

*Original Article***Better Functional Outcomes in Plate Fixation of Midshaft Clavicle Fracture in Dr. Soetomo General Academic Hospital**Mouli Edward^{1,2} , Steesy Benedicta³, Teddy Heri Wardhana^{1,2} ¹Department of Orthopedics and Traumatology, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia²Department of Orthopedics and Traumatology, Dr. Soetomo General Academic Hospital, Surabaya, Indonesia³Department of Orthopedics and Traumatology, EMC Pulomas, Jakarta Timur, IndonesiaCorrespondence should be addressed to Teddy Heri Wardhana, Department of Orthopedics and Traumatology, Faculty of Medicine, Universitas Airlangga, Jl. Mayjend Prof. Dr. Moestopo 6-8, Surabaya 60286, Indonesia. e-mail: teddy-heri-w@fk.unair.ac.id**ABSTRACT**

Background: Clavicle fractures are common, with treatment trends shifting from conservative to operative. While malunion often has minimal functional impact, nonunion rates and associated complications remain a concern. This study evaluates functional outcomes between plating and conservative approaches for midshaft clavicle fractures.

Methods: A total of 531 cases with a midshaft clavicle fracture presented to the emergency room between January 1, 2014 and December 31, 2018 at Dr. Soetomo General Academic Hospital, Surabaya, Indonesia. Patients with a head injury, multiple traumas, re-fracture, malunion, open fracture, and pathological fracture were excluded. 161 patients remained. A conservative group (84 patients) was treated using an arm sling, and an operative group (77 patients) with Open Reduction and Internal Fixation (ORIF) and S-plate. Clinical and functional scores were evaluated retrospectively a minimum of 6 months after treatment. Shoulder function was evaluated using the Constant Shoulder Score and Manual Muscle Test.

Results: 117 (72.7%) patients were male, with a mean age of 35.4 ± 12.33 years old. The right side was dominantly injured. The Manual Muscle Test score in the operative group was five, and in the conservative group, four. The Constant Shoulder score in the operative group was 93.38 ± 7.529 , and in the conservative group, 86.60 ± 7.560 ($p < 0.001$). The DASH score in the operative group was 10.05 ± 6.98 and in the conservative group, 23.67 ± 3.49 ($p < 0.001$).

Conclusion: In our study, surgery on clavicle midshaft fractures showed significant improvement and satisfaction compared to conservative treatment. Patients gained better function.

Keywords: Clavicle; Fracture; Operative procedure; Conservative treatment; Human and medicine

INTRODUCTION

Clavicle fractures have the highest incidence rate, accounting for 2.6-3% of all fractures. The cause of clavicle fractures is mostly from direct blows to the clavicle with the highest incidence in the second and third decades of life. Cochrane compared operative and conservative treatments for clavicle fractures using a systematic review and meta-analysis and found that patients treated with open reduction internal fixation (ORIF) had a union rate of 2.5% compared to the operative group. Malunion of the clavicle has little functional consequence. Many techniques showed a high hand injury union rate and low complication rate in the fixation of clavicle fractures.^{1,2}

A clavicle fracture is also possible to treat non-operatively. Clinical research should be objectively directed to encourage each injury assessment, such as function and the patient's expectations, as well as fracture location, fracture type therapy based on this evaluation, and the rational consideration of risk potency and the benefits of the operation. Some recent studies have shown that the nonunion rate in midshaft clavicle fractures ranges from 15-20%, with a loss of shoulder strength in 18-33%, mild to moderate residual pain, and brachial plexus irritation.^{3,4} Some research has also described functional and cosmetic deficits associated with malunion of the clavicle.^{5,6}

The therapy goal in clavicle fractures is fewer complications and better functional out-



comes. Return to function and the avoidance of long-term complications are of socio-economic importance.⁶

Some modern concepts, such as validation, responsiveness, and consistency in measurement, are now available for the evaluation of shoulder girdle injuries. A clinical study based on the anatomical area used patient-oriented measurement states, such as SF-36, the patients' extremity specific results, such as Disability of the Arm, Shoulder, and Hand (DASH), Constant Shoulder Score (CSS), and radiological measurements. In the conservative treatment, patients were given an arm sling or modified figure of eight bandages. In the operative treatment, superior S-plate osteosynthesis was selected because it provides less muscular stripping and better biomechanics.⁴ This study evaluated union rate and functional improvement in patients with clavicle fractures, comparing conservative and operative treatments in Dr. Soetomo General Academic Hospital from January 1, 2014 to July 31, 2018.

MATERIAL AND METHODS

Study Design

This retrospective, analytical, observational study was performed at the Orthopaedic and Traumatology outpatient clinic of Dr. Soetomo General Academic Hospital, Surabaya,

Indonesia. The ethical committee had already approved the study at the hospital. All patients were informed and gave informed consent.

Participants

Using the hospital database, we identified 531 cases. The inclusion criteria were (1) new cases < 14 days between fracture and treatment, (2) and the patients were aged between 18-60 years old. The exclusion criteria were (1) multiple trauma, (2) multiple fractures, (3) assisted neurological or vascular injury, (4) open fractures, (5) bilateral clavicle fractures, and (6) pathological fractures. After excluding these cases, 100 patients were unable to be contacted or refused to participate in the research, and a total of 161 cases were included. Out of these patients, 84 patients were treated operatively and 77 patients were treated conservatively (Figure 1).

Interventions

For all patients, we evaluated the clinical examination along with standard anteroposterior and oblique clavicle and bilateral anteroposterior radiographs. Undisplaced midshaft clavicle fractures had an arm sling prescribed. Displaced midshaft fractures were treated with modified eight bandages using stockinette and orthopaedic padding wrapped across the shoulders and the patient's back (Figure 2). The figure of eight bandages or arm sling were

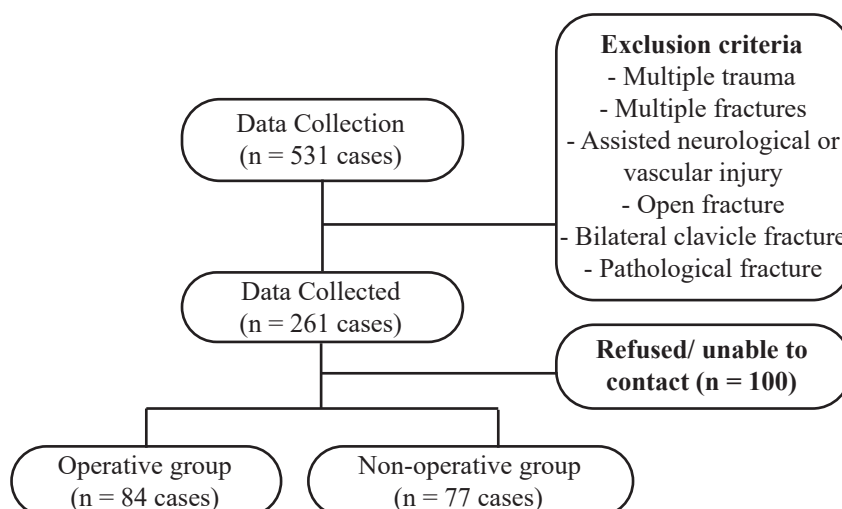


Figure 1. Flowchart of inclusion in the study design





Figure 2. Conservative treatment of a midshaft clavicle fracture, left to right: (A) Clinical appearance of the clavicle midshaft fracture. (B) Treated with the figure of eight bandages. (C) Initial radiograph of the fracture.



Figure 3. Operative treatment of midshaft clavicle fracture (A). Intraoperative reduction using a 3.5mm-9 hole reconstruction plate and lag screw fixation. (B) Initial radiograph of the fracture. (C) Radiograph after fracture fixation.

used for six weeks with assisted active range of motion exercises as the pain was tolerated. After three weeks, the patients were asked to perform pendulum exercises. At week 8, the patients were asked to remove the arm sling or figure-of-eight bandages and perform full weight-bearing.

In the operative group, the subject was put under general anesthesia. The patient was in a supine position with a pillow under the affected shoulder. The anterior approach was performed with the protection of the supraclavicular nerve. The fracture was reduced to gain a normal length. In comminuted fractures, we reduced as much as anatomically possible and fixed a 3.5mm S-reconstruction plate in the superior clavicle with a minimum of six cortices in each fragment. If necessary, a lag screw was also added to the stabilized fragments. The wound was sutured with an absorbable monofilament suture. The patient was given an arm sling for 10-14 days until the wound completely healed. Active range of motion exercises started in the second week (Figure 3).

Outcome Measures

The patients were evaluated retrospectively, and a minimal evaluation was conducted six months after injury. We used telephone calls, texting, mail, and home visits to contact patients to complete the Disability of Arm, Shoulder, and Elbow (DASH) score

questionnaire and Constant Shoulder Score (CSS) and Manual Muscle tests. The DASH Score consists of 30 questions to evaluate the patients' functional activity. The scores range from 0 (no disabilities) to 100 (most severe disability). The Constant Shoulder Score consists of two parts. The first part is patient function, while the second part consists of the patient's shoulder range of movement with a possible maximum score total of 100 points (best function). The Manual Muscle test consists of 5 levels, with level 0 being no contraction, and 5 showing full range of motion (ROM).

Complications include nonunion, malunion, infection, and implant failure. Nonunion is described where there is no evidence of healing three months after injury. Malunion describes the presence of angular deformity and shortening > 2 cm with persistent pain three months after injury.

Statistical Analysis

The samples were tested using an independent T-test determined using the ROM, Manual Muscle Test (MMT), CSS, and DASH scores. A $p < 0.005$ represent a significant difference, and the evaluation of union was done using the Pearson Chi-square analysis. A $p < 0.05$ represents a statically significant difference. The analysis was performed using SPSS software version 23.0 (IBM Corporation, Armonk, NY, USA).

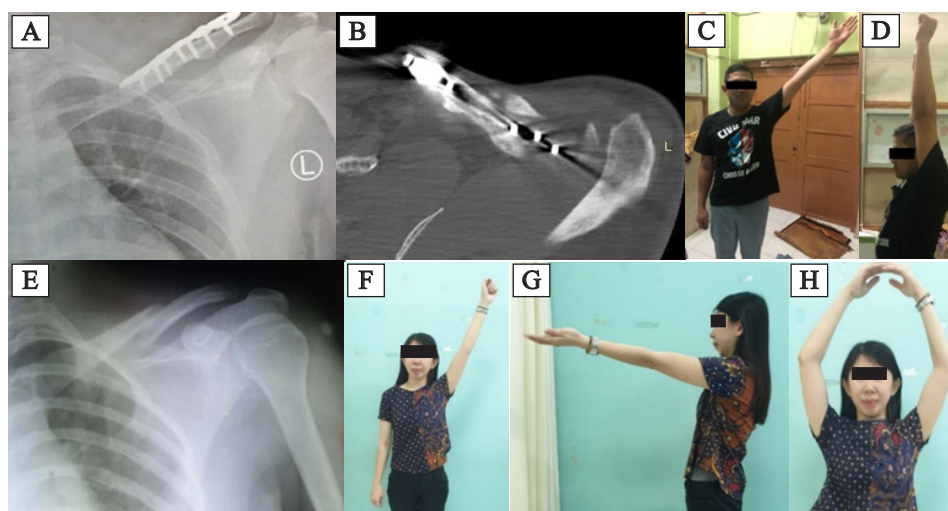


Table 1. Demographics of patients.

Demographic	Conservative	Operative	Total (%)
Sex			
Male	60 (71.4%)	57 (74%)	117 (72.7%)
Female	24 (28.6%)	20 (26%)	44 (27.3%)
Mean of Age	34.23 ± 13.07	36.69 ± 11.19	35.4 ± 12.23
Side			
Right	52 (61.9%)	48 (62.3%)	100 (62.61%)
Left	32 (38.1%)	29 (37.9%)	61 (37.9%)
Dominant Hand			
Right	77 (91.7%)	73 (94.8%)	159 (98.75%)
Left	7 (8.3%)	4 (5.2%)	2 (1.24%)

Table 2. DASH score, CSS, and MMT for the operative and conservative groups.

	Conservative Group (n = 84)	Operative Group (n = 77)	p value
DASH Score	23.67 ± 3.49	10.85 ± 6.98	< 0.001
Constant Shoulder Score	86.60 ± 7.56	93.38 ± 7.529	< 0.001

**Figure 4.** Evaluation, one-year (A-D) operative treatment radiological evaluation, CT scan, and clinical evaluation. (E-H) Conservative treatment radiological and clinical evaluations.

RESULTS

A total of 161 patients with midshaft clavicle fractures were evaluated, consisting of those operated on (77 patients, 47.8%) and those treated conservatively (84 patients, 52.2%). The patients' characteristics were males making up a total of 117 patients (72.7%), and females, totaling 44 patients (27.3%). The patients' ages ranged from 18-60 years old, with a mean age of 35.4 ± 12.23 years old (Table 1). Mode of injury was divided into motor vehicle collisions (MVC) 25 patients (14.28%), motorcycle crashes (MCC) for 34

patients (21.11%), single motorcycle injury for 66 patients (41%), pedestrian vs. motorcycle 7 patients (4.36%), falling from height 17 patients (10.56%), and a direct hit for 12 patients (7.45%).

Significant differences are present in the primary outcomes, specifically the DASH score, Constant Shoulder score, and Manual Muscle Test between the two groups ($p < 0.001$). The DASH score in the operative group was 10.85 ± 6.98 , compared to the conservative group of 23.67 ± 3.49 , which shows that there is better shoulder function in the operative group. The Constant Shoulder Score in the operative group was 93.38 ± 7.529 while in the



conservative group, it was 86.60 ± 7.56 . Both groups showed good results for shoulder function but with better results in the operative group (Table 2).

Even though both had function between the operative and conservative groups, shortening was present in the nonoperative cases (Figure 4). Patient satisfaction was also higher in the operative group, as well as an earlier return to activity time. Some patients complained of a lump on the anterior shoulder in the conservative group.

DISCUSSION

Clavicle midshaft fractures are one of the most common fractures. With good treatment, good function will result because of the fast healing rate. A previous study reported 29-58 cases per 100.000 populations.^{6,7} In our study, we sampled 531 cases, around 130-150 cases per year. Based on several studies, we found that the mechanism of injury was mostly motor vehicle crashes. Our study also found that a single motorcycle injury was the most common cause of injury by 41%. Since motorcycles are one of the easiest modes of transportation to access in the country compared to cars, the incidence of motorcycle injuries had the highest rank. Cases of males with fractures also had a higher incidence than females. According to our study, this was confirmed by male cases making up 72.7%, mostly in young adults.⁸⁻¹⁰

The tendency for management therapy to treat midshaft clavicle fractures has moved from conservative to operative. The nonoperative group mostly complained about the risk of nonunion, shortening, shoulder malposition, and bony prominence.⁸ Patient satisfaction and union time are higher in the operative group. Faster union time and better function are related to a faster back to work time. Some complications like malunion and nonunion are also higher in the conservative group. The most complained about symptoms in the surgical group were implant prominence and scar-related cosmetics.¹¹

Using the DASH score, the operative group showed better outcomes than the nonoperative group in our evaluation. According to a previ-

ous study by Patel, who evaluated the DASH score between operative and conservative, better scores were found in the operative group.¹² According to Tamaoki et al., a one-year evaluation of the DASH score showed no significant difference. A study by the Canadian Orthopedic Trauma Society showed that the operative group had a better score.¹³ The mean constant score was also higher in the operative group than in the conservative group.

This study showed that operative treatment gives superior functional outcomes compared to the conservative group. The operation can be performed using a plate and screw or TENS (Titanium Elastic Nail System), which results in a smaller scar. Newer meta-analysis research shows that the nonunion risk is higher in the nonoperative group (15%) than the operative (2.2%), especially with a good fixation technique.¹⁴ Some patients also complained of constant pain, nonunion, malunion, and lowered shoulder function.¹³

It is better for patients who underwent surgery in the acute phase (less than 14 days), having a higher union rate than performing the operation >14 days. By performing the operation, rigid fixation and correct lengthening are provided, resulting in better union and function in addition to less pain and better function due to early rehabilitation and movement. Early mobilization enables faster recovery when it comes to shoulder movement and muscle strength. In a longer evaluation, if there are no complaints around the shoulder, such as a tingling sensation or implant prominence, removal of the implant was unnecessary, except in patients doing body contact sports. A shorter return to preinjury activity was also found in the operative group with a difference of 4 weeks faster. Some research has already compared superior and anteroinferior plating to see whether it increases patient satisfaction and has less complications.^{4,13-15}

Some of the conservative group complications include shoulder dysfunction, mostly caused by the shortening of the bone segment, residual bone deformity, loss of force, and persistent pain. Shortening of 1.5-2 cm could result in decreased



shoulder function. However, conservative treatment remains a gold standard in simple undisplaced midshaft fractures. The gold standard for treatment in midshaft displaced and comminuted fractures for young active adult patients must be considered a regimen of therapy related to better shoulder function.^{11,13,15}

CONCLUSION

The operative treatment of midshaft clavicle fractures has been accepted as the gold standard worldwide for displaced or comminuted fractures in inactive young adults. It has better bone healing, less healing time, and superior shoulder function than conservative treatment. Patient satisfaction is also higher in the operative group. The Indonesian population was mostly filled with active young adults, and motorcycle are commonly used as the main transportation, so the incidence of clavicle fractures was common in this context. We need a multi-centered prospective randomized trial to get a better result, and objective radiological measurements can be added in future research.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

REFERENCES

1. Bajuri MY, Maidin S, Rauf A, Baharuddin M, Harjeet S. Functional outcomes of conservatively treated clavicle fractures. *Clinics* 2011;66(4):635–9.
2. Murray IR, Foster CJ, Eros A, Robinson CM. Risk factors for nonunion after nonoperative treatment of displaced midshaft fractures of the clavicle. *J Bone Joint Surg Am* 2013;95(13):1153–8.

3. McKee RC, Whelan DB, Schemitsch EH, McKee MD. Operative versus nonoperative care of displaced midshaft clavicular fractures: a meta-analysis of randomized clinical trials. *J Bone Joint Surg Am* 2012;94(8):675–84.
4. Toogood P, Coughlin D, Rodriguez D, Lotz J, Feeley B. A biomechanical comparison of superior and anterior positioning of precontoured plates for midshaft clavicle fractures. *Am J Orthop (Belle Mead NJ)* 2014;43(10):E226-31.
5. Bhat SA, Bhat K, Gupta S, Suhail M, Bhat A, Ali N. Changing trends in the management of adult clavicular fractures. A prospective study. *Int J Adv Res* 2014;1(2):843–9.
6. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. *Injury* 2006;37(8):691–7.
7. Kihlström C, Möller M, Lönn K, Wolf O. Clavicle fractures: epidemiology, classification and treatment of 2 422 fractures in the Swedish Fracture Register; an observational study. *BMC Musculoskelet Disord* 2017;18(1): 82.
8. Tamaaki MJS, Matsunaga FT, Costa ARF da, Netto NA, Matsumoto MH, Bellotti JC. Treatment of displaced midshaft clavicle fractures: Figure-of-eight harness versus anterior plate osteosynthesis: A randomized controlled trial. *J Bone Jt Surg* 2017;99(14):1159–65.
9. Sharma SK and Yadav SS. Evaluation of functional outcome after plate fixation of midshaft fracture of clavicle. *Int J Orthop Sci* 2018;4(3):373–6.
10. Napora JK, Grimberg D, Childs BR, Vallier HA. Factors affecting functional outcomes after clavicle fracture. *J Am Acad Orthop Surg* 2016;24(10):721–7.
11. Naveen BM, Joshi GR, Harikrishnan B. Management of mid-shaft clavicular fractures: comparison between nonoperative treatment and plate fixation in 60 patients. *Strategies Trauma Limb Reconstr* 2017;12(1):11–8.
12. Patel MM, Patel JJ, Gupta AK, Shah SS, Shethna S. Comparative evaluation of operative versus non-operative management of midshaft displaced clavicle fractures: A case series. *Int J Orthop Sci* 2017;3(32):594-9.
13. Canadian Orthopaedic Trauma Society. Nonoperative treatment compared with plate fixation of displaced midshaft clavicular fractures. A multicenter, randomized clinical trial. *J Bone Jt Surg* 2007;89(1):1–10.
14. Ai J, Kan SL, Li HL, Xu H, Liu Y, Ning GZ, et al. Anterior inferior plating versus superior plating for clavicle fracture: a meta-analysis. *BMC Musculoskelet Disord* 2017;18(1):159.
15. Formaini N, Taylor BC, Backes J, Bramwell TJ. Superior versus anteroinferior plating of clavicle fractures. *Orthopedics* 2013;36(7):e898-904.

