparison of Complications

Complications	Anderson[7]	Chapman[8]	Frankie[9]	Present study	
				Group A	Group B
Superficial infection	2.9%	2.5%	02%	20%	00%
Non-union	2.9%	2.3%	00%	10%	00%
Post-int. nerve injury	02%	1.5%	03%	10%	10%
Radio-ulnar synostosis	1.2%	2.3%	00%	00%	00%

In most of the reported series, it is usually around 12 weeks except in the series of Anderson *et al.*, 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 and also on interobserver variation.
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 (8 to 24 weeks), in group A with 100% union in radius and 90% union in ulna and in group B, an average union time of 12.3 weeks (6 to 16 weeks) with 100% union in both radius and ulna.

Table 8: The results of our present study are comparable to the previous studies

Series	Union times (weeks)	Range (Weeks)	Union (%)
Anderson[7]	7.4	5-10	97
Chapman[8]	12	6-14	98
Frankie[9]	17	8-36	100

McKnee[10]		10.7	5-18	97.3
Present study	Group A	14.2	8-24	90
	Group B	12.3	6-16	100

Anderson's *et al*. scoring system was used as a measure for the functional outcome.

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.

Chapman *et al*. reported about 36 (86%) cases as excellent, 3 (7%) satisfactory,1 (2%) as unsatisfactory and 2 (5%) as failure.

Frankie Leung reported 98% cases as excellent and 2% as satisfactory results.

In present study, we had 8 cases (80%) with excellent results, 1 case (10%) with satisfactory and 1 case (10%) of failure in Group A and in Group B, 9 cases (90%) with excellent results, 1 case (10%) with satisfactory result.

Table 9: Functional results

Series		Excellent (%)	Satisfactory (%)	Unsatisfactory (%)	Failure (%)
Anderson[7]		50.9	34.9	11.3	2.9
Chapman[8]		86	07	12	05
Frankie[9]		98	02	00	00
Burwell[11]		77	23.8	10.8	1.4
Present study	Group A	80	10	00	10
	Group B	90	10	00	00

In our study the average duration of follow up was 10.1 months in group A(6 to 17 months), and it was 10.2 months in group B (3-20 months) which is comparable to Chapman series but other series had longer follow-up.

Table 10: Duration of follow-up in months

Series		Range	Average
Anderson[7]		4-9 years	3 years
Chapman[8]		6-48 months	12 months
Moed[12]		12 months-9 years	3 years
Frankie[9]		14-40 months	22 months
Present study	Group A	6-17 months	10.1 months
	Group B	3-20 months	10.2 months

DURATION OF SURGERY AND TOURNIQUET TIME

The duration of surgery ranged from 75 to 90 minutes with an average of 84 minutes in 50% of cases of group A and 75 to 90 minutes with an average of 89 minutes in 70% of cases of group B.

In 60% of group A patients the tourniquet time ranged from 71 to 80 minute with an average of 63 minutes, and in 40% of group B patients the tourniquet time ranged from 61 to 70 minute with an average of 64 minutes. These findings could not be compared to the previous studies, as there was no data available.

FATE OF DISTAL RADIO ULNAR JOINT (DRUJ) IN BOTH BONE FOREARM FRACTURE

Most of the times the interosseous membrane and DRUJ will be disrupted in both bones forearm fractures. We routinely used above elbow cast in all the 20 cases for 6 weeks. We didn't have any case of DRUJ subluxation or dislocation in our study. Routine use of AE cast for first 6 weeks helps in preventing the DRUJ subluxation or dislocation.

CONCLUSION

- The Limited Contact Dynamic Compression Plating of diaphyseal bones produce excellent results when applied properly, the advantages being early union and hence prevention of fracture disease. The only disadvantage is that it is more expensive than DCP.
- LCDC Plating of both bones forearm produces excellent results
- To obtain excellent results proper pre-operative planning, minimal soft tissue dissection, adherence to AO principles of internal fixation, strict asepsis, proper post-operative rehabilitation and patient education are mandatory.

REFERENCES

1. Sevitt, Simon. Primary repair of fractures and compression fixation. Chap-10 in bone repair and fracture healing in man. Churchill Livingstone, Edinburgh, 1981; pp 145-156.
2. Thakur AJ. Bone plates. Chapter-4 in The elements of fracture fixation, Churchill Livingstone, New Delhi, 1997; pp 57-79.

3. Colton C. History of Osteosynthesis. Chapter-2, in AO / ASIF Instruments and Implants, 2nd ed, Texhammer R,C. Colton, Berlin, Springer Verlag, 1994; pp 3.
4. Chandler RN. Principles of Internal Fixation. Chapter-3, in Fractures in Adults, Vo1.1, 4th ed Rockwood C.A. Jr. *et al*., Philadelphia; Lippincott Raven, 1996;pp 159.
5. Rush LV, Rush HL. A reconstructive operation for comminuted fractures of the upper third of ulna. Am J Surg 1937; 38: 332.
6. Lambrunidi C. Intramedullary Kirshner Wires in the treatment of fractures proceedings of Royal Society of Medicine 1939; 33: 153.
7. Anderson LD, Sisk TD, Tooms RE, Park W, I III. Compression: Plate fixation in acute diaphyseal fractures of radius and ulna. JBJS 1975; 57-A:287-297.
8. Chapman, Michael W, Gordon JE, Zissimos BS, Anthony G *et al*. Compression plate fixation of acute fractures of the diaphyses of radius and ulna. JBJS 1989; 71-A (2): 159-169.
9. Leung, Frankie, Shew-Ping Chow. A prospective, randomized trial comparing the LC-DCP with the point contact fixator for forearm fractures. JBJS 2003;85A (12): 2343-2348.
10. Mcknee MD, Seiler JG, Jupiter JB. The application of limited contact dynamic compression plate in the upper extremity. Analysis of 114 consecutive cases. Injury, 1995; 26 (10): 661-666.
11. Burwell HN, Arnold D. Charnley. Treatment of forearm fractures in adults with particular reference to plate fixation. JBJS 1964; 46-B (3), 404-424.
12. Moed, Berton R, Kellam James F, Foster Robert J, Tilemaa. Immediate internal fixation of open fractures of the diaphysis of forearm. JBJS 1986; 68 (7): 1008-1016.