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ORIGINAL ARTICLE

Comparison of Dynamic and Locking Compression Plates in Humeral Shaft Fractures

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ABSTRACT

Objectives: To compare the functional outcome of shoulder in humeral shaft fractures fixed with dynamic compression plate versus locking compression plate.

Design: This was an RCT (randomized controlled trial).

Study Settings: It was conducted at the Orthopedic Department of Sir Ganga Ram Hospital Lahore over 1 year from March 2018 to February 2019.

Study Procedure: This study involved 62 both male and female patients aged between 18-60 years presenting in orthopedic emergency with humeral shaft fracture. These patients were assigned into two treatment groups randomly. Fracture in Group-A was fixed with dynamic compression plate while locking compression plate was used in Group-B. Outcome variable was functional shoulder outcome which was assessed after 12 weeks of treatment using Modified Constant and Murley Score. An informed written consent was gained from every patient.

Results: The mean age of the patients was 42.6±12.7 years. There were 45 (72.6%) male and 17 (27.4%) female patients in the study group with a male to female ratio of 2.6:1. The mean BMI of these patients was 27.9±3.4 Kg/m^2 and 17 (27.4%) patients were obese. Left side was more frequently involved (53.2%) as compared to the right side (46.8%). Upon follow-up, the Modified Constant and Murley score was significantly higher in patients treated with DCP as compared to LCP (91.3±7.4 vs. 85.8±8.3; p-value=0.008). The frequency of excellent functional shoulder outcome was significantly higher in patients treated with DCP as compared to LCP (87.1% vs. 54.8%; p-value=0.005). When stratified similar difference was observed across various subgroups of patients based on patient's age, gender, side involved, duration since injury and BMI.

Conclusion: Dynamic compression plate was associated with significantly better functional shoulder outcome as compared to locking compression plate in patients with humeral shaft fractures regardless of patient's age, gender, duration since injury, side involved and BMI which along with cheaper hardware cost advocates its preferred use in future practice.

Keywords: Humeral Shaft Fracture, Locking Compression Plate, Dynamic Compression Plate, Functional Shoulder Outcome

INTRODUCTION

Humeral shaft fractures are extra-articular fractures involving diaphysis and among all fractures observed during orthopedics practice, it comes to 3%. Simple fall is usual cause of these fractures particularly in old age besides other causes like sports injuries, RTAs (road traffic accidents), falling from height and direct blow.[1] During last ten years, due to development of improved techniques of operations, these fractures are being handled in a better way.[2] However, various complications are associated with different techniques that includes deep and superficial infections, stiffness of elbow and shoulder, pseudarthrosis, radial nerve palsy, injuries of bicep tendon and supraspinatus, failure of implant etc.[2,3] Injury to the muscles and stiffness of shoulder joint subsequent to humeral shaft fractures and the option chosen for treatment are points of serious concern.[3] Followed by conservative treatment, prolonged immobilization results in stiffness while attempt for early rehabilitation through operative fixation for avoiding stiffness is at the cost of injury to soft tissues and muscles that ultimately reduces function of the shoulder.[3] That's why, prior to planning treatment of humeral shaft fracture, it is imperative to consider existing functioning position of the patient, functional requirements by the patients and patients choice of treatment method. Hence, comparing function of shoulder among various non-operative and operative techniques is yet an area of scorching research.[4-7] With the use of DCP (dynamic compression plate), evaluation of treatment of humeral shaft fractures was made by Vijayashankar et al.[8] (2016) with the help of Modified Constant and Murley score. Excellent functional outcome of shoulder was reported by the author in 91.0% patients. The results of LCP (locking compression plate) were evaluated by Li et al.[9] (2015) in fractures of humeral shaft with the help of Modified Constant and Murley score and in 60.86% cases excellent functional outcome of shoulder was observed.

Thus, in comparison with LCP, DCP appears a better option in reference with functional outcome of shoulder. In another study, Maher et al.[10] (2014) reported excellent functional shoulder outcome with DCP in 60% cases while comparatively better results were exhibited by Govindasamy et al.[11] with LCP who reported excellent functional shoulder outcome in 78.0% cases claiming LCP to be superior to DCP as far as shoulder functional outcome was concerned.

Presently not even a single study has made comparison of functional outcome of shoulder in a single trial between these two techniques. Owing to controversies in the existing literature[7-11] and lacking randomized controlled trial, this study aimed to compare these two implants in reference with shoulder joint functional outcome. In future, results from the present study will help in better management of patients suffering from humeral shaft fractures.

Study Procedure: The present study was a randomized controlled trial carried out at Orthopedic Department of Sir Ganga Ram Hospital Lahore over 1 year from March 2018 to February 2019. Sample size of 62 cases (31 cases in each group) was calculated with 80% power of test and 95% confidence interval (2-sided) while taking expected frequency of excellent functional shoulder outcome to be 91.0% with DCP and 60.86% with LCP in treating humeral shaft fractures.[8,9] Non-probability, consecutive sampling was done and patients of both genders with ages in the range of 18-60 years presenting with humeral shaft fractures (patients presenting with pain and deformity of upper arm after trauma having radiological evidence of fracture involving the humeral shaft i.e. the part of humerus from 7.7 centimeters below the surgical neck and 8.7 cm above the olecranon fossa) were included after taking an informed written consent. Patients were considered if they presented within 4 weeks of injury. Those with multiple fractures, metabolic bone disease, skeletal dystrophy or congenital anomaly were excluded. We also excluded patients with frozen shoulder and history of bone malignancy. All the patients had comprehensive clinical assessment comprising of detailed history and clinical examination. These patients were randomly divided into two treatment groups using lottery method. Fracture in Group-A was fixed with dynamic compression plate while locking

compression plate was used in Group-B. Patients in both the groups underwent surgery and after reduction, fracture was stabilized with DCP or LCP as per treatment group. Post-operatively, the arm was rested in a poly sling and patients received routine course of 2 weeks of antibiotics and oral analgesics. After 2 weeks, stitches were removed and physiotherapy was commenced. Modified Constant and Murley Score was evaluated 12 weeks after treatment. Outcome was assessed in terms of excellent score (86 – 100). All the surgeries were performed by a single surgical team and all the pre and post-operative care as well as patient evaluation of constant score was done by a single researcher to eliminate bias. Confounding factors were addressed by exclusion. The sampled data was analyzed using Statistical Package for the Social Sciences (SPSS) version 23.0. Mean and standard deviation was determined for numerical variables like age, BMI, time since injury and constant score while categorical variables such as gender and side (right and left) and excellent functional outcome were described in frequency and percentage. Mean of constant score was compared between the study groups using t-test while chi-square test was applied for comparison of excellent functional outcome considering p≤0.05 as significant. Data was stratified for age, gender, BMI, time since injury and side (right and left) to defy effect modifiers. Following stratification chi-square test was re-applied taking p≤0.05 as significant.

RESULTS

The age of the patients ranged from 18 years to 60 years with a mean of 42.6±12.7 years. Majority (61.3%) of the patients were aged between 40-60 years followed by 18-39 years (38.7%). There were 45 (72.6%) male and 17 (27.4%) female patients in the study group with a male to female ratio of 2.6:1. The BMI of these patients ranged from 21.1 Kg/m^2 to 33.9 Kg/m^2 with a mean of 27.9±3.4 Kg/m^2. 17 (27.4%) patients were obese. Left side was more frequently involved (53.2%) as compared to the right side (46.8%). The duration since injury ranged from 1 week to 4 weeks with a mean of 2.4±0.97 weeks as shown in Table 1. Both the study groups were comparable in terms of mean age (p-value=0.922), mean duration since injury (p-value=0.897), mean BMI (p-value=0.987) and age (p-value=0.602), gender (p-value=0.776), side (p-value=0.799), time since injury (p-value=1.000) and BMI (p-value=0.939) groups distribution as shown in Table 2. Upon follow-up, the Modified Constant and Murley score was significantly higher in patients treated with DCP as compared to LCP (91.3±7.4 vs. 85.8±8.3; p-value=0.008) as shown in Table 3.

Table 1: Demographic Features of Studied Patients

Characteristic	Study Cohort n=62
Age (years)	42.6±12.7
• 18-39 years	24 (38.7%)
• 40-60 years	38 (61.3%)
Gender	
• Male	45 (72.6%)
• Female	17 (27.4%)
BMI (Kg/m^2)	27.9±3.4
• 20-25 Kg/m^2	15 (24.2%)
• 25-30 Kg/m^2	30 (48.4%)
• 30-35 Kg/m^2	17 (27.4%)
Side	
• Right	29 (46.8%)
• Left	33 (53.2%)
Duration since injury (weeks)	2.4±0.97
• 1-2 weeks	32 (51.6%)
• 3-4 weeks	30 (48.4%)

The frequency of excellent functional shoulder outcome was significantly higher in patients treated with DCP as compared to LCP (87.1% vs. 54.8%; p-value=0.005) as shown in Table 4. When stratified similar difference was observed across various subgroups of patients based on patient's age, gender, side, duration since injury and BMI as shown in Table 5.

Table 2: Demographic Features of Studied Groups n=62

Characteristic	DCP n=31	LCP n=31	P-value
Age (years)	42.5±12.9	42.8±12.8	0.922
• 18-39 years	11 (35.5%)	13 (41.9%)	0.602
• 40-60 years	20 (64.5%)	18 (58.1%)	
Gender			
• Male	23 (74.2%)	22 (71.0%)	0.776
• Female	8 (25.8%)	9 (29.0%)	
BMI (Kg/m^2)	27.9±3.3	27.9±3.6	0.987
• 20-25 Kg/m^2	8 (25.8%)	7 (22.6%)	0.939
• 25-30 Kg/m^2	15 (48.4%)	15 (48.4%)	
• 30-35 Kg/m^2	8 (25.8%)	9 (29.0%)	
Side			
• Right	14 (45.2%)	15 (48.4%)	0.799
• Left	17 (54.8%)	16 (51.6%)	
Duration since injury (weeks)	2.4±0.96	2.4±0.99	0.897
• 1-2 weeks	16 (51.6%)	16 (51.6%)	1.000
• 3-4 weeks	14 (48.4%)	14 (48.4%)	

Insignificant difference on Independent sample t-test and Chi-square test

Table 3: Comparison of Mean Constant Score between the Study Groups n=62

	DCP n=31	LCP n=31	P-value
Modified Constant and Murley Score	91.3±7.4	85.8±8.3	0.008*

* Significant difference on Independent sample t-test

Table 4: Comparison of Excellent Functional Shoulder Outcome between the Study Groups n=62

Excellent Functional Shoulder Outcome	DCP n=31	LCP n=31	P-value
Yes	27 (87.1%)	17 (54.8%)	0.005*
No	4 (12.9%)	14 (45.2%)	
Total	31 (100.0%)	31 (100.0%)	

Chi-square test, * Observed difference was statistically significant

Table 5: Comparison of Excellent Functional Shoulder Outcome between the Study Groups across various Subgroups n=62

Subgroups	Excellent Functional Shoulder Outcome		P-value
	DCP n=27/31	LCP n=17/31	
Age (years)			
• 18-39 years	10/11 (90.9%)	7/13 (53.8%)	0.047*
• 40-60 years	17/20 (85.0%)	10/18 (55.6%)	0.046*
Gender			
• Male	20/23 (87.0%)	12/22 (54.5%)	0.016*
• Female	7/8 (87.5%)	5/9 (55.6%)	0.149
BMI (Kg/m^2)			
• 20-25 Kg/m^2	7/8 (87.5%)	4/7 (57.1%)	0.185
• 25-30 Kg/m^2	13/15 (86.7%)	8/15 (53.3%)	0.046*
• 30-35 Kg/m^2	7/8 (87.5%)	5/9 (55.6%)	0.149
Side			
• Right	12/14 (85.7%)	8/15 (53.3%)	0.060
• Left	15/17 (88.2%)	9/16 (56.3%)	0.039*
Duration since injury (weeks)			
• 1-2 weeks	14/16 (87.5%)	9/16 (56.3%)	0.049*
• 3-4 weeks	13/14 (86.7%)	8/14 (53.3%)	0.046*

Chi-square test, * Observed difference was statistically significant

DISCUSSION

Humeral shaft fractures account for about 1-3 % of all fractures.[12] The overall incidence rate is about 14.5/100,000 people/year, and open fractures amount to 2%.[13] During last ten years, due to development of improved techniques of operations, these fractures are being handled in a better way.[12,13] Injury to the muscles and stiffness of shoulder joint subsequent to humeral shaft fractures and the option chosen for treatment both are points of serious concern.[13] Followed by conservative treatment, prolonged immobilization results in stiffness while attempt for early

rehabilitation through operative fixation for avoiding stiffness is at the cost of injury to soft tissues and muscles that ultimately reduces function of the shoulder.[13-15] Various implants used for fixation of fracture need varying degree of surgical exposure and cause variable soft tissue trauma and therefore differ in terms of functional outcome of shoulder following surgery.[8-11] Dynamic compression plates and locking compression plates are routinely used in such patients and presently there was no research evidence comparing functional shoulder outcome between these two implants that is why need for the present study was felt.

The objective of this study was to compare the functional outcome of shoulder in humeral shaft fractures fixed with dynamic compression plate versus locking compression plate.

In the present study, the mean age of the patients with fractures of humeral shaft was 42.6±12.7 years. A similar mean age of 43.1±9.2 years has been reported by Shah et al.[16] (2013) among patients presenting with humeral shaft fractures at Mardan Medical Complex Teaching Hospital, Mardan. A comparable mean age of 42.5±7.9 years, 44.4±8.7 years and 44.7±9.4 years has been reported by Vijayashankar et al.[8] (2016), Govindasamy et al.[11] (2016) and Kumar et al.[17] (2012) respectively among Indian such patients while Azevedo et al.[18] (2010) reported it to be 46.8±11.2 years in Brazil.

We observed that there were 45 (72.6%) male and 17 (27.4%) female patients in the study group with a male to female ratio of 2.6:1. Our observation is in line with that of Maher et al.[10] (2014) who also reported similar male predominance among patients with humeral shaft fractures with a male to female ratio of 2.3:1 at Liaquat University Hospital Hyderabad while Shah et al.[16] reported it to be 2.7:1 at Mardan Medical Complex Teaching Hospital, Mardan. Singh et al.[19] (2.2:1) and Govindasamy et al.[8] (2.9:1) reported similar male predominance among Indian patients with humeral shaft fractures.

In the present study, the mean BMI of patients was 27.9±3.4 Kg/m^2 and 17 (27.4%) patients were obese. A similar frequency of 26.7% for obesity has been reported by Qamar et al.[20] (2018) among patients presenting with humeral shaft fractures at Shaikh Zayed Hospital, Lahore.

We observed that left side was more frequently involved (53.2%) as compared to the right side (46.8%). A similar distribution of left (60.0%) and right (40.0%) sided humeral shaft fractures have been reported by Maher et al.[10] at Liaquat University Hospital Hyderabad. Vijayashankar et al.[8] reported similar frequency of left (54.0%) and right (46.0%) sided humeral shaft fractures in India. Another Indian study reported the frequency of left and right sided humeral shaft fractures to be 56% and 44.0% respectively.[11]

In the present study, the Modified Constant and Murley score after 12 weeks of surgery was significantly higher in patients treated with DCP as compared to LCP (91.3±7.4 vs. 85.8±8.3; p-value=0.008). The frequency of excellent functional shoulder outcome was significantly higher in patients treated with DCP as compared to LCP (87.1% vs. 54.8%; p-value=0.005).

In a similar randomized controlled trial involving Indian patients with humeral shaft fractures, Shankar et al.[21] also reported similar but insignificant difference in the frequency of excellent functional shoulder outcome between DCP and LCP (70.7% vs. 54.5%; p-value=0.64). However, their study was limited by small sample size of 38 patients. Also they only included patients with established non-union of humeral shaft.

Our observation is also in line with that of Vijayashankar et al.[8] who observed similar frequency of excellent functional shoulder outcome with DCP and reported it to be 91.0%. Li et al.[9] reported comparable frequency of excellent functional shoulder outcome (60.9%) with LCP in humeral shaft fractures.

The present study is first of its kind and has established that dynamic compression plate is associated with significantly better functional shoulder outcome as compared to locking compression plate in patients with humeral shaft fractures regardless of patient's age, gender, duration since injury, side involved and BMI which along with cheaper hardware cost advocates its preferred use in future practice.

A very strong limitation to the present study was that we only considered functional shoulder outcome and ignored other important aspects of orthopedic management like cost, time to return to work, complications like infection, non-union and need for revision etc. which should be addressed before adopting it in routine practice. Such a study is highly recommended in future research.

CONCLUSION

Dynamic compression plate was associated with significantly better functional shoulder outcome as compared to locking compression plate in patients with humeral shaft fractures regardless of patient's age, gender, duration since injury, side involved and BMI which along with cheaper hardware cost advocates its preferred use in future practice.

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