Evaluation of Outcome of Type 2 Clavicular Fractures with Pre-Contoured Locking Compression Plates

Karki P[1], Shrestha D[2], KC D[3], Shrestha S[4], Ranabhat R[5],Yogi S[6], Giri S[7]

A**BSTRACT**

Background: Clavicular fracture is a common traumatic condition encountered around shoulder region in adult population, while mid-shaft fractures (Robinson's type 2) are found to be a most common variety. Management trends have changed in recent years from conservative to surgery, considering the higher rates of malunion, nonunion and poorer functional outcomes when managed non-operatively. An open reduction and internal fixation with precontoured locking compression plates has been a backbone of treatment of these fractures for several years with the aim of anatomical reduction, stable fixation and early rehabilitation of affected shoulder. Objective: To evaluate the outcome of Robinson type 2 clavicular fractures managed surgically with precontoured locking compression plates. **Methods:** Prospective study of 100 adult patients with Robinson type 2 clavicular fractures managed surgically with precontoured locking compression plates from January 2017 to November 2019 at the department of orthopaedics of Nepalgunj Medical College, Kohalpur. Outcomes were evaluated radiologically as well as functionally on the basis of Constant and Murley's scoring system. **Result**: Union was achieved in 98% patients with an average duration of 4.16 months with standard deviation of 1.23. Functional results were excellent in 80% and good in 17%. There were two major complications, one requiring reoperation and hardware removal due to deep infection while other went into nonunion. One patient sustained re-fracture within 2 weeks following implant removal after another trauma. **Conclusion**: Outcome of surgery was satisfactory with desirable result in almost all of the patients. The surgery was simple, easy to perform and was free from radiation exposure.

Keywords: Constant's score , Non-union, Plate exposure, Refracture , Type 2 Clavicular fracture

1. Dr. Prateek Karki
2. Dr. Dinesh Shrestha
3. Dr. Dipendra KC
4. Dr. Sabin Shrestha
5. Dr. Roshani Ranabhat
6. Dr. Sushil Yogi
7. Dr. Sagar Giri

Address for Correspondence:

Dr. Prateek Karki
Lecturer
Department of Orthopedics
Nepalgunj Medical College & Teaching Hospital
Kohalpur, Banke
Email: prateekkarki@gmail.com

INTRODUCTION

Fracture of clavicle is a common skeletal injury around shoulder region due to its subcutaneous location. It accounts for almost 5% of all fractures in adult population[1, 2, 3].

Indirect trauma to the shoulder is associated most frequently with clavicle fractures. Fall on an affected shoulder leading to bending force account for most (87%) of the clavicle fractures, while direct impact results in 7% and falls onto an outstretched hand may lead to 6% of all clavicle fractures[1]. Although rare, clavicle fracture may occur secondary to muscle contractions during seizures or secondary to minimal trauma due to pathological bone or as stress fractures[4]. The injury is more common in males as compared to females [2].

The standard treatment for midshaft clavicular fractures in adults has been conservative by an arm sling and a clavicular brace or a figure of eight bandage. But because of higher incidence of re-displacement, malunion, nonunion, prolonged immobilization and also the idea of moving a fractured limb soon after injury; there has been shift of trend from managing these fractures from conservative to surgical fixation with an intramedullary or an extra medullary devices[5, 6]. Of these two open reduction and internal fixation with pre-contoured locking plates enables an anatomical reduction, offers a stable fixation and allows early mobilization of fractured limb. The operative method has improved patient-oriented outcomes compared to that of non-operative treatment; considering incidence of non-union, functional outcome, pain scores, quality of life, cosmetic aspects and complications [5,6,7].

It has been observed that middle third fracture is the most common site of fracture, being the junction between the two cross-sectional bony configuration and lack of reinforcement by muscles or ligaments distal to the subclavius insertion, resulting in additional vulnerability[8].

Robinson classified middle third clavicle fracture as Type 2 and further subdivided it into four different groups: [9, 10, 11]

Type 2A1: undisplaced
Type 2A2: Angulated
Type 2B1: Displaced/ simple wedge
Type 2B2: Segmental/ Communited

In this study, angulated or displaced Robinson's type 2 clavicular fractures were selected for an internal fixation with pre-countered locking plate and results of surgical the treatment were evaluated.

Informed consent was taken from the patient and only those willing to take part in this study were included.

METHODS

Inclusion criteria:

100 patients with angulated or displaced Robinson's type 2 clavicular fractures, who attended Nepalgunj Medical College Teaching Hospital, Kohalpur from January 2017 to November 2019 were included in this prospective study.

Exclusion criteria:

1. Age < 18 years
2. Open fractures

Surgical technique

Under general anesthesia, patients were placed in beach chair position with a bolster placed in between two scapulas. An appropriate size plate was placed on anterio-superior surface having at least six cortices purchase on either side of fracture. One, two or three lag-screws screws were used as an adjunct for interfragmentary compression on larger fracture fragments.

Figure I: Lag screws used to achieve interfragmentary compression

For comminuted fractures, fixation was supplemented with an autologous cancellous bone graft taken from iliac crest (Figure II). The wound was closed over layers and the arm was placed in a sling.

Figure II: Supplementation with an autologous bone graft

Active assisted exercises were started as soon as the patient was comfortable. Arm pouch sling was given for every patient for two weeks. The sutures were removed after 14 postoperative days. Patients were followed up every month till there was an evidence of clinical and radiological union. Union was assessed clinically by absence of pain, tenderness and mobility at fracture site and radiologically by evidence of consolidation. Functional evaluation of shoulder range of motion was done according to Constant's score (table I) [5,12,13,14].

Constant score	Interpretation
<30	Unsatisfactory
30-39	Fair
40-59	Good
60-69	Very good
>70	Excellent

Table I: Interpretation of Constant score[14]

Deep infection was defined as an infection requiring implant removal, while superficial infections healed with an intravenous antibiotics and a regular change of dressing [15].

RESULT

Results were evaluated radiologically and on the basis of functional assessment in 100 patients with Robinson's type 2 claviclular fractures who were included as per inclusion criteria and underwent surgical fixation with pre-contoured locking compression plates. The patients were followed up for an average of 14 months (range, 12-16).

The injury was common between 30 to 40 years of age with an average age of 37 years with standard deviation of 8.42. Males were more commonly injured 65%. The most commonly observed fracture pattern was 2B1, 64%. Motor vehicle accident contributed the maximum number of patients 43% (figure III).

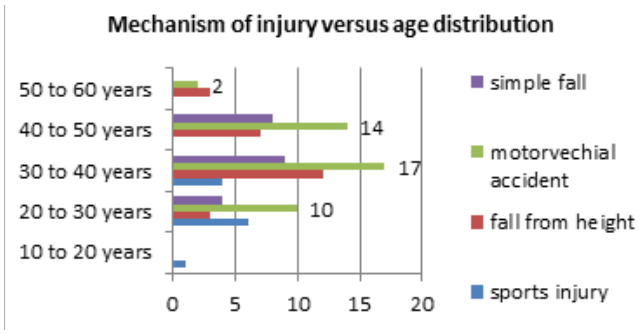

Figure III. Mechanism of injury versus age distribution

Union, both clinical and radiological, was achieved in most of the cases (98%) with an average duration of 4.16 months, standard deviation of 1.23.

One patient had to be re-operated due to deep infection. The implants had to be removed and fixed with an intramedullary elastic nail and skin grafting was done (figure IV), who became lost on subsequent follow up.

Figure IV: Plate removal and subsequent skin grafting after intramedullary splinting

While the other came with an exposed implants after a period of 6 months. The patient denied any further intervention. Plate was removed as per patients wish and no further management was done (figure V). On subsequent follow up he had fair functional outcome and opted to stay as such with physiotherapy.

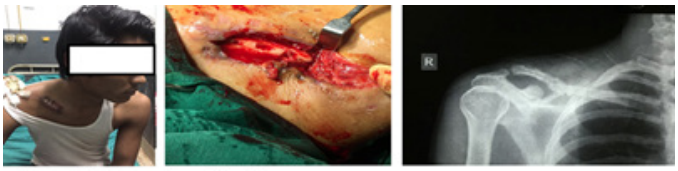

Figure V: Non union with plate exposure

One patient developed re-fracture within two weeks of implant removal following another trauma for which re-plating with bone grafting was done (figures VI).

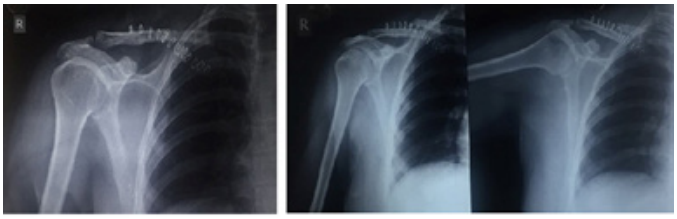

Figure VI: Re-fracture after implant removal

One patient had malunion (figure VII) due to implant loosening, but had good functional outcome.

Figure VII: Malunion in post-operative patient after implant removal

2 patients underwent revision surgery, while implant removal were not considered as a part of revision surgery. This particular subset included patient who underwent debridement with an intramedullary nail fixation (figure IV) and another who underwent re-plating (figure VII) for re-fracture. All remaining minor complications are shown in figure VIII.

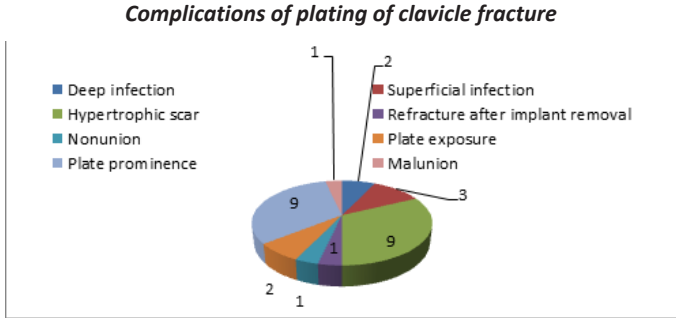

Figure VIII: Complications of plating of clavicle fracture

Functional outcome was excellent in 80 patients, good in 17 and fair in 2 patients (figure IX, X) among those one had non-union while the other had re-fracture after implant removal for which revision plating was done.

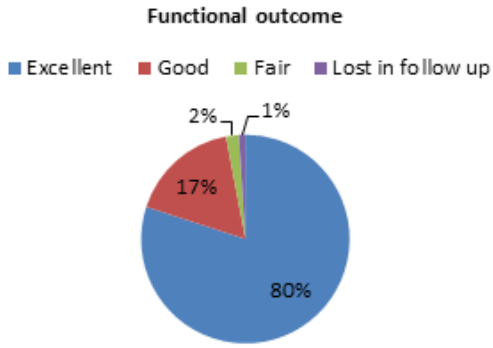

Figure IX: Functional outcome after final follow up according to Constant's score

Figure X: Shoulder range of motion at final follow-up the implants were removed in 45 patients

DISCUSSION

Traditionally clavicular fractures were managed with an arm sling and a figure of eight bandage or a simple arm sling alone. However neither of these techniques aid in direct reduction of fracture. Besides, it has also been observed that a figure of eight bandage carries a risk of an axillary pressure sores and compression of neurovascular bundles. Recent studies have also illustrated a poor functional outcome and a higher

rate of malunion and nonunion after nonoperative treatment, while the results of surgical management have improved substantially[16,17].

Altamimi et al. in his comparative study between non operative treatment versus primary plate fixation for displaced fractures concluded that plating group had better functional outcomes, lower rates of malunion and nonunion and a shorter time to union[18].

Several intramedullary nails have also been used for internal splintage of displaced midshaft clavicle factures; like Kirschner's wires, Knowels pins, Hagie pins, Rockwood pins and titanium nails more recently. But negotiation of nails in the medullary cavity of sigmoid shape bone possesses a challenge while the nail should also be strong enough to withstand deforming force across fracture site till it unites[19,20,21,22].

Golish et al. in his study summarized, plates to be more biomechanically superior than intramedullary nails in clavicular fracture fixation[21]. With the availability of precontoured locking compression plates, less stiffer implants like reconstruction plates have lost their favor in terms picking order being more prone to deform at fracture site.

This prospective study was designed to evaluate the outcome of pre-countered locking plate for displaced type 2 clavicular fracture.

In our study clavicular fracture was found to be more common in males 65% as compared to females 35%. The results were comparable with Toogood et al [2].

Of 80 patients with displaced clavicle fracture 2B, high energy trauma like motorvehicle accident and fall from height resulted in 57 (71.16%) patients (figure III). This result was similar with the study of Schiffer et al. and Van der Meijden et al [1, 4] .

Union was seen in all patients except one developed infected nonunion while the other was lost in follow up. Average time to union was 4.16 months with standard deviation of 1.23. The results were similar to that of Ethiraj et al[5].

Functional outcome was excellent in 80% and good in 17%. The results were comparable with that of Kumar Vijay BS 7 and Ethiraj et al[5].

Deep infection with staphyloccus aureus occurred in one patient where plate was exposed. Multiple debridements were done and eventually a skin flap was raised to cover the defect and was temporarily reduced with an intramedullary elastic nail (figure IV). After wound healing the patient did not come to her regular follow ups and suddenly stopped her visit.

A deep infection in another patient could not be controlled despite aggressive medical treatment and debridement. Subsequently the fracture developed in an established nonunion (figure V), but the patient refused any further treatment. That patient had fair functional outcome after implant removal. Shen et al[15] also mentioned deep infection to cause non-union.

One patient had malunion, most likely due to plate loosening after infection (figure VII) which was successfully managed with I/V antibiotics, eventually the plate was removed and the patient had good functional outcome.

Narsaria et al[23] documented 3% refracture after plate removal. In our study, refracture occurred in one patient within two weeks of implant removal, after a simple fall injury for which replating with autologous bone graft was done (figure VI).

Of minor complications, superficial wound infection in 3 patients were controlled with an intravenous antibiotics and a daily change of dressing for 7-10 days. All had good functional outcome. No patient with infection developed osteomyelitis.

Toogood et al in his study mentioned plate prominence in 8% because of lesser soft tissue envelope[2.] In our study Plate prominence was seen in 9 patients of which 3 had an excellent functional outcome and 6 had good functional.

CONCLUSION

Being a subcutaneously located bone, clavicle is more prone for fracture. Traditionally displaced midshaft clavicle fractures were treated conservatively which lead to increased rates of malunion and non-union. Of surgical intervention open reduction and internal fixation with pre-contoured locking plates seem to be superior to intramedullary nail. Current trend of management with pre-contoured locking plates allows anatomical reduction, stable fixation and better functional outcome. Early mobilization postoperatively within the limits of pain, allows the patient to return to his activities soon after surgery. The chance of infection however may exist which if superficial, can be managed with IV antibiotics and dressing. Plate prominence seemed to be a common complication because of lack of abundant soft tissue coverage which however had no effect in functional outcome. The surgery is simple and does not requires fluoroscopy, making it more feasible in rural settings as well. Duration of hospital stay is also not much of a concern.

REFERENCE

1. Schiffer G, Faymonville C, Skouras E, Andermahr J, Jubel A. Midclavicular fracture: not just a trivial injury: current treatment options. Deutsches Ärzteblatt International. 2010 Oct;107(41):711.
2. Toogood P, Horst P, Samagh S, Feeley BT. Clavicle fractures: a review of the literature and update on treatment. The Physician and sportsmedicine. 2011 Sep 1;39(3):142-50.
3. Van der Meijden OA, Gaskill TR, Millett PJ. Treatment of clavicle fractures: current concepts review. Journal of shoulder and elbow surgery. 2012 Mar 1;21(3):423-9.
4. Finelli PF, Cardi JK. Seizure as a cause of fracture. Neurology. 1989 Jun 1;39(6):858.
5. Prabhu Ethiraj , Parvataneni Prathap D, Arun HS, Nagakumar JS. Functional outcome in surgical management of midshaft clavicle fractures fixed with precontoured plate in adults. International Journal of Orthopaedics. 2016;2(4):458-62.
6. Kulshrestha V. Primary plating of displaced mid-shaft clavicular fractures. Medical Journal Armed Forces India. 2008 Jul 1;64(3):208-11.

7. Kumar Vijay BS. Operative treatment of clavicle midshaft fractures by locking plate. International Journal of Orthopaedics. 2019;5(3):01-3.
8. Bernat A, Huysmans T, Van Glabbeek F, Sijbers J, Gielen J, Van Tongel A. The anatomy of the clavicle: A Three-dimensional Cadaveric Study. Clinical Anatomy. 2014 Jul;27(5):712-23.
9. Robinson CM. Fractures of the clavicle in the adult: epidemiology and classification. The Journal of bone and joint surgery. British volume. 1998 May; 80(3):476-84.
10. Khan LK, Bradnock TJ, Scott C, Robinson CM. Fractures of the clavicle. JBJS. 2009 Feb 1;91(2):447-60.
11. Dhoju D, Shrestha D, Parajuli NP, Shrestha R, Sharma V. Operative fixation of displaced middle third clavicle (Edinburg Type 2) fracture with superior reconstruction plate osteosynthesis. Kathmandu University Medical Journal. 2011;9(4):286-90.
12. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. Clinical orthopaedics and related research. 1987 Jan(214):160-4.
13. Angst F, Schwyzer HK, Aeschlimann A, Simmen BR, Goldhahn J. Measures of adult shoulder function: Disabilities of the arm, shoulder, and hand questionnaire (DASH) and its short version (QuickDASH), shoulder pain and disability index (SPADI), American shoulder and elbow surgeons (ASES) society standardized shoulder assessment form, constant (Murley) score (CS), simple shoulder test (SST), oxford shoulder score (OSS), shoulder disability questionnaire (SDQ), and Western Ontario shoulder instability index (WOSI). Arthritis care & research. 2011 Nov;63(S11):S174-88.
14. Booker S, Alfahad N, Scott M, Gooding B, Wallace WA. Use of scoring systems for assessing and reporting the outcome results from shoulder surgery and arthroplasty. World journal of orthopedics. 2015 Mar 18;6(2):244.
15. Shen WJ, Liu TJ, Shen YS. Plate fixation of fresh displaced midshaft clavicle fractures. Injury. 1999 Sep 1;30(7):497-500.
16. McKee MD, Wild LM, Schemitsch EH. Midshaft malunions of the clavicle. J Bone Joint Surg Am. 2003;85:790-7.
17. McKee MD, Pedersen EM, Jones C, Stephen DJ, Kreder HJ, Schemitsch EH, Wild LM, Potter J. Deficits following nonoperative treatment of displaced midshaft clavicular fractures. J Bone Joint Surg Am. 2006;88:35-40.
18. Altamimi SA, McKee MD. Canadian Orthopaedic Trauma Society. Nonoperative treatment compared with plate fixation of displaced midshaft clavicular fractures. Surgical technique. J Bone Joint Surg Am. 2008;90(Suppl 2):1-8
19. Rowe CR. 4 An Atlas of Anatomy and Treatment of Midclavicular Fractures. Clinical Orthopaedics and Related Research (1976-2007). 1968 May 1;58:29-42.
20. Andermahr J, Jubel A, Elsner A, Johann J, Prokop A, Rehm KE, Koebke J. Anatomy of the clavicle and the intramedullary nailing of midclavicular fractures. Clinical Anatomy: The Official Journal of the American Association of Clinical Anatomists and the British Association of Clinical Anatomists. 2007 Jan;20(1):48-56.
21. Golish SR, Oliviero JA, Francke EI, Miller MD. A biomechanical study of plate versus intramedullary devices for midshaft clavicle fixation. Journal of orthopaedic surgery and research. 2008 Dec;3(1):28.
22. Jubel A, Andermahr J, Schiffer G, Tsironis K, Rehm KE. Elastic stable intramedullary nailing of midclavicular fractures with a titanium nail. Clin Orthop Relat Res. 2003;408:279-85.
23. Narsaria N, Singh AK, Arun GR, Seth RR. Surgical fixation of displaced midshaft clavicle fractures: elastic intramedullary nailing versus precontoured plating. Journal of Orthopaedics and Traumatology. 2014 Sep 1;15(3):165-71.