A Prospective Observational Study on Outcomes of Displaced Mid-Shaft Clavicle Fractures Treated with Locking Compression Plate at a Tertiary Center in Jaipur

Vishal Singh[1], Anil Kumar Marotia[2], Avinash Gundavarapu[3], Alokeshwar Sharma[4]

[1, 2, 4] Department of Orthopaedics, Dhanwantri Hospital, Jaipur, Rajasthan, India.
[3]Department of Orthopaedics, Yashoda Super-speciality Hospital, Hyderabad, Telangana, India.

ABSTRACT

BACKGROUND

Fracture of the clavicle shaft forms 70 % to 80 % of all clavicular fractures. More recent data, suggests that the incidence of non-union in displaced comminuted midshaft clavicular fractures after conservative treatment is higher than previously presumed. The purpose of our study was to analyse the functional outcome of mid third displaced clavicular fractures treated using locking compression plate.

METHODS

Our study is a prospective observational study conducted in Department of Orthopaedics, Dhanwantri Hospital & Research Centre, Jaipur, Rajasthan, from May 2016 to June 2017. Patients presented to emergency room with displaced middle third clavicle fracture, treated with locking compression plate (LCP) were the subjects in our study. 20 cases were evaluated in our study. The functional outcome was assessed by constant and Murley score.

RESULTS

Mean age in our study of 20 cases was 34.85 year. Out of the them, 13 (65 %) patients were males and 7 (35 %) patients were females. According to Robinson classification, 13 cases (65 %) were type 2b1 and 7 cases (35 %) were type 2b2. In majority of cases, (75 %) hospital stay was less than 4 days. Out of the 20 cases, 17 (85 %) patients returned to work within 14 weeks. Majority of cases, 90 % (18) patients in the present study fracture union occurred before 10 weeks. Post-operative complications were seen in 5 cases (25 %). This study showed 85 % of patient (17) had excellent functional outcome and 15 % of patients (3) had good results, the mean ± SD (min to maximum) constant score was 94.20 ± 3.48 (84 to 98).

CONCLUSIONS

Treatment of displaced midshaft clavicle fracture with locking compression plate provides better biomechanical stability, good fracture union rates, high post-operative constant score, early pain resolution, early return to activity, high patient satisfaction rates and excellent functional outcome. These benefits of plating overweigh complications when used in specific indications like displaced with or without comminuted middle third clavicle fracture (Robinson Type 2B1, 2B2).

KEYWORDS

Midshaft Clavicle Fractures, Locking Compression Plate (LCP), Constant Murley Score

Corresponding Author:
Dr. Avinash Gundavarapu,
Department of Orthopaedics,
Yashoda Super-speciality Hospital,
Hyderabad, Telangana, India.
E-mail: avinashrao.dr@gmail.com

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BACKGROUND

Clavicle fractures account for approximately 2 % to 6 % of all fractures and 45 - 60 % of shoulder injuries are associated with clavicle fractures. Fracture of the shaft account for 70 % to 80 % of all clavicular fractures; whereas fractures of the lateral and medial third of the clavicle account for 15 % and 5 %, respectively. Open clavicular fracture is an absolute rarity, found in only 0.1 % to 1 % of cases.[1] Historically, clavicle fractures have been treated mostly non-operatively, with expectation for return to painless, reliable function and the incidence of non-union of mid-clavicular fractures ranged from 0.1 to 0.8 % previously. More recent data, based on detailed classification of fractures, suggests that the incidence of non-union in displaced comminuted midshaft clavicular fractures after conservative treatment is higher than previously presumed and is between 10 and 15 %.[2]

Non-operative treatment of these fractures with axial shortening is associated with non-union, delayed union, and malunion. Surgery is accepted more and more as primary treatment for displaced mid-shaft clavicular fractures, mainly because the results of non-operative treatment are interpreted as inferior to operative treatment both clinically and functionally.[3] There are various methods of treating clavicle mid-shaft fractures such as intramedullary K-wires or Steinmann pins fixation and plate fixation. In particular, locking compression plate fixation can help obtain firm anatomical reduction in severe displaced or comminuted fractures.[4,5] There are various plates including Sherman plates, dynamic compression plates and semi tubular plates. Among them a reconstruction plate or a pre-contoured locking compression plate are the most preferred.

Objectives

1. To assess the outcome of surgical treated displaced mid-shaft fractures of clavicle treated with LCP using constant and Murley score.[6]
2. To assess the complications associated with clavicle fractures treated with locking compression plate.

METHODS

Our study is a prospective observational study conducted in Department of Orthopaedics, Dhanwantri Hospital & Research Centre, Jaipur, Rajasthan, from May 2016 to June 2017. The study was approved by institutional ethics committee (IEC no - DHRC / 2016 – 17 / 162 - a) prior to its commencement. Patients between age group of 18 - 60 years, fulfilling inclusion and exclusion criteria, presented to emergency room with displaced middle third clavicle fracture were selected as subjects for the study. The sample size of our study was 20 patients with isolated displaced middle third clavicle fractures. A written informed consent was obtained at the time of admission. All the patients were treated operatively with open reduction and internal fixation using locking compression plate, and all the patients had regular follow-up visits to our out-patient department (OPD) for the entire duration of treatment. Results of our study were assessed by constant and Murley score.[6] Sample size was 20 patients with mid 1 / 3rd clavicle fracture fulfilling inclusion and exclusion criteria.

Inclusion Criteria

1. Age > 18 years and < 60 years.
2. Isolated closed fractures of midshaft clavicle fractures with displacement > 2 cm, shortening > 2 cm.
3. Robinson classification 2B1 and 2B2 (displaced fractures).[7]
4. 2B1 - Simple or single butterfly fragment.
5. 2B2 - Comminuted or segmental.

Exclusion Criteria

1. Open fracture.
2. Fracture in proximal or distal third of clavicle.
3. Pathological fractures and other injuries around shoulder girdle.
4. Associated Neuro-vascular injury.
5. Clavicle fractures treated with other fixation modalities.

Study Procedure

Detailed history recording and thorough general physical examination, local examination, X-ray of chest with both shoulders antero-posterior (AP) view, plain radiograph of clavicle AP view, 30^0 cephalo-caudal views were performed, and documentation of injuries were done in emergency room. All the patients were given arm pouch in emergency room (ER) for temporary fracture splinting. Surgical profile and pre-anaesthetic evaluation were performed prior to admission. All our patients received prophylactic antibiotic (Inj. cefoperazone + sulbactum) ½ hour prior to surgery and were operated under general anaesthesia. Patients were operated in supine position with sandbag under the scapulae. Keeping the sandbag allows the shoulder girdle to fall backwards. It restores the length and increases the exposure to clavicle. Incision was marked along the axis of the clavicle, centring the fracture site. Subcutaneous tissue along with platysma was incised together and mobilized. Myofascial layer is incised and elevated. Fracture site was exposed with minimal periosteum stripping. Fracture hematoma was washed out. Soft tissue attachments to the small fracture fragments were preserved. Fracture pattern was assessed intraoperatively. We studied Robinson 2B1 (Butterfly fragment) and 2B2 (segmental/comminuted) type of fractures which involve displaced midshaft clavicle fractures. 2B1 with large butterfly fragments with fragment size more than twice diameter of bone was reduced with bone clamps and a lag screw were used to fix the fragment to fractured bony ends. Compression was achieved with lag screw. Then LCP was used as a neutralization plate to maintain the reduction achieved. In case of a small butterfly fragment, it was reduced with cerclage wire only and used LCP as a neutralization plate. Segmental fractures of midshaft clavicle (Robinson 2b2) were reduced using bone clamps and locking compression plate is placed over the

superior surface of the clavicle, fixed initially with eccentrically placed 3.5 mm cortical screw on either side of fracture site, to achieve compression at fracture sites and affix plate to bone, later 3.5 mm locking screws in remaining plate holes to stabilize fracture. If there is comminution (Robinson 2B2) all the small fragments were meticulously handled to preserve soft tissue attachments to them and fixed with LCP as a bridging plate and cerclage wire was used to align the fragments at fracture site. A minimum of six cortical purchases were attained on either side of the fracture. Myofascial layer was sutured to cover plate and skin closure is achieved with sub cuticular tissue sutures. Sterile dressing was applied, and extremity was immobilized in arm pouch. Antibiotics were continued for 3 days. Analgesics and tranquilizers were given for 5 days. The operated upper limb was immobilized in an arm pouch. Check x-rays were taken to study the alignment of fracture fragments. The wound was inspected at 2nd post-operative day and discharged later with an arm pouch. Suture removal was done on 14th post-operative day. Pendulum movements / Codman's exercises were started from 3rd post-operative day. 2nd week: The sling was discontinued, and unrestricted range of motion exercise was allowed. They followed every two weeks till 3 months followed by every 4 weeks till 6 months and every 8 weeks till one year. Sports activities and heavy weighting are avoided till 12 weeks. The functional outcome was assessed by constant and Murley score.[6]

Statistical Analysis

Descriptive and inferential statistical analysis was carried out in the present study using computer software (SPSS Trial version 23 and primer). The qualitative data was expressed in proportion and percentages, and the quantitative data was expressed as mean and standard deviations. The difference in proportion was analysed by using chi square test and the difference in means among the groups was analysed using the student t test. Significance level for tests were determined as 95 % ($P < 0.05$).

RESULTS

This study was conducted in 20 cases with displaced mid-shaft clavicle fractures treated with locking compression plate, at the Department of Orthopaedics, Dhanwantri Hospital and Research Centre, Jaipur from May 2016 to June 2017. The data obtained was coded and entered into the Microsoft Excel Spread Sheet. The data was analysed, and results obtained were tabulated. Age of the patients vary from 19 years to 60 years. Mean age was 34.85 years. In our study, 70 % of the patients were young belong to 3rd and 4th decade. Out of the 20 cases, 13 (65 %) patients were males and 7 (35 %) patients were females. Male to female ratio was 1.85 : 1. Out of the 20 patients, 10 patients sustained injury to the right side and remaining 10 patients on left side. In majority of the cases, road traffic accidents (RTA) (70 %) was the cause for injury followed by accidental fall (30 %). In our study equal numbers of patients sustained injury by direct impact on shoulder (50 %) & fall on outstretched hand (50 %). According to Robinson classification, 13 cases (65 %) were type 2B1 and 7 cases (35 %) were type 2B2. Out of 13 cases in 2B1, 4 required inter-fragmentary lag screw fixation and remaining 6 cases required cerclage wiring and 3 required buttressing of small fragment under LCP and compression achieved at fracture site. Out of 7 patients in type 2B2, 5 required cerclage wiring, 2 cases with segmental fracture required compression plating using LCP. In majority of cases (75 %) hospital stay was less than 4 days. Mean ± SD was 4 ± 0.858 days with 3 to 6 days.

Out of the 20 cases, 17 (85 %) patients returned to work within 14 weeks with mean ± SD was 13.90 ± 2.713. Only one patient could return to work after 24 weeks due to complication. Majority of cases (90 %), in 18 patients of the present study, fracture union occurred before 10 weeks. Mean ± SD 9.95 ± 3.502. In our study, one case took 24 weeks to unite fracture because of complication.

Complication	No. of Patients	Percentage (%)
Absent	15	75
Present	5	25
Infection	2	6.67
Plate loosening	0	0.0
Plate breakage	1	3.33
Hardware irritation	3	10
Restriction shoulder motion	1	3.33
Delay union	1	3.33
Malunion	1	3.33

Table 1. Distribution of the Cases According the Complication

In our study, we did not have any significant intraoperative problems. Complications were seen in 5 cases (25 %). Hardware irritation in 2 cases, infection and restriction of shoulder motion in 1 case, plate breakage with malunion was present in one case and infection + hardware irritation + delayed union was present in one case. Infection was managed with debridement with intravenous antibiotics in one case. Debridement and bone graft was done in one case of infection, hardware irritation and delayed union. Plate removal was done in 2 cases of plate irritation, and re-plating & bone graft was done in plate breakage and malunion. The mean ± SD (min to maximum) constant score was 94.20 ± 3.48 (84 to 98). So functional outcome with LCP is excellent. Table 3 depicts the association of outcome with Robinson classification. No significant difference was observed in hospital stay days, return to work weeks, time of union weeks and constant score in 2B1 & 2B2 cases.

Constant Score Number	No. of Patients	Percentage (%)
84	1	5
88	1	5
90	1	5
92	1	5
94	6	30
96	7	35
98	3	15
Mean ± SD	94.20 ± 3.48	

Table 2. Distribution of the Cases According to the Constant Score

Robinson Classification	2B1			2B2		
	Number	Mean	SD	Number	Mean	SD
Hospital days stay	13	3.85	0.69	7	4.29	1.11
Return to work weeks	13	13.08	1.32	7	15.43	3.95
Time of union weeks	13	9.23	1.01	7	11.29	5.79
Constant score	13	94.77	2.09	7	93.14	5.27

Table 3. Mean Scores of Different Outcome Variables Based on Robinson Classification

Case 1. Complication – Plate Breakage

Complications	2B1 (N = 13)		2B2 (N = 7)	
	Number	(%)	Number	(%)
Infection	0	7.69	1	14.29
Plate loosening	0	0.00	0	0.00
Plate breaking	0	0.00	1	14.29
Hardware irritation	1	7.69	2	28.57
Delay union	0	0.00	1	14.29
Malunion	0	0.00	1	14.29
Restriction shoulder motion	1	7.69	0	0.00

Table 4. Frequency Distribution of Complications with Robinson Classification

No significant association was observed in complications with Robinson classification. Minimal complications were present in both 2B2 & 2B1 type of fractures. In the present study, 85 % of patients (17) had excellent functional outcome and 15 % of patients (3) had good results, in which 1 case had delayed union with infection and another one infected, and one plate breakage with malunion.

DISCUSSION

Traditionally displaced mid-shaft clavicular fractures have been successfully treated nonoperatively and have a high union rate with few complications. In a study conducted to analyse the results of conservative treatment by Hill et al.[4] in 1997, and Robinson et al.[7] in 2004 found poor results following conservative treatment of displaced middle third clavicle fracture. So, there is specific indication like displacement, with or without comminuted middle third clavicle fracture (Robinson Type 2B1, 2B2). The patients treated with early, rigid fixation of their clavicle fractures shared a high post-operative constant score, early pain resolution early return to activity and high patient satisfaction rating. Plating has the advantages of maintaining the length especially in comminuted fractures. There is little chance for hardware breakdown and migration.

Out of the 20 cases in our study, 70 % of the patients were young belong to 3rd & 4th decade. In our study the average age group (mean ± SD) was 34.85 ± 12.64 years and it varies from 19 years to 60 years. It is comparable with study by Elidrissi et al.[8] and K.B Ravi[9] (2017) where mean age was 36 ± 6 years. Dhoju D (2011) studied on cases with mean age of the patients was 31.5 years with SD 11.5 years (range 15 - 60 years).

In our study, according to Robinson classification,[3] 13 cases (65 %) were of 2B1 and rest 7 cases (35 %) were 2B2. Out of them, KB Ravi[9] observed that study according to the Robinson classification, 2A2 category was seen in 3.3 %, 2B1 was seen in 80 %, 2B2 was seen in 16.7 % of the subjects. Dr. Saidapur SK[10] et al. observed Robinson type-2 B1 in 81.6 % and Robinson type 2 in 18.3 % patients. Mulimani VM et al.[11] (2016) observed that type 2B1 (occurred in 16 patients (80 %) and type 2B2 fracture occurred in 4 patients (20 %).

In majority of cases (75 %), hospital stay was less than 4 days. Mean ± SD was 4 ± 0.858 days with 3 to 6 days. KB Ravi[9] observed that 63.3 % had a stay of 4 - 6 days, 20 % stayed for 7 - 10 days, 6.7 % were admitted for 11 - 16 days and 6.7 % were hospitalized for 17 or more days. Mean hospital stay was of 7 ± 5 days.

In our study, the average time of union was 9.95 ± 3.502 weeks (min 8 to 24 weeks). Union in (90 %) 18 cases were within 10 weeks. It is also comparable with other studies like Elidrissi et al.[8] Dhoju et al.[12] Most of our patients return to work at 2-and-a-half-month time. KB Ravi[9] observed that most of the patients i.e., 16 (53.3 %) of them achieved radiological union in 12 weeks and 11 patients (36.7 %) achieved union in 24 weeks. 3 patients (10 %) had non-union. Dr. Saidapur SK et al. observed that 93.3 % of his patients had fracture union at an average of 12.7 weeks. Three patients had delayed union which were united by 16 - 18 weeks (5 %). There was implant failure in one case which went on to develop painless non-union as patient did not want to have reoperation (1.7 %). Mulimani VM et al.[11] (2016) observed that among 20 patients with middle third clavicle fracture treated with pre-contoured locking plate, 18 fractures united at an average of 9.3 weeks.

Yong-Geun Park[13] et al. (2017) observed that all 80 cases were confirmed to have achieved bone union through radiographs with an average union period of 10.9 weeks (range: 7 – 18 weeks). The complications were present in 5 cases (25 %). Hardware irritation in 3 cases, infection, and restriction of shoulder motion in 1 case, plate breaking with malunion was present in only one case (5 %), delay union

with infection in 1 (5 %) case. KB Ravi[9] observed that 10 (33.33 %) patients had complications. Plate prominence and restriction of shoulder movements were noted in 10 % of the study subjects. 7 % of the patients had non-union. Plate breakage and infection were noted in 3 % of the patients. There were no wound healing problems, infection or refracture. Two patients developed incisional numbness. There were no peri-operative complications. There was 1 case with moderate pain around shoulder joint, decreased strength and restricted range of motion (ROM) of shoulder.

Infection		
Nathan et al.[14]	Superior plating Antero inferior plating	Nil 2.50 %
Elidrissi et al.[8]	Deep infection	3 %
Dhoju et al.[12]	Deep infection	5 %
Our study	Superficial infection	2 / 20 (10 %)
Study	Implant failure	Malunion
Dhoju et al. (Reconstruction Plate)[12]	Nil	Nil
Elidrissi et al. (Reconstruction Plate)[8]	Nil	Nil
Olivier et al. (low contact dynamic compression plate)[15]	Nil	5 %
Nathan et al. (superior reconstruction Plate)[14]	3 %	20 %
Our study (superior LCP)	5 %	5 %

Table 6. Comparison of Complications with Other Similar Studies

In our study of 20 cases of displaced mid clavicular fractures, complications were treated with plate removal in 2 cases due to hardware irritation, debridement in one case of infection, debridement, and bone graft in one case of infection with delayed union, and re-plating and bone graft in one case of plate breakage & malunion (5 %).

Study	Constant Score
Eldrissi et al.[8]	95.33
Oliver et al.[15]	88
Dhoju et al.[12]	97.45
C.M Robinson et al[7].	92
Yong-Geun Park et al.[13]	92.5 (range: 65-100)
Our study	94.20

Table 7. Comparison of Constant Score with Other Similar Studies

This table depicts that the mean ± SD (min to maximum) constant score was 94.20 ± 3.48 (84 to 98). It is also comparable with other studies by Eldrissi et al.[8] and Oliver et al.[15] and Yong – Geun Park et al.[13] Study shows excellent outcome with LCP clavicle plating. No significant difference was observed in hospital stay days, return to work weeks, time of union weeks and constant score in 2B1 & 2B2 cases. No significant association was observed in complications with Robinson classification. Minimal complications were present in both 2B1 & 2B2 type fractures. We assessed the functional outcome using constant score. According to the outcome, out of 20 cases, 17 (85 %) were observed in excellent category. 3 (15 %) cases were observed in good category. Mulimani VM et al.[11] (2016) observed that the functional outcome according to constant and Murley score[6] after fracture union were excellent in 16 patients, good in 3 patients and fair in 1 patient. KB Ravi[9] observed that as per the constant scoring system, in 23 patients (77 %) the functional outcome was excellent, 4 patients (13 %) fell under good category, 2 patients (7 %) had fair functional outcome while 1 patient (3 %) had poor outcome. Dr. Saidapur SK et al.[10] observed that as per constant-Murley scores, there were 55 patients (92 %) with excellent to good, 3 patients (5 %) with fair and 2 patients (3 %) with poor results. We assessed the functional outcome of displaced mid shaft clavicle fractures treated with locking compression plate using constant score. Patient treated with locking compression plate showed an early return to day to day activities and work. The score was significantly more in excellent outcome as compared to good. ($P < 0.001S$). Locking compression plate provides better biomechanical stability.

CONCLUSIONS

Open reduction and internal fixation of displaced midshaft clavicle fracture with locking compression plate provides better biomechanical stability, good fracture union rates, high post-operative constant score, early pain resolution early return to activity and high patient satisfaction rating and excellent functional outcome. The functional outcome assessment was done using constant and Murley score, it showed excellent to good results and scores were significantly more in patients with excellent outcome. Although complications like hardware irritation, incisional numbness, infection, delayed union, and restriction of shoulder motion associated with plating are seen, the advantages of locking plate to maintain the length of clavicle in comminuted fractures, little chance of hardware breakdown and migration overweigh the surgical complications which are encountered less frequently. When used for specific indication like placement, with or without comminuted middle third clavicle fracture (Robinson Type 2B1, 2B2), locking compression plating of clavicle provides excellent to good functional scores. Complications like infection can be managed effectively with debridement and intravenous antibiotics. Hardware irritation can be addressed by implant removal after satisfactory bony union. Incisional numbness can be prevented by meticulous dissection of supra clavicular nerve branches and avoiding injury to them. Delayed union can be prevented to some extent by avoiding excessive periosteal stripping and achieve compression at fracture site, established cases can be treated by bone grafting at fracture site.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
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REFERENCES

[1] Schiffer G, Faymonville C, Skouras E, et al. Midclavicular fracture: not just a trivial injury – current treatment options. Dtsch Arztebl Int 2010;107(41):711-717.
[2] Shen WJ, Liu TJ, Shen YS. Plate fixation of fresh displaced midshaft clavicle fractures. Injury 1999;30(7):497-500.

[3] Stegeman SA, de Jong M, Sier CFM, et al. Displaced midshaft fractures of the clavicle: non-operative treatment versus plate fixation (Sleutel-TRIAL). A multicentre randomized- controlled trial. BMC Musculoskeletal Disorders 2011;12:196.
[4] Hill JM, McGuire MH, Crosby LA. Closed treatment of displaced middle-third fractures of the clavicle gives poor results. J Bone Joint Surg Br 1997;79(4):537-539.
[5] Chu CM, Wang SJ, Lin LC. Fixation of mid-third clavicular fractures with knowles pins: 78 patients followed for 2-7 years. Acta Orthop Scand 2002;73(2):134-139.
[6] Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. Clinical Orthopaedics & Related Research 1987;(214):160-164.
[7] Robinson CM. Fractures of the clavicle in the adult. Epidemiology and classification. J Bone Joint Surgery Br 1998;80(3):476-484.
[8] Elidrissi M, Mahadane H, Mechchat A, et al. Functional outcome of midclavicular fracture fixation utilising a reconstruction plate. Malays Orthop J 2013;7(3):6-9.
[9] Ravi KB, Ravishankar J, Puneeet S, et al. Operative management of clavicle fractures by LCP. International Journal of Orthopaedics Sciences 2017;3(3):519-530.
[10] Saidapur SK, Khadabadi NA. Locking plate fixation of midshaft clavicle fractures: analysis of complications, reoperation rates and functional outcome. International Journal of Orthopaedics Sciences 2017;3(3):1071-1073.
[11] Mulimani VM, Ramesh M, Babu CP, et al. A clinical study of displaced clavicle fractures treated with anatomically pre-contoured locking compression plate. J Evolution Med Dent Sci 2016;5(83):6218-6222.
[12] Dhoju D, Shrestha D, Parajuli NP, et al. Operative fixation of displaced middle third clavicle (Edinburg Type 2) fracture with superior reconstruction plate osteosynthesis. Kathmandu Univ Med J (KUMJ) 2011;9(36):286-290.
[13] Park YG, Kang H, KimS, et al. Mini-open treatment using plate of clavicle mid-shaft fractures. Clinics in Shoulder and Elbow 2017;20(1):37-41.
[14] Nathan F, Benjamin CT, Jeffrey B, et al. Superior versus anteroinferior plating of clavicle fractures. Orthopedics 2013;36(7):e898-904.
[15] Van der Meijden OA, Gaskill TR, Millett PJ. Treatment of clavicle fractures: Current concepts review**.** J Shoulder Elbow Surg 20112;21(3):423-429.