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Study of role of limited contact dynamic compression plates versus locking plates in long bone fracture management

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ABSTRACT

Background: Present study was conducted to assess the functional, radiological, clinical factors associated with long bone fractures stabilized with limited contact dynamic compression plating (LC-DCP) and locking plates.
Methods: In this retrospective observational study conducted over 2 years, 60 osteoporotic patients undergoing surgery for diaphyseal fractures of long bones at the study centre were studied. Two groups were formed on the basis of usage of LC-DCP plate or the locking plate in fracture management. Participants were thoroughly evaluated clinically. Radiographic assessments included evaluation of callus formation and fracture fragments after the functional load. Functional outcome was assessed based on the range of movements and the ability to carry out daily activities. Disabilities of the arm, shoulder and hand (DASH) score was also calculated. Post-operative follow-ups were conducted at 6 weeks, 12 weeks and 1 year.
Results: Radius or ulna were the commonest site of fracture with more than half (35, 58.33%) patients affected with 93.3% having middle 1/3rd diaphysis fracture. There were no significant differences between the genders for site or location of fractures. DASH scores were comparable in both groups. The mean union time was significantly higher among females (9.76±2 weeks) than males (8.59±1.21 weeks). Most patients took 14-16 weeks to achieve the functional outcome, with LC-DCP observed to provide faster functional recovery.
Conclusions: Radius or ulna fractures are the commonest amongst long bone fractures, with middle 1/3rd diaphysis being the commonest site of affection. LC-DCP facilitates slighty faster fracture union and functional recovery than locking plates, with union time being significantly longer in females.

Keywords: Limited contact dynamic compression plates, Locking plates, Long bone fracture, Union time, Functional outcome, DASH score

INTRODUCTION

Traumatic orthopaedic injuries are increasing exponentially with the almost universal usage of motorised vehicles.[1] Following trauma, long-bone fractures is the most common non-fatal injury worldwide, with the overall incidence estimated to be as high as 406 per 100,000 population per year.[2] Thus, it is imperative that we manage these injuries promptly and appropriately.

The use of surgical and other interventions in fracture management is mainly to properly align the bone, provide stability and allow the bone to heal itself; a process which begins almost as soon as the fracture happens. Compression plating is most commonly used for rigid

fracture fixation and depends on securing the screw in bone and the frictional force between the plate and bone.[3] Decreased vascularity, necrosis, bone resorption, and increased infection rates are some of the issues that arise due to contact between the plate and the bone and all of these factors increase complication rates in the form of rate of infection, re-fracture, delayed union, and non-union.[4] The large contact surface of plate and bone in dynamic compression plating (DCP) interferes with cortical perfusion leading to cortical porosis and possible re-fractures. Keeping this in mind, the limited contact DCP (LC-DCP) was developed to limit contact between the bone and plate to reduce the interference with cortical perfusion, which did sort out the issues, but only partially.[5]

Off-late, locking plates are being hypothesized to be ideal for fixing diaphyseal fractures in osteoporotic bone due to its improved biomechanics.[6] Locking plates offer enhanced stability of the internal fixation, especially in osteoporotic bones, and comminuted or highly unstable fractures compared to the conventional compression plates.[4,5] Although locking plates have become commoner in clinical practice to fix diaphyseal osteoporotic bone, clinical studies verifying their efficacy vis-à-vis DCP are scarce, especially from this part of the world. Hence, a study was planned with the objective of comparative analysis of LC-DCP vs. locking plates in the management of diaphyseal fractures of radius, ulna and humerus using functional, radiological and clinical outcome measures.

METHODS

This was a retrospective observational study conducted at D. Y. Patil Hospital, Nerul, Navi Mumbai (a tertiary care centre in Western India) over the period of two years (July 2015 to June 2017). The study population consisted of osteoporotic patients who underwent surgery for diaphyseal fractures of long bones at the study centre.

Following selection criteria were employed for participant recruitment:

- Patients above the age of 25 years.
- Patients with closed fractures.
- Patients with mild to moderate degree of comminution.
- Patients with osteoporotic fractures stated with Singh's index <3.[7]
- Patients with DEXA scan results <1.5.
- Patients willing to give written consent

A total of 60 participants fulfilling the selection criteria were finally enrolled in the study. The study was initiated after necessary obtaining necessary from the institutional ethics committee and written informed consent from each of the participants.

Two groups were formed on the basis of usage of LC-DCP plate or the locking plate in the fracture management. All the participants were clinically assessed with the help of detailed history and examination. Various subjective and objective parameters were evaluated thoroughly as part of clinical assessment. The subjective parameters included factors such as pain, functional limitations and occupational considerations etc., while objective evaluation included inspection of the forearm for deformity, tenderness, abnormal mobility of the joints above and below the fractures and measurement of range of movements extending from shoulder to digits of the affected arm. The radiographic assessments included evaluation of callus formation and the fracture fragments after the functional load. The functional outcome was assessed based on the range of movements and the ability to carry out day to day activities. The Disabilities of the arm, shoulder and hand (DASH) score was calculated as per guidelines.[8] Post-operative follow ups were conducted at 6 weeks, 12 weeks and 1 year. At every visit the patients was assessed thoroughly using both clinical, radiological and functional examination to evaluate the progress. All the patients were started on elementary calcium 1 gm per day and vitamin D supplementation. Sixty thousand I.U per week for 8 weeks. The patients were advised to carry out exercises of the shoulder, elbow, wrist and the digits of the affected arm throughout the follow up period.

The data entry and analysis was performed using the SPSS-version 16 software (SPSS Inc., Chicago, IL, USA). Chi-square test was used to analyse and compare categorical data between the two groups. Pearson correlation test was used for parametric correlation analysis while Spearman correlation test was used to analyze non-parametric correlation.

RESULTS

A total of 60 osteoporotic patients who underwent surgery for diaphyseal fractures of long bones and fulfilled the study selection criteria were considered for analysis. Out of this, 35 (58.33%) were ≤45 years of age and 25 (41.7%) were >45 years of age, with significant male preponderance (65% were males and 35% were females).

On history, it was noted that 27 (45%) participants had suffered high velocity injury and 33 (55%) had suffered low velocity injury. Right side (40, 66.67%) was more commonly affected than the left (20, 33.33%). Radius/ulna were the commonest site of fracture with more than half (35, 58.33%) patients affected. As many as 93.3% had middle 1/3rd diaphysis fracture and 6.7% had distal 1/3rd diaphysis fracture, with significant difference in the proportion of patients depending on the locations of fracture. There were no significant differences between the genders for side, site or location of fractures (Table 1).

Table 1: Side, site and location of fracture among study participants.

	Number (n=100)	Percentage (%)	P value
Side of fracture			
Right	40	66.67	<0.05
Left	20	33.33	
Site of fracture			
Radius/ulna	35	58.34	<0.05
Humerus	23	38.33	
Radius	2	3.33	
Location of fracture			
Middle 1/3rd diaphysis	56	93.33	<0.001
Distal 1/3rd diaphysis	4	6.67	

LC-DCP plate was used in 32 (53.33%) patients, while locking plate was used in 28 (46.67%) patients and 40% were on regional block anaesthesia and 60% were on general anaesthesia. The present study recorded DASH score between 1-50 in 87.5% with LC-DCP plate and 82.1% with locking plate; and DASH score between 51-100 in 12.5% with LC-DCP plate and 17.8% with locking plates. No significant difference in the DASH score was found with the usage of the two types of plates (p=0.562).

The present study recorded a mild VAS score (0-4) in 69.2% males and 52.4% females; a moderate VAS score (5-7) in 25.6% males and 47.6% females; and a severe VAS score (8-10) in 5.1% males. No significant difference in the VAS scores was found between the genders.

The vitamin D3 levels recorded in the present study were as follows: 56.7% were deficient, 36.7% were had insufficient levels, 6.7% had normal levels, and none showed toxic levels. In patients treated with LC-DCP, vitamin D3 levels were: deficient in 37.5%, insufficient in 50% and normal in 12.5% and in patients treated with locking plates, the levels were: deficient in 78.6% and insufficient in 21.4%; with a significant difference in the Vitamin D3 levels recorded in patients treated with the two different types of plates.

The mean union time recorded in the present study was 8.59±1.21 weeks (LC-DCP: 8.29±1.02 weeks; locking plate: 9.07±1.29) in males and 9.76±2 weeks (LC-DCP: 9.62±2.29 weeks; locking plate: 9.85±1.70) in females. The difference in the mean union time between the genders was found to be significant. Amongst our study population, the mean union time in patients with deficient vitamin D3 levels were 9.26±1.74 weeks, insufficient vitamin D3 levels were 8.54±1.08 weeks and those with normal vitamin D3 levels were 9.25±2.16 weeks; with no significant difference in the union time taken by the patients having different vitamin D3 levels.

Table 2: Fracture union time among study participants.

	Union time (in weeks)		
	Mean	SD	P value
Gender			
Males			
LC-DCP	8.29	1.02	0.0064
Locking plate	9.07	1.29	
Males total	8.59	1.21	
Females			
LC-DCP	9.62	2.29	
Locking plate	9.85	1.70	
Females total	9.76	2.00	
Vitamin D3 levels			
Normal	9.25	2.16	0.32
Insufficient	8.54	1.08	
Deficient	9.26	1.74	
Total	9	1.62	

The time taken to achieve functional outcome was as follows: 26 participants took 12 to 14 weeks to get back to functional outcome; out of which maximum (20, 76.92%) belonged to LC-DCP group. Twenty eight participants took 14-16 weeks for the same, with most belonging to locking plate group (19, 67.86%) (Table 3).

Table 3: Functional outcome assessment.

Back to functional outcome time (in weeks)	N	LC-DCP	Locking plate
		N (%)	N (%)
12 to 14	26	20 (76.92)	6 (23.08)
14 to 16	28	9 (32.14)	19 (67.86)
16 to 18	1	0	1 (100)
18 to 20	4	3 (75)	1 (25)
20 to 22	1	0	1 (100)
Total	60	32	28

The present study reported no complications in 55 (91.7%) participants, while infection was found to have occurred in 5 (8.3%) participants.

DISCUSSION

The present study was undertaken to study the alignment of bone fractures and to evaluate correlation and biomechanical outcomes in osteoporotic long bone fractures stabilized with LC-DCP and locking plates; along with assessment of the functional, radiological, clinical factors and complications associated with the diaphyseal fractures of the radius ulna. Other objectives of the study were to assess the and mobility of the affected limb's joints and to conduct a retrospective study of diaphyseal long bone fracture patients treated with LC-DCP and locking plates. A total of 60 patients were enrolled and studied.

Amongst total study participants, 35 (58.33%) were ≤45 years of age and 25 (41.7%) were >45 years of age, with significant male preponderance. Meling et al, in a study among patients with long bone fractures, reported median age of 41 years with 41% male and 59% female participants.[2] Sharma et al, in a similar study, reported 86.7% to be males and 13.3% to be females, with mean age of 38 years.[9] The age and gender distribution is comparable to the results observed in previous studies.

With respect to the mode of injury, 45% had suffered high velocity injury and 55% had suffered low velocity injury. Similarly, Leung reported 43% had high energy trauma and 57% had low energy trauma, a finding confirmed in a larger study by the same author 3 years later.[10,11] Two third of the participants had injury on the right side, which is comparable to the findings of Meling et al and Meena et al.[2,12] Radius and ulna were the commonest site of fracture with more than half (35, 58.33%) patients affected. Leung F et al had also reported fractures of the radius and ulna to be the most common, with radius fracture in 32.6%, ulna fracture in 31.5% and both in 35.9%.[10] Significantly higher number of patients had middle 1/3rd diaphysis fracture in the present study.

Almost half (53.3%) patients were treated with LC-DCP with the other half (46.7%) being treated with locking plates. The present study recorded DASH score between 1-50 in 87.5% with LC-DCP plate and 82.1% with locking plate; and DASH score between 51-100 in 12.5% with LC-DCP plate and 17.8% with locking plates. No significant difference in the DASH score was found with the usage of the two types of plates. A study by Azboy et al in patients with diaphyseal forearm fractures found a mean DASH score of 14 among patients treated with LCP and in DCP group the DASH score was 18.[5] Meena RK et al in their study observed the DASH raw score to range between 0 to 24.2 in LCP group and 0 to 38.4 in LC-DCP group.[12] Plecko et al, in a study among patients undergoing fixed angle plating to treat proximal humerus fracture, had recorded mean DASH score of 18.[13] Thus, with most of the patients with DASH scores in between 1 to 50, the observations sit pretty with available evidence, although we did find patients with scores higher than 50 as well.

The mean union time recorded in the present study was 8.59±1.21 weeks (LC-DCP: 8.29±1.02 weeks; locking plate: 9.07±1.29) in males and 9.76±2 weeks (LC-DCP: 9.62±2.29 weeks; locking plate: 9.85±1.70) in females, with females taking significantly longer time for fracture union. Azboy et al had reported a mean union time to be 15 weeks in patients treated with LCP and 17 weeks in those treated with DCP.[5] Leung reported a mean union time of 20 week in the participants who were treated with LCP.[11] Ahmad et al, in a case series among patients treated with locking plates for distal tibia fracture, found the mean union time to be 23.1 weeks.[14] A study by Saikia et al on patients with forearm fractures reported the mean union time to be 14.16 weeks in LCP group and 16.27 weeks in the LC-DCP group.[15] A study by Reddy et al among patients with forearm fractures reported mean union time to be 18 weeks in LCP group as against 16 weeks in LC-DCP group.[16] Most of the studies also observed longer union time in females.[14-16] Thus, our findings are largely corroborative of available evidence. The duration taken by patients treated with LC-DCP to get back to functional outcome was observed to be slightly lesser than locking plates.

In conclusion, it can be said that radius/ulna are the commonest amongst long bone fractures, with majority having middle 1/3rd diaphysis fracture. LC-DCP facilitates slighter faster fracture union and functional recovery than locking plates, with union time being significantly longer in females.

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