

## A COMPARATIVE STUDY ON FIXATION OF FRACTURE SHAFT OF HUMERUS WITH LOCKING COMPRESSION PLATE AND DYNAMIC COMPRESSION PLATE

Mahesh Sagar Athinarapu<sup>1</sup>, Venkateswarlu Kurukunda<sup>2</sup>, Nagaraju Madiga<sup>3</sup>, Shyamdhara Tirumuru<sup>4</sup>, Srikar Jakkala<sup>5</sup>, Naveen Raj K<sup>6</sup>

<sup>1</sup>Junior Resident, Department of Orthopaedics, Kurnool Medical College, Kurnool, Andhra Pradesh.

<sup>2</sup>Professor, Department of Orthopaedics, Kurnool Medical College, Kurnool, Andhra Pradesh.

<sup>3</sup>Assistant Professor, Department of Orthopaedics, Kurnool Medical College, Kurnool, Andhra Pradesh.

<sup>4</sup>Assistant Professor, Department of Orthopaedics, Kurnool Medical College, Kurnool, Andhra Pradesh.

<sup>5</sup>Junior Resident, Department of Orthopaedics, Kurnool Medical College, Kurnool, Andhra Pradesh.

<sup>6</sup>Junior Resident, Department of Orthopaedics, Kurnool Medical College, Kurnool, Andhra Pradesh.

### ABSTRACT

#### BACKGROUND

The aim of this study was to compare the locking compression plate (LCP) over dynamic compression plate (DCP) in the management of diaphyseal fractures of the humerus. 38 patients with diaphyseal fracture of the shaft of the humerus were randomized prospectively and treated by open reduction and internal fixation with LCP or DCP. 11 patients underwent internal fixation by LCP and 27 by DCP. Fixation was done through an anterolateral or posterior approach. The outcome was assessed in terms of the union time, union rate, functional outcome, ROM and the incidence of complications. Functional outcome was assessed using the Romen's et al series grading system. On comparing the results by tests of significance like Chi-square test, there was no significant difference in Romen's et al scores between the two groups ( $P > 0.05$ ). Though the average union time and recovery of ROM was found to be better for LCP as compared to DCP, it is not statistically significant. Complications such as infection were found to be higher with DCP as compared to LCP. This study proves that LCP can be considered a better surgical option for the management of diaphyseal fractures of the humerus as it offers a short union time and lower incidence of serious complications like infection. However, there appears to be no difference between the two groups in terms of the rate of union and functional outcome.

#### MATERIALS AND METHODS

In this study, 27 patients of fracture shaft of humerus fixed by open reduction and internal fixation using dynamic compression plate were compared with 11 more patients treated by open reduction and internal fixation by locking compression plate. Functional outcome was assessed using Romen's et al scores and radiological findings were compared at 3, 6, and 12 months postoperatively.

#### RESULTS

In patients treated by DCP, 11 patients (41%) had excellent results, 15 patients (56%) had good results and 1 patient (3%) had poor results. In patients treated by LCP, 6 patients (55%) had excellent results and 5 patients (45%) had good results.

#### CONCLUSION

LCP has been shown to be advantageous over the conventional DCP in the osteoporotic bones. In younger patients, LCP produces visible callus and allows for early mobilization of fracture because of the stability of the implant.

#### KEYWORDS

Locking Compression Plate, Dynamic Compression Plate, Humerus Shaft Fracture.

**HOW TO CITE THIS ARTICLE:** Athinarapu MS, Kurukunda V, Madiga N, et al. A comparative study on fixation of fracture shaft of humerus with locking compression plate and dynamic compression plate. *J. Evid. Based Med. Healthc.* 2019; 6(9), 627-632. DOI: 10.18410/jebmh/2019/130

#### BACKGROUND

38 patients with diaphyseal fracture of the shaft of the humerus were randomized prospectively and treated by

*Financial or Other, Competing Interest: None.*  
*Submission 10-02-2019, Peer Review 13-02-2019,*  
*Acceptance 21-02-2019, Published 26-02-2019.*

*Corresponding Author:*

*Dr. K. Venkateswarlu,*  
*H. No. 50-760a, 127, 23-24,*  
*Gayatri Estates,*  
*Kurnool- 518002, Andhra Pradesh.*  
*E-mail: kvenkee66@gmail.com*  
*DOI: 10.18410/jebmh/2019/130*



open reduction and internal fixation with LCP or DCP. 11 patients underwent internal fixation by LCP and 27 by DCP. Fixation was done through an anterolateral or posterior approach. The outcome was assessed in terms of the union time, union rate, functional outcome, ROM and the incidence of complications. Functional outcome was assessed using the Romen's et al series grading system. On comparing the results by tests of significance like Chi-square test, there was no significant difference in Romen's et al scores between the two groups ( $P > 0.05$ ). Though the average union time and recovery of ROM was found to be better for LCP as compared to DCP, it is not statistically significant. Complications such

as infection were found to be higher with DCP as compared to LCP. This study proves that LCP can be considered a better surgical option for the management of diaphyseal fractures of the humerus as it offers a short union time and lower incidence of serious complications like infection. However, there appears to be no difference between the two groups in terms of the rate of union and functional outcome.

**Aims and Objectives**

1. To study the role of the dynamic compression plate and locking compression plate in the management of fracture shaft of the humerus.
2. To study the advantages of locking compression plate over dynamic compression plate (conventional plate).
3. To study the complications following fixation using a locking compression plate and the dynamic compression plate.

**MATERIALS AND METHODS**

It is a prospective comparative study which was carried out with patients who were operated from August 2016 and were up to October 2018 in Kurnool Govt. General Hospital attached to Kurnool Medical College, Kurnool. In this study, 27 patients of fracture shaft of humerus fixed by open reduction and internal fixation using dynamic compression plate were compared with 11 more patients treated by open reduction and internal fixation by locking compression plate.

**Inclusion Criteria**

- All adult patients with fracture shaft of the humerus.
- Patients who are medically fit for surgery.

**Exclusion Criteria**

- Compound fractures of humerus-type 3 and type 4
- Pathological fractures
- Patients with open physis and children
- Patients medically unfit for surgery

**Sample Size**

38 cases.

**Sample Procedure**

A prospective study and patients are followed up periodically postoperatively.

**Patients Assessed By**

Romen’s et al series grading system after treatment.

**Methodology**

After thorough radiological and clinical examination. The patients with humeral shaft diaphyseal fractures surgery was performed and the details of the surgical procedures as follows: After induction of anaesthesia. Skin was incised by either posterior or antero lateral approach, Fracture is exposed and reduced by either DCP or LCP.

**Post-Operative Regimen**

Post operatively suction drain was removed after 24 to 48 hours. Sutures are removed on 9<sup>th</sup> to 12<sup>th</sup> post-operative day

and check x-rays were taken in antero-posterior and lateral views. Appropriate analgesics and antibiotics were given till the time of suture removal. After suture removal, patients were discharged with an arm pouch and advised to perform shoulder, elbow wrist and finger movements.

All the patients were followed up at monthly intervals with a mean period of follow up of 6 months. One patient who developed non-union required follow up for 9 months until fracture get united with bone grafting. Functional evaluation was done using the Romen’s et al series grading system.

**RESULTS**

Our study comparing the results of DCP with the LCP in the treatment of Humeral shaft fractures at Kurnool Government General Hospital. 38 patients with fracture of humerus who were operated from August 2016 were followed up to October 2018 with a mean period of follow up of 6 months. One patient who developed nonunion required to follow up for 9 months until fracture get united with bone grafting. Out of this, 27 patients were treated using the DCP and 11 patients were managed with the LCP. We have not followed any criteria to fix the fracture by LCP or DCP.

Age in Years	Number of Patients	
	DCP (%)	LCP (%)
16-30	8 (29.62%)	1 (9.09%)
31-40	15 (55.55%)	2 (18.18%)
41-60	4 (14.82%)	8 (72.72%)
>60 Years	-0-	-0-
Total	27 (99.99%)	11 (99.99%)

**Table 1. Age Distribution Pattern**

Fisher’s p-value = 0.0023; S

Sex	Number of Patients	
	DCP (%)	LCP (%)
Male	20 (74.07%)	8 (72.72%)
Female	7 (25.92%)	3 (27.27%)
Total	27 (99.99%)	11 (99.99%)

**Table 2. Sex Distribution Pattern**

Fisher’s p-value = 0.93; NS

Mode of Injury	Number of Patients	
	DCP (%)	LCP (%)
RTA	14 (51.85%)	8 (72.72%)
Domestic Accidents and Falls	10 (37.03%)	3 (27.27%)
Assaults	3 (11.11%)	-0-
<b>Total</b>	<b>27(99.99%)</b>	<b>11(99.99%)</b>

**Table 3. Mode of Injury**

$\chi^2 = 0.66$ ;  $p=0.41$ ; NS

Associated Injuries	Number of Patients
Posterior Dislocation of Ipsilateral Hip With # Acetabulum	1
Ipsilateral # Both Bones Leg	1
Ipsilateral # Ulna	1
Head Injury	1
Ipsilateral #Clavicle	1
Radial Nerve Palsy	1
Total	6/38 patients

**Table 4. Associated Injuries**

Side	Number of Patients	
	DCP (%)	LCP (%)
Right	12 (44.44%)	4 (36.36%)
Left	15 (55.55%)	7 (63.63%)
Total	27 (99.99%)	11 (99.99%)

**Table 5. Side Affected**

Fisher's p-value = 0.64; NS

G. A. Classification	Number of Patients	
	DCP	LCP
Type I	1	1
Type II	1	2
Total	2	3

**Table 6. Compound Fracture Pattern**

Level of Fractures	Number of Patients	
	DCP (%)	LCP (%)
Proximal Middle 1/3	2 (7.41%)	2 (18.18%)
Middle 1/3	7 (25.92%)	5 (45.45%)
Middle 1/3 – Distal 1/3	18 (66.66%)	4 (36.36%)
Distal 1/3	0	-0-
Total	27(99.99%)	11 (99.99%)

**Table 7. Distribution of Fracture Level**

$\chi^2 = 3.04$ ; p=0.21; NS

Type	Number of Patients	
	DCP (%)	LCP (%)
12A1	2 (7.41%)	1 (9.09%)
12A2	8 (29.62%)	1 (9.09%)
12A3	10 (37.04%)	-0-
12B1	-0-	1 (9.09%)
12B2	7 (25.92%)	4 (36.36%)
12B3	-0-	4 (36.36%)
Total	27 (99.99%)	11 (99.99%)

**Table 8. Fracture Classification**

Type	Number of Patients	
	DCP (%)	LCP (%)
Transverse	12 (44.45%)	1 (9.09%)
Long Oblique	1 (3.7%)	1 (9.09%)
Short Oblique	7 (25.92%)	-0-
Comminuted	6 (22.22%)	9 (81.81%)
Segmental	1 (3.7%)	-0-
Total	27 (99.99%)	11 (99.99%)

**Table 9. Fracture Type**

Anaesthesia	Number of Patients	
	DCP (%)	LCP (%)
G.A.	8	3
B.P.B.	19	8
Total	27 (99.99%)	11 (99.99%)

**Table 10. Anaesthesia**

Duration in Weeks	Number of Patients	
	DCP (%)	LCP (%)
≤14 Weeks	2 (7.41%)	4 (36.36%)
14-18 Weeks	19 (70.36%)	7 (63.63%)
18-22 Weeks	5 (18.52%)	-0-
>22 Weeks	1 (3.7%)	-0-
Total	27 (99.99%)	11 (99.99%)

**Table 11. Time of Union of The Fracture**

$\chi^2 = 6.65$ ; p=0.07; NS

Level of Injury	Delayed Union	Nonunion
P/3 - M/3	-0-	-0-
M/3	2	1
M/3 - D/3	3	-0-
D/3	-0-	-0-
Total	5	1

**Table 12. Relations of The Level of Injury with Delayed and Non-union**

Type	Type of Union	
	Delayed Union	Nonunion
Transverse	2	-0-
Long oblique	-0-	-0-
Short oblique	1	-0-
Comminuted	1	1
Segmental	1	-0-
Total	5	1

**Table 13. Relationship of The Type of Fracture with Delayed and Nonunion**

ROM	Number of Cases	
	DCP (%)	LCP (%)
Excellent	14 (51.85%)	6 (54.54%)
Good	12 (44.44%)	5 (45.45%)
Poor	1 (3.7%)	0
Total	27 (99.99%)	11 (99.99%)

**Table 14. Range of Movements**

$\chi^2 = 0.0015$ ; p=0.96; NS

Infection	Number of Patients	
	DCP	LCP
Superficial	-0-	2
Deep	4	0
Total	4	2

**Table 15. Infection**

Result	Number of Cases	
	DCP (%)	LCP (%)
Excellent	12 (44.44%)	5 (45.45%)
Good	14 (51.85%)	6 (54.54%)
Poor	1 (3.7%)	0
<b>Total</b>	<b>27 (99.99%)</b>	<b>11 (99.99%)</b>

**Table 16. Functional Assessment**

$\chi^2 = 0.0015$ ;  $p=0.96$ ; NS

**DISCUSSION**

Concepts in the management of trauma in Orthopaedics are very rapidly changing to keep pace with the increasing severity and complexities of the fractures. Patients with osteoporosis are at a greater risk for delayed union or nonunion following plate fixation of a humeral diaphyseal or meta-diaphyseal fracture because of poor screw purchase or loosening. Many studies have shown the mechanical advantage of LCP over the conventional fixation. Many lab

**Age Incidence**

Series	Year	Total No. of Patients	Average Age
McCormack RG et al <sup>2</sup> (DCP Vs IMN)	2000	44	49
Wilairatana V, Prasongchin P <sup>3</sup> (DCP)	2001	21	29
<b>Present Study</b>			
DCP	2018	27	35
LCP		11	43

**Table 17. Age Incidence in Various Studies**

The average age of the patients studied in various series and in our study series was approximately coinciding especially with the studies of Mc Cormack RG et al. Patients treated by dcp were relatively younger and those treated by LCP were of relatively elder.

**Sex Distribution**

There was a definitive male predominance in both groups of our study series. This may be due to the fact that males were more often involved in outside activities and had increased chances of road traffic accidents which is the

studies using saw bones and cadaveric models have tried various permutations and combinations of screw fixation and found that after cyclic loading, the unlocked screw constructs had significantly lower stability compared with both the locked and hybrid constructs.<sup>1</sup>

Our study was done to evaluate the efficacy of locking compression plate (LCP) over the dynamic compression plate (DCP) in the treatment of the shaft of humerus. 27 patients treated by dynamic compression plate after open reduction and internal fixation was compared with 13 patients who were treated by locking compression plate. We selected patients who were operated from August 2016 and were followed up to October 2018 with a mean follow up period of 6 months. One patient who had nonunion required to follow up for 10 months (until the fracture is united). We have not followed any criteria to fix the fracture by LCP or DCP.

We evaluated our results and compared them with those obtained by various other studies utilizing different modalities of treatment. Our analysis is as follows: most common cause for the fractured humerus as per our study.

Series	Year	M:F Ratio	% of Males
Strong GT, Walls N, McQueen MM <sup>4</sup> (Studied Epidemiology)	1998	111:138	44.6
Tingstad EM et al <sup>5</sup> (DCP)	2000	44:38	53.6
McCormack RG et al <sup>2</sup> (DCP Vs IMN)	2000	28:16	63.6
Wilairatana V, Prasongchin P <sup>3</sup> (DCP)	2001	16:5	76.2
<b>Present Study</b>			
DCP	2018	20:7	74
LCP		8:3	72

**Table 18. Sex Incidence in Various Studies**

**Mode of Injury**

Road traffic accidents are the most common cause of humeral shaft fractures in our study, consisting of 22 patients (58%) followed by domestic accidents and falls of 13 cases (35%) and assaults of 3 cases (11.11%).

Series	Year	Total No. of Patients	Commonest Mode of Injury
Strong GT, Walls N, McQueen MM <sup>4</sup> (Studied epidemiology)	1998	249	RTA
Tingstad EM et al <sup>5</sup> (DCP)	2000	83	RTA
McCormack RG et al <sup>2</sup> (DCP Vs IMN)	2000	44	RTA
Dayez J <sup>6</sup> (DCP)	1999	36	RTA and Sports
<b>Present Study</b>			
DCP	2018	27	RTA (51.85%)
LCP		11	RTA (72.72%)

**Table 19. Mode of Injury in Various Studies**

**Side Affected**

In our total study group, the left arm was predominantly affected.

Study	Right (%)	Left (%)
Heim D et al (1993) <sup>7</sup> (DCP)	43.9	55.1
Strong GT, Walls N, McQueen MM (1998) <sup>4</sup> (Studied Epidemiology)	44.2	55.8
<b>The Present Study (2018)</b>		
DCP	44 (12 pts)	56 (15 pts)
LCP	36 (4 pts)	64 (7 pts)

**Table 20. Side Affected in Various Studies**

**Site of Fracture**

In our total study group, most of the fractures were noted at the middle 1/3-distal 1/3 junction same was reciprocated in the DCP group but in the LCP group fractures were most commonly noted at the middle 1/3 level.

Series	Year	Total No. of Patients	Commonest Site Affected	No. of Cases
Klenerman L <sup>8</sup> (DCP)	1966	98	Middle Third	44 (44.9%)
Bell MJ et al <sup>9</sup> (DCP)	1985	38	Upper Third and Middle	15 (38.5%)
Griend RV, Tomasin J, Ward et al <sup>10</sup> (DCP)	1999	36	Middle Third	23 (63.9%)
Strong GT, Walls N, and McQueen MM <sup>4</sup> (Studied Epidemiology)	1998	249	Middle Third	160 (64.2%)
<b>Present Study</b>				
DCP	2018	27	Middle 1/3 <sup>rd</sup> Distal 1/3 <sup>rd</sup>	18 (67%)
LCP		11	Middle 1/3 <sup>rd</sup>	5(45%)

**Table 21. Site of Fracture**

**Fracture Union**

Series	Total No. of Patients	Delayed Union	Nonunion	Overall Results
Klenerman L (1966) <sup>8</sup> (DCP)	98	8 (8.2%)	-	98 (100%)
Bell MJ et al (1985) <sup>9</sup> (DCP)	34	-	1 (3%)	33 (97%)
Griend RV, Tomasin J, Ward et al (1999) <sup>10</sup> (DCP)	36	5(14.6%)	1 (3%)	35 (97%)
RING et al (2004) <sup>11</sup> (LCP)	24	2(8%)	--	22 (92%)
<b>The Present Study (2018)</b>				
DCP	27	5(19%)	1 (3.7%)	21 (96.3%)
LCP	11	0	0	11 (99.99%)

**Table 22. Fracture Union Rate Obtained in Various Studies**

**Overall Results**

In patients treated by DCP, 11 patients (41%) had excellent results, 15 patients (56%) had a good result and 1 patient (3%) had a poor result. In patients treated by LCP, 6 patients (55%) had excellent results and 5 patients (45%) had good results.

Study	Year	No. of Patients	Method of Treatment	Excellent/Good Results (%)
Heim D et al <sup>7</sup>	1993	127	DCP	87.3
McCormack RG et al <sup>2</sup>	2000	44	DCP & Intramedullary Nail Fixation	95.7
Tingstad EM et al <sup>5</sup>	2000	44	DCP	94
Ring et al <sup>11</sup>	2004	24	LCP	92
<b>Present Study</b>				
DCP	2018	27	DCP	96.3
LCP		11	LCP	99.9

**Table 23. Overall Results Obtained in Various Studies**

From this, the results of our both the groups appear to be same as with the other study series and the results of both the groups are approximately equal and the same.

We are aware of the limitations of our study. Though the total number of patients treated by LCP were small in number, all the patients had excellent to good results. None of the patients who were treated by LCP had poor results. As per biomechanics, the screws of LCP virtually act as pegs resisting axial, rotational, translational and bending forces. Because of more stability of the implant and intact periosteum producing early callus and primary fracture union producing visible callus allows early mobilization of joints around the fracture. The only limiting factor with the usage of LCP regularly is the cost of the implant.

### CONCLUSION

1. LCP has been shown to be advantageous over the conventional DCP in osteoporotic bones, but there is no significant advantage of its use in the younger patients.
2. The results obtained by LCP are comparable with that obtained by DCP in younger patients. Moreover, LCP produces visible callus and allows for early mobilization of fracture because of the stability of the implant.
3. Limiting factor for regular use of LCP is its cost, but it can be overcome by increasing the use of LCP in the treatment of humeral shaft fractures, which ultimately paves way for a reduction in the prices of LCP.
4. Further studies with larger sample are required to comprehensively prove the advantages of LCP over DCP in the overall population at large.

### REFERENCES

- [1] Gardner MJ, Griffith MH, RH, Demetrakopoulos D, et al. Hybrid locked plating of osteoporotic fractures of the humerus. *J Bone Joint Surg Am* 2006;88(9):1962-1967.
- [2] McCormack RG, Brien D, Buckley RE, et al. Fixation of fracture shaft of the humerus by dynamic compression plate or intramedullary nail. A prospective, randomised trial. *J Bone Joint Surg Br* 2000;82(3):336-339.
- [3] Wilairatana V, Prasongchin P. The open reduction and internal fixation of humeral diaphysis fracture treatment with a medial approach. *J Med Assoc Thai* 2001;84 Suppl 1:423-427.
- [4] Tytherleigh-Strong G, Walls N, McQueen MM. The epidemiology of humeral shaft fracture. *J Bone Joint Surg Br* 1998;80(2):249-253.
- [5] Tingsted EM, Wolinsky PR, Shyr Y, et al. Effect of immediate weight bearing on plated fractures of the humeral shaft. *J Trauma* 2001;49(2):278-280.
- [6] Deyez J. Internal screwed plate for recent fractures of humeral diaphysis in adults. *Rev Chir Orthop Reparatrice Appar Mot* 1999;85(3):238-244.
- [7] Heim D, Herkart F, Hess P, et al. Surgical treatment of humeral shaft fractures--the basal experience. *J Trauma* 1993;35(2):226-232.
- [8] Klenerman L. Fractures of the shaft of the humerus. *J Bone Joint Surg Br* 1966;48(1):105-111.
- [9] Bell MJ, Beauchamp CG, Kellam JK, et al. The results of plating humeral shaft fractures in patients with multiple injuries. *J Bone Joint Surg Br* 1985;67(2):293-296.
- [10] Vander Griend R, Tomasin J, Ward EF. Open reduction and internal fixation of humeral shaft fractures. Results using AO plating techniques. *J Bone Joint Surg Am* 1986;68(3):430-433.
- [11] Ring D, Kloen P, Kadzielski J, et al. Locking compression plates for osteoporotic nonunions of diaphyseal humerus. *Clin Orthop Relat Res* 2004;425:50-54.