APCCR
Advances in Pre-Clinical and Clinical Research

ASCENTIA PUBLISHERS

Original Research

Functional and Radiological Outcomes Following Locking Plate Fixation of Midshaft Clavicle Fractures

Sujith Shahul [1]*, Hashir Hassan [1], Sanoj Shahul [2], Shani Rahim [3], Navin K Gazi [4], Basavaraj G.C [5]

[1] Department of Orthopedics, Rashid Hospital, Dubai, UAE
[2] Department of Orthopedic Oncology, Medstar Georgetown Orthopedic Institute, Washington, DC, USA
[3] Department of General Surgery, Khorfakkan Hospital, Sharjah, UAE
[4] Department of Family Medicine, VA North Texas Health Care System, Dallas, TX, USA
[5] Department of Orthopedics, J.J.M Medical College, Davangere, Karnataka, India

Abstract: Midshaft clavicle fractures are injuries that frequently require surgical treatment. This study aimed to assess the results of operative treatment with a locking plate for midshaft clavicle fractures. Twenty male patients, aged 19-59 years, with displaced midshaft clavicle fractures were treated with a locking plate between May 2010 and August 2012. The patients were evaluated according to injury mode, fracture classification, surgical timing, and postoperative results. Fractures were classified according to Robinson's system. Functional results were assessed using the Constant and Murley scoring systems. The leading cause of injury noted was a two-wheeler fall on the shoulder (40%), followed by a road traffic accident (25%). Most fractures (85%) were of type B1. Ninety percent of the surgeries were performed less than 7 days post-injury. Most patients (90%) experienced fracture union between 8-12 weeks. Hypertrophic scars (15%), prominence of the plate (10%), delayed union (10%), and loosening of the plate (5%) were minor complications. Good functional results were obtained in 75% of patients, fair results in 20%, and good results in 5%. This study demonstrated that operative fixation of midshaft clavicle fractures using locking plates showed good fracture healing and functional rehabilitation. Treatment was associated with low complications and excellent functional outcomes in most patients soon after surgery.

Keywords: Clavicle fracture; Locking plate; Midshaft; Midshaft

Citation: Shahul S, Hassan H, Shahul S, Rahim S, Gazi NK, Basavaraj GC. Functional and Radiological Outcomes Following Locking Plate Fixation of Midshaft Clavicle Fractures. Advances in Preclinical and Clinical Research. 2025; 2:202502.

***Corresponding Author**: sujithshahul@gmail.com; Tel.: +971 556450682

Funding: None

Conflict of Interest: None

Received: 05 Apr 2025; **Accepted**: 10 Apr 2025; **Published**: 14 Apr 2025

Copyright: © 2025 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Published by Ascentia Publishers; eISSN: xxxx-xxxx

Introduction

Fractures of the clavicle are one of the most prevalent injuries caused by trauma, accounting for approximately 5-10% of all fractures. Mid-clavicle fractures, specifically, constitute about 60-80% of all clavicle fractures and often occur due to falls on the shoulder or direct blows to the region.[1] These fractures tend to be classified based on the Neer classification system, dividing them into three parts depending on the extent of displacement and involvement of the surrounding anatomical structures.[2]

Treatment of these fractures has been controversial, as conventional treatments such as sling immobilization tend to have suboptimal functional results, especially in extensively displaced fractures or fractures in active patients.[3]

Traditionally, non-operative treatment has been the initial management for the majority of clavicle fractures with a high union rate in uncomplicated and minimally displaced fractures.[4] Non-operative treatment, however, can lead to malunion, non-union, or poor function when fractures are displaced or have substantial shortening.[5] Recent developments in surgery and implants have increased the trend in operative management, particularly for fractures with notable displacement, comminution, or high-demanding patients.[1] Locking plates have become more popular in the fixation of midshaft clavicle fractures because of their biomechanical properties, especially stability and the capacity to bridge complicated fractures.[6] Locking plates offer more stable fixation in osteoporotic bone and fractures with low bone quality, which are frequently difficult to stabilize using conventional non-locking plates or intramedullary implants.[7] The plates also provide improved fracture alignment and minimize the risk of plate failure, making them a good option for fractures with extensive comminution or displacement. The present study aimed to assess the results of operatively managed clavicle midshaft fractures with locking plate fixation by evaluating the incidence of union, complications, and functional results.

Materials And Methods

The present study was carried out between May 2010 and August 2012 at the Department of Orthopedics of Bapuji Hospital and Chigateri General Hospital, which is attached to J.J.M. Medical College, Davangere. Twenty male patients with midshaft clavicle fractures underwent surgery.

Inclusion and Exclusion Criteria: Male patients aged > 18 years who needed surgical treatment for displaced and comminuted midshaft clavicle fractures were included in the study. Formal consent was obtained from all patients before inclusion. The exclusion criteria were as follows: age < 18 years, open fractures, medial or lateral third clavicular fractures, pathological fractures, undisplaced fractures, concomitant head or neurovascular injuries, known non-union from known previous fractures, and medical surgical contraindications, such as heart or renal failure.

Data Collection and Preliminary Examination: General details such as name, age, sex, occupation, and address were noted. A thorough history was elicited for the mode of injury, which fell on the shoulder, road traffic accidents, direct injury to the shoulder, and outstretched hand falls. Details of the location of the pain and swelling were also elicited. History of past medical conditions and family history were recorded. A systematic physical examination was performed starting from the overall condition of the patients (pallor, pulse rate, and blood pressure). The respiratory and cardiovascular systems were examined for any abnormalities. Local inspection of the clavicle included observation, palpation, and evaluation of the shoulder movements. Abnormal swelling, state of skin, tenderness, abnormal movement, and crepitus were observed. The distal neurovascular status of the involved limbs was also examined.

Radiological Evaluation: Clavicle plain radiographs were obtained, as well as anteroposterior shoulder views, to evaluate the location of the fracture, its displacement, and comminution. Robinson's classification system was used to classify fractures.

Preoperative Preparation: Physician evaluated all the patients for fitness for surgery. Preoperative investigations, such as hemoglobin level, total and differential white blood cell counts, ESR, renal function tests, and ECG, were performed. HBsAg and HIV levels were also measured. Patients were fasted for 6 hours prior to surgery, and intravenous antibiotics (1 g Inj. Taxim) was administered 30 min prior to surgery.

Surgical Procedure: The operation was performed under general anesthesia. An incision of 7-9 cm was made over the fracture site on the anterior surface of the clavicle. Dissection of the soft tissues such as the skin, subcutaneous tissue, and platysma was performed, and there was minimal periosteal dissection. The fracture was reduced and a 3.5 mm locking compression plate was fixed to the superior side of the clavicle. Locking and cortical screws were used to fix the plate onto the medial and lateral fragments. The wound was closed in layers following careful hemostasis.

Postoperative Care and Rehabilitation: Postoperatively, the patients were maintained nil orally for 4-6 hours and administered intravenous fluids. Antibiotics were maintained for 10 days and analgesics were administered as required. The arm was immobilized on an arm pouch. Rehabilitation was initiated at 2 weeks with the use of gentle pendulum exercises, and active range of motion exercises were initiated at 4-6 weeks. Follow-up was planned every four weeks to check for fracture healing and shoulder function.

Functional Outcome Assessment: Functional outcomes were assessed using the Constant and Murley scoring system, which includes both subjective and objective items such as pain, activities of daily living, range of shoulder movement, and strength. The aggregate score ranged from 0 to 100 points, with > 90 indicating excellent, 80-89 good, 70-79 fair, and less than 70 poor.

Results

This study included 20 male patients who were treated surgically for midshaft clavicle fractures with a locking plate. The injury mode distribution showed that 8 cases (40%) were caused by falls on the shoulder from two-wheelers, 5 cases (25%) were caused by road traffic accidents, 4 cases (20%) were caused by simple falls, and 3 cases (15%) were caused by falls on an outstretched hand. In terms of age groups, 8 patients (40%) were aged 19-29 years, 4 patients (20%) were aged 30-39 years, 3 patients (15%) were aged 40-49 years, and 5 patients (25%) were aged 50-59 years. Most fractures (85%) were on the left side, while only 3 cases (15%) were on the right side. With respect to the type of fracture, 17 cases (85%) were B1 type (middle third clavicle fracture) and 3 cases (15%) were B2 type. The majority of the operations (90%) were conducted within 7 days of trauma, and 2 cases (10%) were operated between 7-14 days. The size of the locking plate differed, with 12 patients (60%) receiving plates with 7 holes, 4 patients (20%) receiving plates with 8 holes, and 4 patients (20%) receiving plates with 9 holes. Most patients (90%) healed the fracture between 8-12 weeks, and 2 patients (10%) took more than 12 weeks to achieve union. (Table 1)

Table 1. Demographic and clinical characteristics of male patients with middle third clavicle fractures treated by locking plate (n=100)

Demographic and clinical characteristics		Frequency (%)
Mode of Injury	Fall on shoulder from two	8 (40%)
	Road traffic accident	5 (25%)
	Simple fall on	4 (20%)
	Fall on outstretched hand	3 (15%)
Age groups	19-29	8 (40%)
	30-39	4 (20%)
	40-49	3 (15%)
	50-59	5 (25%)

Side	Right	3 (15%)
	Left	17 (85%)
Types – 2 Middle third clavicle fracture	B1	17 (85%)
	B2	3 (15%)
Time of surgery	< 7 days	18 (90%)
	7-14 days	2 (10%)
Length of Plate	7 holes	12 (60%)
	8 holes	4 (20%)
	9 holes	4 (20%)
Duration of union	8-12 week	18 (90%)
	>12 weeks	2 (10%)

In the present study, functional results and postoperative complications were evaluated in all patients. Minor complications included hypertrophic skin scars in 3 (15%), prominence of the plates in 2 (10%), delayed union in 2 (10%), and loosening of the plate in 1 (5%). There were no cases of plate breakage (0%), which was noted as a major complication. With regard to functional outcomes, most patients had a very good result, with 15 patients (75%) having an excellent functional outcome. Four patients (20%) had a good functional outcome and one patient (5%) had a fair outcome, with no patients (0%) having a poor outcome. (Table 2)

Table 2. Postoperative complications and functional outcomes in male patients with clavicle midshaft fractures treated by locking plate

Postoperative complications and functional outcomes		**Frequency (%)**
Minor	Hypertrophic skin scar	3 (15)
	Plate prominence	2 (10)
	Delayed union	2 (10)
	Plate loosening	1 (5)
Major	Pate breakage	0 (0)
Functional outcome	Excellent	15 (75%)
	Good	4 (20%)
	Fair	1 (5%)
	Poor	0 (0%)

The radiological and functional progression of a patient who underwent surgery for midshaft clavicle fracture using a locking plate is shown in figure 1. Preoperative radiography revealed a displaced fracture, and immediate postoperative radiography indicated successful internal fixation with the locking plate. Six weeks after the operation, radiological assessment revealed a good union of the fracture. The patient showed an enhanced shoulder mobility. Twelve weeks after surgery, an additional radiological evaluation revealed continued osseous union, and the patient exhibited nearly complete recovery of shoulder function. Serial clinical photographs showed gradual improvements in shoulder abduction, forward flexion, and internal rotation, suggesting a successful result after surgery.

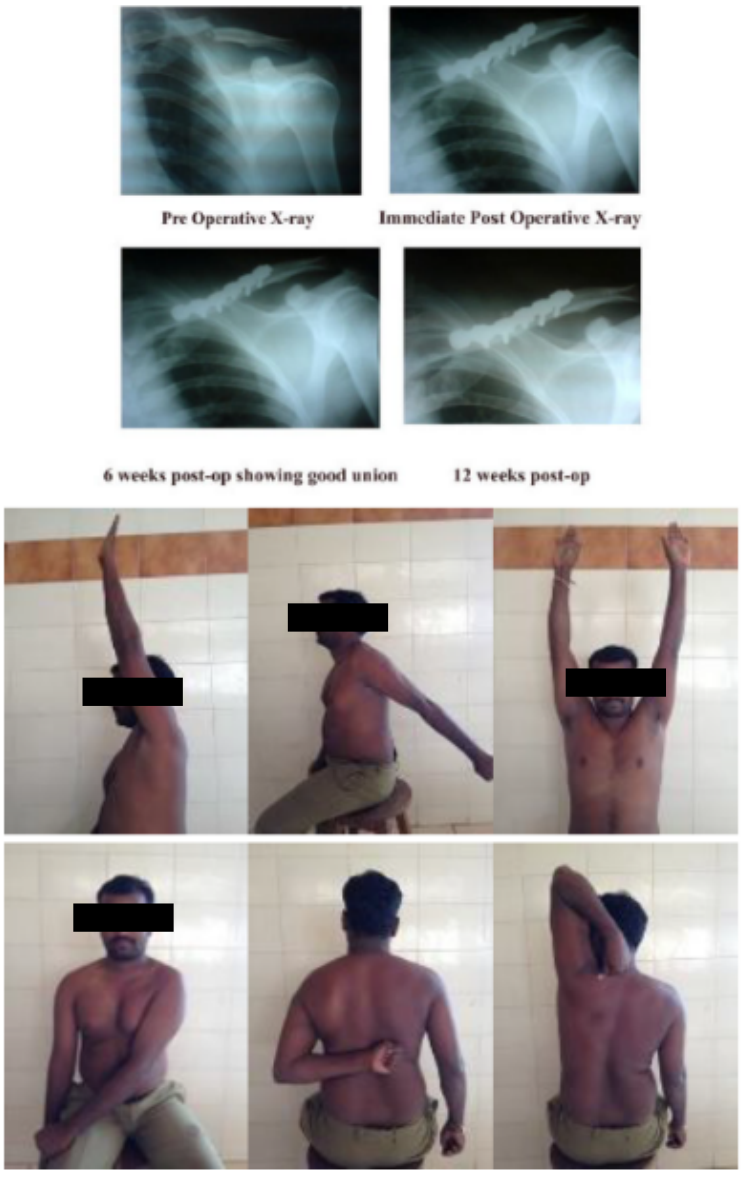

Figure 1. Postoperative radiological and functional outcomes of midshaft clavicle fracture: Flexion, Extension, Abduction, Internal and External Rotation

Discussion

The present study compared the operative fixation of midshaft clavicle fractures with a locking plate with the existing literature on the basis of the parameters of importance. Regarding the causation of the injury, in the present study, it was found that 40% were caused by a fall on the shoulder from a two-wheeler, 25% by road traffic accidents, 20% by simple falls, and 15% by a fall on an outstretched hand. The age distribution in the present study revealed that 40% of the patients belonged to the 19-29 age group. Other research, including Modi et al. and Schiffer et al., did not report specific injury causes, and age range information.[8,9] With regard to the side of fracture, 85% of the fractures in this study were on the left side, as per Modi et al., though other studies did not report specific fracture side statistics.[8] The classification of fractures in this study was also mainly B1 (85%), followed by 15% of B2 fractures, a pattern which was also found by Modi et al. to be the same.[8] The fractures were classified according to the system outlined by CM Robinson (28 Type B1 fractures and 25Type B2 fractures).[10] Altamimi and McKee examined rates of persistent oriented result and complications after non-operative treatment and those following plate fixation of displaced midshaft clavicle fractures. 132 patients with a displaced midshaft fractures of the clavicle were randomized to operative treatment with plate fixation or non-operative treatment and results showed that mean time to radiographic union 16.4 weeks in the operative group.[11] In 2010, Gereon Schiffer et al. reported and assessed the present treatment options based on a selective review of the literature.[9] They validated some long-standing concepts and disproved others. The danger of non-union following conservative treatment was earlier in the range of 1% to 2% but has proved to be much higher in selected subgroups like in those with severe displacement, female gender, and old age patients.[9] Recent implants and methods have enhanced the safety and chances of resulting in bony union with a Reconstruction plate or reconstruction LCP for clavicle shaft fracture and can be utilized to achieve stable fixation.[9,12]

Surgical timing in the present study showed that 90% of surgeries were performed within 7 days of injury and that Modi et al., had no mention of the timing of surgery.[8] Plate types utilized in the present study were locking plates of 7, 8, or 9 holes, with the majority being 7-hole plates (60%). Whereas other studies, such as those of Modi et al., employed locking compression plates (LCP), the plate configurations were not described in detail. Union times in this study indicated that 90% of the patients had their union by 8-12 weeks and that a minority (10%) took longer than 12 weeks.[8] Modi et al., had reported a mean union time of 4.6 months or about 18.4 weeks.[8] For complications, the present study revealed some minor problems in the form of hypertrophic scars (15%), prominence of plates (10%), delayed union (10%), and loosening of plates (5%), without any plate breakages. Modi et al., had 1 superficial infection that was managed by oral antibiotics, 1 stress fracture medial to the plate, which was treated conservatively and the fracture healed. There were 2 plate failures which needed revision, one at 8 days post-op and another at 6 weeks.[8] Although Erborgt et al., mentioned a variety of complications, wound infection was observed in 18% of the cases, %% of the cases had non-union, 7% had neurological symptoms and %% of the cases had refracture.[13] The functional outcome in this study was excellent in 75% of patients, with 5% having fair outcomes, and this was in line with generally positive outcomes in other studies, albeit some studies, such as those conducted by Modi et al., did not report sufficient functional outcome data.[8] Tavitian and Davison studied preoperative disabilities, postoperative outcomes, and complications among clavicle fractures. Eleven fractures occurred in the midshaft, eight in the lateral third, and one in the medial third included within the study. Complications included were clavicle non-union with 18 (6%) cases, 45 (15%) soft tissue complications, seven (2%) scar complication and 24 (8%) union failures.[14]

Conclusion

Operative management of midshaft clavicle fractures with locking plates showed promising results in the present study. Most patients had fracture union between 8-12 weeks, and 75% of cases had excellent functional results. Hypertrophic scars and plate prominence were seen as minor complications, but no severe complications such as plate breakage were encountered. The findings favored the use of locking plates in midshaft clavicle fractures, with minimal complications and excellent functional outcomes.

References

1. Pecci M, Kreher JB. Clavicle fractures. American family physician. 2008;77(1):65-70.
2. Kristiansen B, Andersen UL, Olsen CA, Varmarken JE. The Neer classification of fractures of the proximal humerus: an assessment of interobserver variation. Skeletal radiology. 1988;17:420-2.
3. Van der Meijden OA, Gaskill TR, Millett PJ. Treatment of clavicle fractures: current concepts review. Journal of shoulder and elbow surgery. 2012;21(3):423-9.
4. Paladini P, Pellegrini A, Merolla G, Campi F, Porcellini G. Treatment of clavicle fractures. Translational Medicine@ UniSa. 2012;2:47.
5. Wiesel BB, Getz CL. Current concepts in clavicle fractures, malunions and non-unions. Current Opinion in Orthopaedics. 2006;17(4):325-30.
6. Little KJ, Riches PE, Fazzi UG. Biomechanical analysis of locked and non-locked plate fixation of the clavicle. Injury. 2012;43(6):921-5.
7. Cronier P, Pietu G, Dujardin C, Bigorre N, Ducellier F, Gerard R. The concept of locking plates. Orthopaedics & Traumatology: Surgery & Research. 2010;96(4):S17-36.
8. Modi N, Patel AD, Hallam P. Outcome of 62 clavicle fracture fixations with locked compression plate: Is this the right way to go?. Injury Extra. 2011;42(9):118.
9. Schiffer G, Faymonville C, Skouras E, Andermahr J, Jubel A. Midclavicular fracture: not just a trivial injury: current treatment options. Deutsches Ärzteblatt International. 2010;107(41):711.
10. Robinson CM. Fractures of the clavicle in the adult: epidemiology and classification. The Journal of Bone & Joint Surgery British Volume. 1998;80(3):476-84.
11. Altamimi SA, McKee MD. Non-operative treatment compared with plate fixation of displaced midshaft clavicular fractures: Surgical technique. JBJS. 2008;90(Supplement_2_Part_1):1-8.
12. Cho CH, Song KS, Min BW, Bae KC, Lee KJ. Reconstruction plate versus reconstruction locking compression plate for clavicle fractures. Clin Orthop Surg. 2010;2(3):154-9.
13. Verborgt O, Pittoors K, Van Glabbeek F, Declercq G, Nuyts R, Somville J. Plate fixation of middle-third fractures of the clavicle in the semi-professional athlete. Acta Orthop Belg. 2005;71(1):17-21.
14. Der Tavitian J, Davison JN, Dias JJ. Clavicular fracture non-union surgical outcome and complications. Injury. 2002;33(2):135-43.

Disclaimer/Publisher's Note: The content, viewpoints, and information in every publication are exclusively those of the respective author(s) and contributor(s) and not indicative of the stance held by Ascentia Publishers or the editor(s). Ascentia Publishers and/or the editor(s) disclaim any responsibility for any injury to individuals or property resulting from the ideas, methods, instructions, or products referred to in the content.