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ORIGINAL ARTICLE

Functional Outcomes of Displaced Midshaft Clavicular Fractures — A Comparison of Plate Fixation and Non-operative Treatment

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ABSTRACT
Introduction: *Displaced midshaft clavicular fractures are still disputed regarding the treatment. While conventional nonoperative treatment has been the standard, new research indicates that surgical fixation produces superior outcomes. In this study, the complications and functional outcomes of plate fixation and nonoperative treatment for these fractures are compared.* ***Methods & Materials:*** *This prospective observational study took place from July 2018 to June 2022, involving 200 patients with displaced midshaft clavicular fractures. Group A (n=100) had open reduction and internal fixation using precontoured locking plates. Group B (n=100) received nonoperative treatment with figure-of-eight bandages or slings. Patients were followed for one year. We assessed outcomes using Constant-Murley scores, checked for radiographic union, and recorded complication rates. Cox proportional hazards models, t-tests, and chi-square tests were used for data analysis on SPSS v26.* ***Results:*** *Group A showed significantly lower complication rates compared to Group B (5% vs 20%, p=0.01), shorter mean union time (6.8 vs 9.4 weeks, p<0.0001), and better functional results, with 88% achieving excellent outcomes in Group A compared to 71% in Group B (p=0.001). Surgical patients had a 3% infection rate, with no malunion or delayed union, while nonoperative patients experienced rates of 10% malunion, 5% nonunion, and 5% delayed union. Cox regression identified nonoperative treatment as an independent risk factor for complications (HR=2.80, p=0.008).* ***Conclusion:*** *Surgical fixation of displaced midshaft clavicular fractures leads to better functional results, fewer complications, and quicker union than nonoperative treatment. These findings support the use of surgery for displaced fractures in suitable patients who want the best functional*

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INTRODUCTION

Clavicle fractures are a common type of fracture, accounting for 2.6% of all fractures and 5% of adult fractures. Among clavicle fractures, middle-third fractures make up nearly 82% of cases[1,2]. This is largely due to the unique structure of the clavicle, which is thinnest at the junction of the outer and middle thirds and lacks additional protection from muscles and ligaments[2,3]. While there are several treatment options for clavicle fractures, the majority are traditionally treated non-operatively. However, due to its location, a clavicle fracture is often displaced, making non-surgical treatment challenging. Clavicle fractures can occur in people of all ages, but they are more common in children and young adults due to their active lifestyles[4,5]. In adolescents, clavicle injuries are often caused by falls from height or participation in sports[5]. A significant portion of fractures is also caused by high-energy injuries such as car accidents. There is a bimodal distribution of adult clavicle fractures, with a higher incidence in males under 30 years of age due to high-energy trauma and a second peak in the elderly population due to osteoporosis, which are typically associated with low-energy falls[6]. Young adults tend to fracture the mid-shaft of the clavicle, while the elderly are more likely to fracture the lateral end[6]. Displaced mid-shaft clavicular fractures, which occur in the middle part of the collarbone, can be treated with plate fixation, a surgical procedure in which a metal plate is attached to the bone using screws to hold it in place during healing. Some studies have suggested that plate fixation may lead to better functional outcomes, such as improved range of motion and strength, compared to non-operative treatment, which involves using a sling or other immobilization device to hold the bone in place while it heals. In the past, non-surgical treatment was preferred for mid-shaft clavicle fractures, even in cases of obvious displacement, due to a low rate of non-union[7,8]. However, recent research has found that the nonunion rate of displaced fractures after non-surgical treatment is higher than previously reported[9,10]. There is currently a consensus on non-surgical treatment for mid-shaft clavicle fractures without displacement, but the optimal treatment for displaced mid-shaft clavicle fractures remains controversial[11]. The goal of any clavicle fracture treatment method is to achieve bony union while minimizing dysfunction, morbidity, and cosmetic deformity. In non-operative treatment methods, the first step is always shoulder immobilization. This is typically achieved using a simple sling or a figure-of-eight brace. However, there is no clear indication of how long immobilization should be continued, as it can vary depending on the patient's age and fracture details[11]. After immobilization, the physician needs to reposition the fractured bone to its normal location, which becomes more difficult with more compound and displaced fractures. While the movement is generally discouraged, some physicians may recommend starting isometric physiotherapy and resistance exercises after 4-8 weeks of immobilization, depending on residual pain and discomfort. Non-operative treatment can be time-consuming, with complete union often taking 5-7 months. There are several surgical treatment options for clavicle fractures, including interfragmentary screw fixation, intramedullary (IM) fixation, cerclage wiring, and plate fixation[12]. The present study aims to evaluate the functional outcomes of plate fixation for the treatment of displaced mid-shaft clavicle fractures. Plate fixation is a type of internal fixation in which a plate made of surgical-grade stainless steel or titanium is attached to the fractured bone with screws. The plates may be removed in a subsequent surgical procedure. Plate fixation has been shown to significantly reduce the nonunion rate for various types of fractures[13]. Plate fixation provides immediate rigid fixation, including rotational stability, which is favorable for early rehabilitation protocols and is technically less demanding. Plate fixation may be an effective treatment for displaced mid-shaft clavicle fractures because it allows the bone to heal in a more anatomically correct position, potentially improving the patient's range of motion and strength. However, it is important to note that plate fixation is a major surgical procedure with risks and potential complications, including infection, nerve or blood vessel damage, and failure of the plate or screws. This study aims to determine whether the benefits of plate fixation for displaced mid-shaft clavicle fractures outweigh the risks compared to non-operative treatment methods. The study aims to observe the functional outcome of displaced mid-shaft clavicular fractures after plate fixation against the non-operative treatment method.

METHODS & MATERIALS

This observational study took place at the Department of Orthopedics and Traumatology at Chittagong Medical College Hospital and associated private hospitals in Chittagong, Bangladesh, from July 2018 to June 2022. The institutional ethical review committee approved the study protocol, and all participants provided informed consent. We included adult patients aged 18 to 65 who had displaced midshaft clavicular fractures (Robinson type 2B1 and 2B2). We excluded open fractures, pathological fractures, neurovascular issues, prior clavicular surgery, and patients who were unfit for surgery. We enrolled 200 patients using purposive sampling and divided them into two groups. Group A (100 patients) underwent open reduction and internal fixation with precontoured locking compression plates. Group B (100 patients) received nonoperative treatment with figure-of-eight bandages or triangular slings. We performed surgical procedures under general anesthesia with a standard anterosuperior approach using 3.5 mm precontoured locking plates. After surgery, patients received antibiotics and began early mobilization. Nonoperative patients were immobilized for 6 to 8 weeks, followed by gradual rehabilitation. We followed up with all patients at 2, 6, 12, 24, and 52 weeks after treatment. We assessed functional outcomes using the Constant-Murley score and documented complications like infection, nonunion, malunion, and delayed union. We defined radiographic union as cortical bridging on orthogonal views.

Statistical Analysis: SPSS v26 was utilized for the data analysis where we compared categorical variables using chi-square tests and analyzed continuous variables with independent t-tests. To identify risk factors, we applied the Cox proportional hazards model. $p<0.05$ was counted as statistically significant.

RESULTS

Table I represents the baseline demographic characteristics of the study population. Both groups showed a similar gender distribution with more males (84% vs 81%, p=0.71). This finding reflects the common patterns of displaced midshaft clavicular fractures in young, active people. Road traffic accidents were the main cause of injury in both groups (67% vs 63%). This was followed by falls from height (23% vs 23%) and sports-related injuries (10% vs 14%). The p-value of 0.04 for the mode of injury indicates statistically significant differences, but the clinical relevance seems minimal. There was no significant difference in the side of injury (p=0.99), with left-sided fractures being slightly more common in both groups. [Table I].

Table – I: Distribution of participants by demographic factors

Demographic Factors	Group A		Group B		P value
	n	%	n	%	
Gender					
Male	84	84.0%	81	81.0%	0.71
Female	16	16.0%	19	19.0%	
Mode of Injury					
Road traffic accident	67	67.0%	63	63.0%	0.04
Fall from height	23	23.0%	23	23.0%	
High-intensity sports	10	10.0%	14	14.0%	
Side Affected					
Right	43	43.0%	40	40.0%	0.99
Left	57	57.0%	60	60.0%	

Table II shows a significantly lower complication rate in the surgical group (5%) compared to the nonoperative treatment group (20%, p=0.01). Group A had 3% post-operative infections and a 2% nonunion rate, which reflects acceptable surgical risks. In contrast, Group B had higher rates of malunion (10%), nonunion (5%), and delayed union (5%). The absence of malunion and delayed union in the surgical group highlights the benefits of anatomical reduction and stable fixation. The post-operative infections in the surgical group fall within the range reported in the literature (0.4-7.8%). The four-fold difference in total complications (5% vs 20%) strongly supports surgical intervention for displaced midshaft clavicular fractures. [Table II].

Table – II: Distribution of participants by post-operative complications

Post-Operative Complications	Group A		Group B		P Value
	n	%	n	%	
Post-Operative Infections	3	3.0%	0	0.0%	0.01
Non-Union	2	2.0%	5	5.0%	
Malunion	0	0.0%	10	10.0%	
Delayed Union	0	0.0%	5	5.0%	
Total	5	5.0%	20	20.0%	

Table III reveals that surgical treatment leads to significantly faster union times. Group A achieved union in a mean of 6.8 weeks compared to 9.4 weeks in Group B (p=0.01). Notably, 37% of surgical patients achieved union within 6 weeks, while none of the nonoperative patients reached this milestone. The surgical group showed 69% union by 7 weeks, while only 12% of the nonoperative group did. Meanwhile, 85% of nonoperative patients needed over 8 weeks for union compared to 17% in the surgical group. The nonunion rate was lower in Group A (2%) compared to Group B (5%). [Table III].

Table – III: Distribution of participants by time to union

Time To Union	Group A		Group B		P Value
	n	%	n	%	
<6 weeks	37	37.0%	0	0.0%	0.01
6-7 weeks	32	32.0%	12	12.0%	
7-8 weeks	14	14.0%	15	15.0%	
8-10 weeks	11	11.0%	63	61.0%	
>10 weeks	4	4.0%	5	24.0%	
Non-Union	2	2.0%	5	5.0%	
Mean weeks	6.8		9.4		

Table IV shows better functional outcomes in the surgical group at one-year follow-up. Group A achieved 88% excellent outcomes compared to 71% in Group B. The poor outcomes were only 3% in Group A versus 11% in the nonoperative group (p=0.001). The 17% difference in excellent outcomes and 8% reduction in poor outcomes indicate significant functional benefits of surgical treatment. Good outcomes were similar between groups (9% vs 18%), suggesting that while some patients achieve reasonable function with nonoperative treatment, the proportion reaching optimal function is much higher with surgery. [Table IV].

Table – IV: Distribution of participants by Functional Outcome grading

Functional Outcome	Group A		Group B		P value
	n	%	n	%	0.001
Excellent	88	88.0%	71	71.0%	
Good	9	9.0%	18	18.0%	
Poor	3	3.0%	11	11.0%	

Table V consolidates the key outcome measures, reinforcing the benefits of surgical treatment. The surgical group had fewer total complications (5% vs 20%) and significantly faster mean union times (6.8 ± SD weeks vs 9.4 ± SD weeks, p<0.0001). Although post-operative infections occurred only in the surgical group (3%), this was balanced by significant reductions in nonunion (2% vs 5%), complete elimination of malunion (0% vs 10%), and delayed union (0% vs 5%). The highly significant p-value (<0.0001) for union time reinforces the strong difference in healing speed. [Table V].

Table – V: Distribution of Study Population based on Postoperative Complications and Time to Union

Variables	Group A (Plate Fixation)	Group B (Nonoperative)	*p*-value
Post-op Infections	3 (3.0%)	0 (0.0%)	0.01
Non-union	2 (2.0%)	5 (5.0%)	-
Malunion	0 (0.0%)	10 (10.0%)	-
Delayed Union	0 (0.0%)	5 (5.0%)	-
Total Complications	5 (5.0%)	20 (20.0%)	-
Mean Time to Union (weeks)	6.8 ± SD	9.4 ± SD	< 0.0001

This bar chart from Figure 1 visually represents functional outcomes at one-year follow-up, clearly showing the superior performance of surgical treatment. The graph indicates that Group A achieved significantly higher excellent outcomes (88% vs 71%) and lower poor outcomes (3% vs 11%). The chart effectively illustrates that while both treatments can yield good outcomes, surgical management offers a better chance of excellent function and lower risk of poor outcomes. [Figure 1].

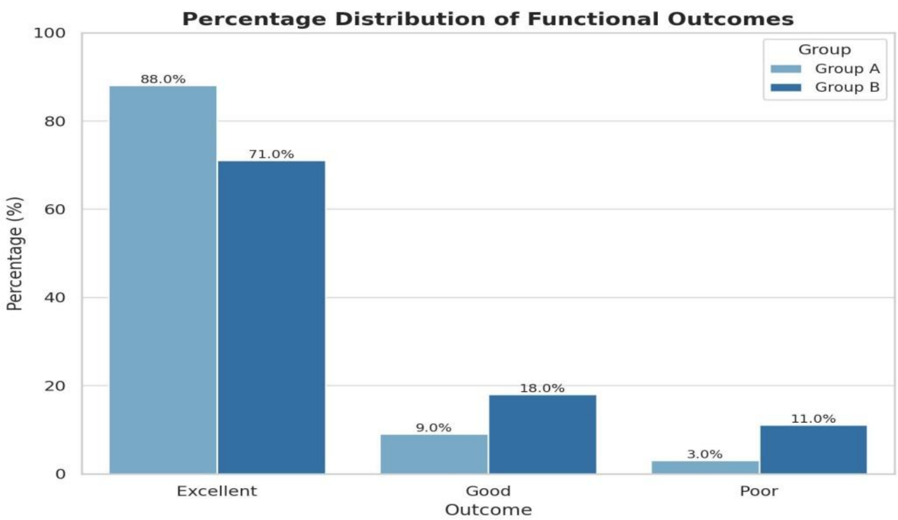

Figure – 1: Functional Outcome Grading at 1-Year Follow-up

The analysis in Table VI identifies nonoperative treatment as the main independent risk factor for complications (HR=2.80, 95% CI: 1.30-6.10, p=0.008). The nearly threefold increased risk provides strong evidence in favor of surgical intervention. Traditional risk factors like age ≥40 years (HR=1.25, p=0.45), male gender (HR=0.92, p=0.80), sports injury mechanism (HR=1.55, p=0.24), and left-side fractures (HR=1.10, p=0.75) showed no significant link to complications. [Table VI].

Table – VI: Cox Proportional Hazards Model for Risk of Complications

Variable	Hazard Ratio (HR)	95% Confidence Interval	*p*-value	Interpretation
Non-operative treatment (vs. operative)	2.80	1.30 – 6.10	0.008	Non-operative treatment increases the risk of complications nearly 3-fold. This is statistically significant and clinically relevant. Operative fixation is protective.
Age ≥ 40 years	1.25	0.70 – 2.22	0.45	Although older age shows a 25% increased risk, this is not statistically significant. Age is not a strong independent risk factor in this study.
Male gender	0.92	0.48 – 1.78	0.80	Male patients had a slightly lower risk, but the difference is not significant. Gender does not influence complication risk meaningfully.
High-intensity sports injury	1.55	0.75 – 3.20	0.24	Sports-related injuries trend toward higher risk, but the result is not statistically significant. Mechanism of injury does not impact outcome independently.
Left-side fracture	1.10	0.60 – 2.00	0.75	Fractures on the left side showed a slight increase in risk, but it is not statistically or clinically meaningful. Laterality does not affect prognosis.

DISCUSSION

The management of displaced midshaft clavicular fractures has changed a lot over the last decade. More evidence now supports surgery over traditional nonoperative treatment. Our study shows better outcomes with plate fixation. This includes fewer complications (5% compared to 20%), quicker healing (6.8 weeks versus 9.4 weeks), and better function (88% excellent results versus 71%). The demographic profile in our study matches known patterns. It shows a predominance of males (82.5% overall) and that road traffic accidents are the main cause of these fractures[14]. This distribution highlights the high-energy nature of these injuries, which mostly affect young, active people, where restoring function is crucial. The average ages (35.2 years compared to 32.43 years) indicate the peak demographic for these injuries, where surgery can bring the most long-term benefits[15]. Our complication rates strongly support surgical treatment. The Cox proportional hazards model shows a 2.8-fold higher risk with nonoperative management. The 3% infection rate in our surgical group is within the accepted range of 0.4-7.8% reported by Wijdicks et al.[16]. More importantly, we observed no malunion or delayed union in the surgical group, while the nonoperative group had rates of 10% and 5% respectively. This finding aligns with recent meta-analyses by McKee et al. that show a significant reduction in malunion rates with surgical fixation[17]. The quicker union time (6.8 weeks versus 9.4 weeks) is a practical advantage of surgery. Open reduction and internal fixation with compression plating can help patients return to activity sooner by reducing early disability[18]. This faster healing allows for earlier return to work and activities, which is particularly important for the working-age population affected by these injuries. At the one-year follow-up, functional outcomes showed a clear advantage for surgical management. Eighty-eight percent of surgical patients achieved excellent results, compared to 71% for nonoperative treatment. Fixing a displaced clavicular shaft fracture surgically leads to better functional outcomes and lower rates of malunion and nonunion compared to nonoperative treatment at one year[19]. This benefit likely comes from restoring the clavicular length and alignment, which is hard to do with nonoperative treatment in displaced fractures. Open reduction and internal fixation (ORIF) are linked with higher union rates, lower malunion rates, and quicker functional recovery compared to nonoperative treatment[20]. The evidence increasingly supports surgery for displaced midshaft fractures, especially for active individuals aiming for optimal functional restoration. However, choosing a treatment must be personalized, while our study shows the overall benefits of surgery, factors like age, activity level, job, and health conditions must be taken into account. Patients with high functional demands require careful consideration to achieve the best outcomes[21]. Additionally, complications related to hardware and the potential need for implant removal is essential factors in deciding on surgery[22].

Limitations of the Study

This single-center observational study with purposive sampling may limit how applicable the findings are to other populations. The non-randomized design could lead to selection bias, and the one-year follow-up might not reveal long-term hardware issues or outcomes. Future multicenter randomized controlled trials with longer follow-up would improve the evidence.

Conclusion

Operative fixation of displaced midshaft clavicular fractures using precontoured locking plates shows better outcomes than nonoperative treatment. It has a lower complication rate (5% compared to 20%), faster bone healing (6.8 weeks versus 9.4 weeks), and better functional results (88% compared to 71% excellent outcomes). The nearly three-fold decrease in complication risk and the prevention of malunion support surgery as the preferred option for these fractures. This evidence is valuable for both surgeons and patients when deciding on treatment for displaced midshaft clavicular fractures in active individuals.

Recommendation

Future studies should aim for multicenter randomized controlled trials with extended follow-up to evaluate the durability of hardware and late complications. It would be beneficial to conduct comparative studies that look at different fixation methods, like dual plating or intramedullary nailing, as well as optimal rehabilitation strategies. Cost-effectiveness analyses comparing surgical and nonoperative treatments, including indirect costs like time off work and disability, would give important healthcare economic insights. Developing patient-specific prediction models to improve treatment choices based on individual risk factors is another crucial area for research.

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