



ORIGINAL RESEARCH ARTICLE

FUNCTIONAL OUTCOME OF PLATING FOR DISPLACED MIDDLE THIRD CLAVICLE FRACTURES IN ADULTS

Jyoti Sitaula¹, Ananda Prasad Regmi¹, Akesh Prajapati¹, Suresh Bahadur Thapa¹, Bishnu Dev Sharma¹, Sujit Raj Shrestha¹,
Pujan Pant¹, Sanjeeb Rijal¹

¹Department of Orthopedics, Chitwan Medical College Teaching Hospital, Bharatpur-10, Chitwan

*Correspondence to: Dr. Jyoti Sitaula, Chitwan Medical College, Bharatpur, Chitwan, Nepal.

Email: jyotisitaula2013@gmail.com

ABSTRACT

Introduction: Clavicle fractures are the common fractures around the shoulder. Conservative treatment is associated with higher incidence of nonunion. We conducted this study to assess the functional outcome of plating for displaced middle third clavicle fractures. **Methods:** This prospective study included 60 patients with displaced middle third clavicle fractures from April 2016 to March 2017. Fixation was done with a 3.5 mm reconstruction plate placed at the superior surface of the clavicle. Patients were followed-up for a minimum of one year. Functional outcome was assessed using Constant shoulder score. **Results:** There were 48 male and 12 female patients with a mean age of 33.17 years (range 18-74 years). The average follow-up period was 17.82 months. All fractures united at an average of 5.35 months. The mean Constant score at final follow-up was 89.12. There were two superficial infections and three implant failures. **Conclusion:** We conclude that treatment of displaced middle third clavicle fracture with plate gives good results.

Key words: Clavicle, Displaced, Middle third, Plate.

INTRODUCTION

Clavicle fractures are the most common fractures around the shoulder girdle.¹ They account for approximately 44% of the shoulder girdle injuries and 70 to 80% of these fractures occur in the middle third.^{2,3} These fractures can be managed conservatively or with surgical methods. However conservative treatment is associated with higher rate of nonunion up to 16% in displaced fractures and 5.9% even in undisplaced fractures.^{4,5} Various surgical treatment modalities are available including plates, Kirschner wires, Steinmann pins and external fixators.⁵⁻¹⁰ Recent trend is towards plate fixation with improved functional outcomes and fewer complications.^{5, 11} The aim of this study is to assess the functional outcome of plating in displaced middle third fractures in our setup.

METHODS

This was a prospective study conducted in Chitwan Medical College Teaching Hospital, Department of

orthopedics from April 2016 to March 2017. Patients with displaced clavicle fractures were included in this study and followed up for a minimum of one year. The inclusion criteria in our study were age > 18 years, middle third clavicle fractures displaced more than one bone width, shortening >15mm, comminuted fractures or tenting of the overlying skin. Patients with concomitant injury to the upper extremity of the same side, polytrauma patients, open fractures, fractures > 3 weeks old, neurovascular injury and patients with medical contraindication to surgery were excluded from the study.

Approval for the study was granted from the Institutional Review Committee of Chitwan Medical College and informed consent was taken from all the participants.

Sixty-eight patients with fracture clavicle meeting the inclusion criteria were fixed with recon plate and were recruited for this study. However eight patients

lost to follow-up and thus 60 patients were included for final analysis.

Surgery was performed under interscalene block or general anesthesia. A longitudinal incision parallel to the long axis of the clavicle centered above the fracture was made along the superior border of the bone. Fixation was done using 3.5-mm reconstruction plate, after contouring of the plate with lateral plate bender, at the superior surface of clavicle. Patient was discharged on day four and sutures/staples were removed at two weeks. Patient was kept in an arm pouch sling for two weeks allowing pendulum exercise. Active-assisted motions of shoulder were then begun but heavy lifting, pushing and pulling

were avoided. Full return of activities was allowed when fracture healing was present, usually at 2 to 3 months.

Follow-up evaluation was performed at 6 weeks, 3 months, 6 months and 1 year. Both clinical and radiological evaluations were done. The primary outcome measure was the Constant shoulder score¹² -a combined subjective and objective shoulder score consisting of 4 variables: pain, activities of daily living, range of motion, and strength (Table 1). The total best possible score is 100. The secondary outcome measures were the union rate and complication rates.

Table 1: Constant Score

Pain (15 points)	
15	None
10	Mild
5	Moderate
0	Severe
Activities of daily living (10 points)	
0/4	Ability to work (no/yes)
0/4	Ability to engage in recreational activities (no/yes)
0/2	Ability to sleep (no/yes)
Ability to work at a specific level (10 points)	
10	Above head
8	Head
6	Neck
4	Chest
2	Waist
Range of motion (10 points): flexion	
10	>150°
8	121°-150°
6	91°-120°
4	61°-90°
2	30°-60°
0	<30°
Range of motion (10 points): abduction	
10	>150°
8	121°-150°
6	91°-120°
4	61°-90°

2	30°-60°
0	<30°
Combined active external rotation (10 points)	
10	Full elevation from top of head
8	Hand on top of head, elbow back
6	Hand on top of head, elbow forward
4	Hand behind head, elbow back
2	Hand behind head, elbow forward
Combined active internal rotation (10 points)	
10	Interscapular region
8	Inferior tip of scapula
6	Twelfth rib
4	Lumbosacral junction
2	Buttocks
0	Lateral thigh
Strength of abduction (pounds) (25 points)	

Statistical data analysis was done using the SPSS (Statistical Package for Social Sciences) version 20.0. Analysis was done using frequencies, descriptive option for mean and standard deviation and

Friedman's 2-way ANOVA. Values of $p < 0.05$ were taken to indicate significance with confidence interval of 95%.

RESULTS

The mean age of the patients was 33.17 ± 12.94 years (range 18-74 years) with 48 males and 12 females.

The most common mechanism of injury was Road Traffic Accident, 36 patients. (Table 2).

Table 2: Baseline characteristics of patients

Variable	
Male/ Female, n	48/ 12
Mean (SD*) age, years	33.17 (12.94)
Mechanism of injury, n (%)	
Road Traffic Accident	36 (60%)
Fall	21 (35%)
Sports related	3 (5%)
Affected side (right/ left)	29/31
Mean follow-up duration, months	17.82

*Standard Deviation

Most of the surgeries were done under interscalene block-50 (83.3%) and the rest 10 (16.7%) under general anaesthesia. The patients were followed up for an average of 17.82 months. All the fractures united- the mean time for union was 5.35 ± 1.57 months.

The final Constant score at 12 months follow-up was 89.12 ± 4.79 which improved significantly from 3 months (score = 66.68) to 6 months (score = 84.57) ($p < 0.001$, Table 3).

Table 3: Mean Constant shoulder scores during follow-up period

Parameter	Follow-up			p-value†
	3 months*	6 months*	12 months*	
Pain	11.58 ± 3.5	13.33 ± 2.55	14.42 ± 1.86	0.000
ADL‡	13.43 ± 2.36	18.90 ± 1.40	19.63 ± 0.94	0.000
ROM§	25.14 ± 3.69	33.07 ± 3.07	35.23 ± 3.30	0.000
Power	16.53 ± 2.67	19.27 ± 2.97	19.83 ± 3.22	0.000
Total score	66.68 ± 6.01	84.57 ± 4.84	89.12 ± 4.79	0.000

*Mean ± Standard Deviation

†Friedman's 2-way ANOVA

‡Activities of Daily Living

§Range Of Motion

The overall complication rate was 8.33% (5 patients). There were two superficial infections (3.33%) which were managed with local wound care and antibiotics. Three patients (5%) had implant failure that required revision surgery.

DISCUSSION

Though clavicle fractures have been managed conservatively, there has been a trend towards surgical treatment of clavicle fractures to reduce the incidence of nonunion and malunion, and to improve functional outcome.^{2,4,13,14} We have conducted this study to find out the functional outcome of superior plating for clavicle fractures in our setup.

The mean age of our study was 33.17 years, which is comparable to other studies- 33.5 years in the study by Canadian Orthopedic Trauma Society,¹¹ 33.4 years Bostman et al,¹⁵ 35 years Ricci WM;¹⁶ while Ferran et al had lower mean age 29.3 years,¹⁷ and higher mean age was seen in Serrano et al 38.3 years and Shen et al 37.3 years.^{18,19}

Males were predominantly involved in our study as was the case in all other studies.^{16, 18, 20, 21} Left side was affected more than right in our study (51.7% left, 48.3% right). Similarly left predominance was seen in study by Serrano et al (55.16%),¹⁸ whereas others had right side predominance- Bostman et al (61.17%)¹⁵ and Shen et al (52.29%).¹⁹

Most patients had Road Traffic Accident (60%), followed by fall (35%) and only 5% had sports related injury. This is similar to other studies by Serrano et al¹⁸ and Shen et al¹⁷ where motor vehicle accident

was the major mode of injury whereas sports injury predominated in studies of Thyagarajan et al²² and Ferran et al.¹⁷

The mean Constant score at final follow-up at one year was 89.12 which is comparable to study by Ferran et al (88.7).¹⁷ Studies by Thyagarajan et al (93.7)²² and Canadian Orthopedic Trauma Society (94)¹¹ had a higher Constant score. The meta analysis by Nourian et al also showed a higher Constant score (93.34, 17 studies).²¹

The overall complication rate was 8.33%- superficial infection in 2 cases (3.33%) and implant failure in 3 cases (5%). All fractures united with no nonunion. The mean time for union was 5.35 months which is similar to Nourian et al (17.12 weeks),²¹ Serrano et al (152 days)¹⁸ and Canadian Orthopedic Trauma Society (16.4 weeks).¹¹ However Shen et al had an earlier time to union 10 weeks.¹⁹ Studies of Ferran et al and Shetty et al similarly had union in all cases.^{17, 23} However many studies had non unions- Bostman et al (6.82%, 3 cases),¹⁵ Thyagarajan et al (5.88%, 1 case),²² Canadian Orthopedic Trauma Society (3.23%, 2 cases),¹¹ Shen et al (3%, 7 cases),¹⁹ Woltz et al (2.7%, 3 cases),²⁰ Serrano et al (2.23%, 3 cases)¹⁸ and meta analysis by Nourian et al (2%, 27 studies, 1104 patients).²¹ Delayed union was seen in studies of Thyagarajan et al (2 cases, 11.76%)²² and Bostman et al (3 cases, 6.82%).¹⁵

Serrano et al reported 1 infection (0.75%),¹⁸ Woltz et al 1 superficial infection (0.9%),²⁰ Canadian Orthopedic Trauma Society 3 wound infection (4.84%)¹¹ and Ferran et al 3 superficial infection (9.38%).¹⁷ Some studies also had deep infections-

Shen et al 1 deep infection (0.43%) and 4 superficial infections (3.03%),¹⁹ and Thyagarajan et al had 1 superficial and 1 deep infection (5.88% each).²² Bostman et al had 15 plate failure (34.01%),¹⁵ Woltz et al had 14 implant complication (12.6%),²⁰ Serrano et al 1 implant failure (0.77%)¹⁸ and Nourian et al 0.03% implant failure (15 studies, 624 patients).²¹

CONCLUSION

Our study concludes that plate fixation of displaced middle third clavicle fractures gives good functional outcome.

REFERENCES

1. Craig EV. Fractures of the clavicle. In: Rockwood CA, Matsen FA, editors. *The shoulder*. Vol 1. 3rd ed. Philadelphia: WB Saunders Company; 1990. p. 367-401.
2. Rowe CR. An atlas of anatomy and treatment of midclavicular fractures. *Clin Orthop Relat Res*. 1968;58:29-42.
3. Postacchini F, Gumina S, De Santis P, Albo F. Epidemiology of clavicle fractures. *J Shoulder Elbow Surg*. 2002;11(5):452-6.
4. Zlowodzki M, Zelle BA, Cole PA, Jeray K, McKee MD. Treatment of acute midshaft clavicle fractures: systematic review of 2144 fractures: on behalf of the Evidence-Based Orthopaedic Trauma Working Group. *J Orthop Trauma*. 2005;19(7):504-7.
5. Robinson CM, Goudie EB, Murray IR, Jenkins PJ, Ahktar MA, Read EO, et al. Open reduction and plate fixation versus nonoperative treatment for displaced midshaft clavicular fractures: a multicenter, randomized, controlled trial. *J Bone Joint Surg Am*. 2013;95(17):1576-84.
6. Wenninger JJ, Dannenbaum JH, Branstetter JG, Arrington ED. Comparison of complication rates of intramedullary pin fixation versus plating of midshaft clavicle fractures in an active duty military population. *J Surg Orthop Adv*. 2013;22(1):77-81.
7. Poigenfurst J, Rappold G, Fischer W. Plating of fresh clavicular fractures: results of 122 operations. *Injury*. 1992;23(4):237-41.
8. Mueller M, Burger C, Florczyk A, Striepens N, Rangger C. Elastic stable intramedullary nailing of midclavicular fractures in adults: 32 patients followed for 1-5 years. *Acta Orthop*. 2007;78(3):421-3.
9. Putnam MD, Walsh TM. External fixation for open fractures of the upper extremity. *Hand Clin*. 1993;9(4):613-23.
10. Schuind F, Pay-Pay E, Andrianne Y, Donkerwolcke M, Rasquin C, Burny F. External fixation of the clavicle for fracture or non-union in adults. *J Bone Joint Surg Am*. 1988;70(5):692-5.
11. Canadian Orthopaedic Trauma Society. Nonoperative treatment compared with plate fixation of displaced midshaft clavicular fractures. A multicenter, randomized clinical trial. *J Bone Joint Surg Am*. 2007;89(1):1-10.
12. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. *Clin Orthop Relat Res*. 1987(214):160-4.
13. 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):537-9.
14. McKee MD, Pedersen EM, Jones C, Stephen DJ, Kreder HJ, Schemitsch EH, et al. Deficits following nonoperative treatment of displaced midshaft clavicular fractures. *J Bone Joint Surg Am*. 2006;88(1):35-40.
15. Bostman O, Manninen M, Pihlajamaki H. Complications of plate fixation in fresh displaced midclavicular fractures. *J Trauma*. 1997;43(5):778-83.
16. Ricci WM. In Completely Displaced Midshaft Fractures of the Clavicle, Plate Fixation and Elastic Stable Intramedullary Nailing Did Not Differ in Function at One Year. *J Bone Joint Surg Am*. 2018;100(10):883.
17. Ferran NA, Hodgson P, Vannet N, Williams R,

Evans RO. Locked intramedullary fixation vs plating for displaced and shortened mid-shaft clavicle fractures: a randomized clinical trial. *J Shoulder Elbow Surg.* 2010;19(6):783-9.

18. Serrano R, Borade A, Mir H, Shah A, Watson D, Infante A, et al. Anterior-Inferior Plating Results in Fewer Secondary Interventions Compared to Superior Plating for Acute Displaced Midshaft Clavicle Fractures. *J Orthop Trauma.* 2017;31(9):468-71.

19. Shen WJ, Liu TJ, Shen YS. Plate fixation of fresh displaced midshaft clavicle fractures. *Injury.* 1999;30(7):497-500.

20. Woltz S, Duijff JW, Hoogendoorn JM, Rhemrev SJ, Breederveld RS, Schipper IB, et al. Reconstruction plates for midshaft clavicular fractures: A retrospective cohort study. *Orthop Traumatol*

Surg Res. 2016;102(1):25-9.

21. Nourian A, Dhaliwal S, Vangala S, Vezeridis PS. Midshaft Fractures of the Clavicle: A Meta-analysis Comparing Surgical Fixation Using Anteroinferior Plating Versus Superior Plating. *J Orthop Trauma.* 2017;31(9):461-7.

22. Thyagarajan DS, Day M, Dent C, Williams R, Evans R. Treatment of mid-shaft clavicle fractures: A comparative study. *Int J Shoulder Surg.* 2009;3(2):23-7.

23. Shetty SK, Chandran R, Ballal A, Mathias LJ, Hegde A, Shetty A. To Operate or not to Operate the Mid-Shaft Fractures of the Clavicle: A Comparative Study of Functional Outcomes of the Two Methods of Management. *J Clin Diagn Res.* 2017;11(1):Rc01-3.

FIGURES

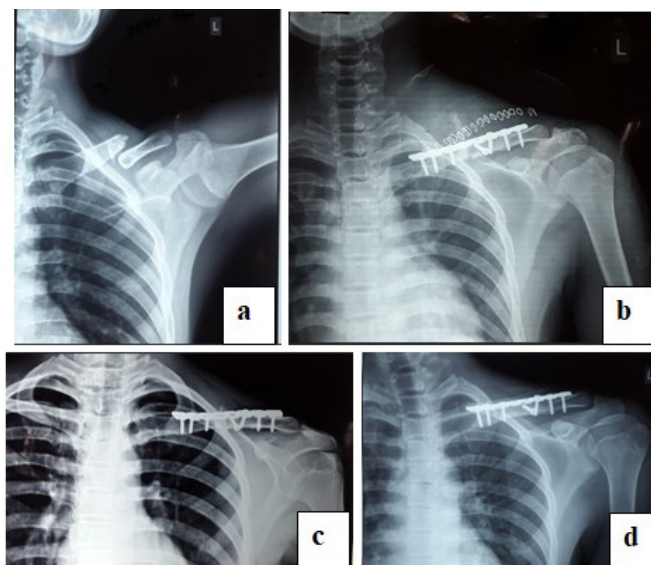


Figure 1 Preoperative (a) and immediate postoperative (b) radiographs of left clavicle fracture in 18 year old male. Follow-up radiographs at 3 months (c) and 1 year (d)



Figure 2. Range of motion at final follow-up (affected side left)

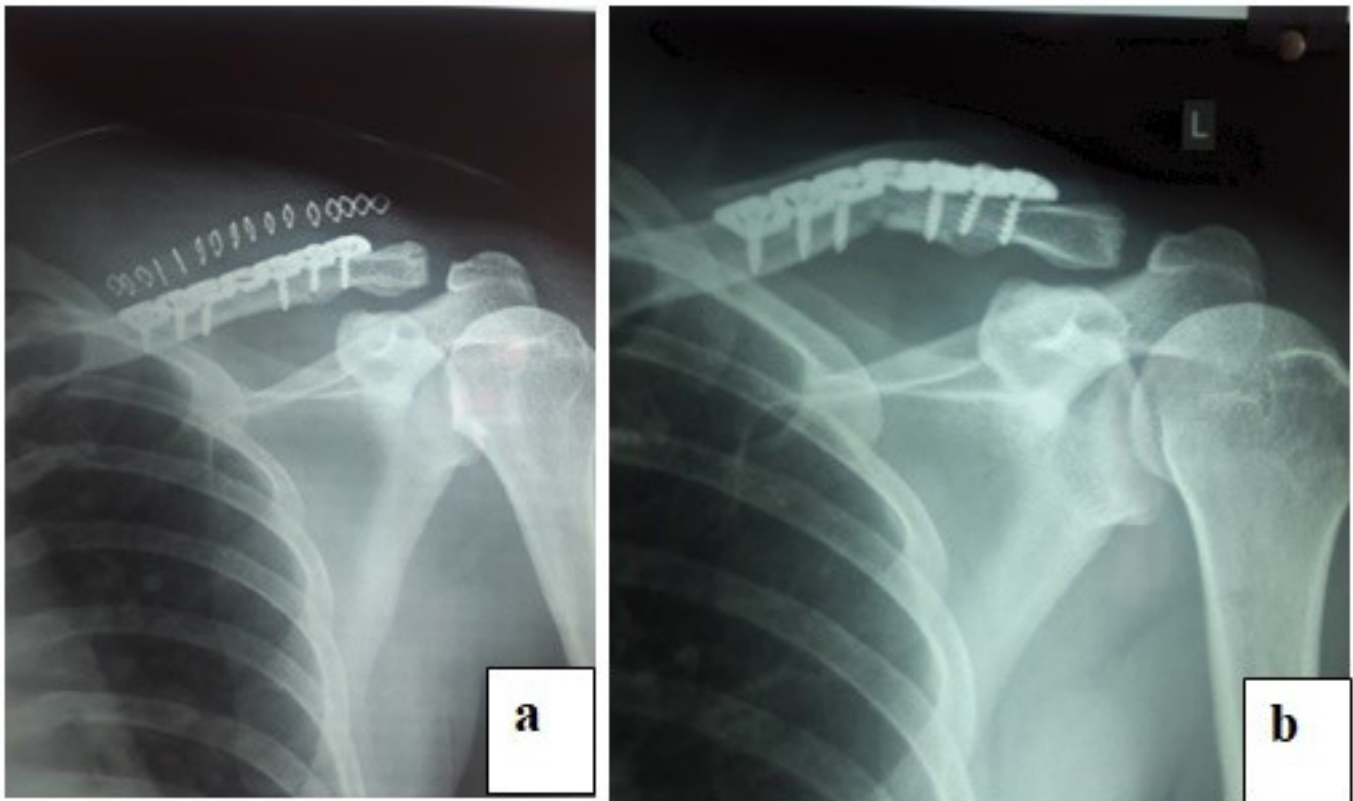


Figure 3. Radiograph showing implant failure. a. immediate postop b.6 weeks