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Original Research Article

CLAVICULAR PLATING, INTRAMEDULLARY NAILING, AND CONSERVATIVE MANAGEMENT FOR MIDSHAFT CLAVICLE FRACTURES: A COMPARATIVE STUDY OF CLINICAL OUTCOME

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ABSTRACT

Background: Midshaft clavicle fractures are the most frequently encountered fractures in young and active adults. Most of these fractures are managed by plating, intramedullary nailing, and conservative management. However, there is a lack of consensus on optimal management of these cases. In the current study, we tried to evaluate the clinical and functional outcomes following treatment of middle-third clavicular fractures with plating, conservative management, and intramedullary nailing.

Materials and Methods: The current study was a prospective investigation of cases of midshaft clavicular fractures. The sample size was 20 cases, as reported in the duration of the study. They were allotted into three groups based on treatment modality: plating (n=9), conservative (n=7), and nailing (n=4). The functional outcomes were evaluated using the Constant-Murley Score (CMS) and the DASH Score, and the frequency of complications was recorded in each group. The statistical analysis was performed to determine the outcome.

Results: The results of this study showed that the highest frequency of plating cases was with good outcomes (88.9%), followed by the nailing group (50%) and the conservative group (14.3%). Functional analysis by CMS and DASH showed the plating group had a CMS mean score of 89.56 ± 2.67, and a DASH mean score of 7.11 ± 2.33. The conservative group had a mean CMS score of 68.14 ± 7.76, a DASH mean score of 21.86 ± 7.09, and a nailing group CMS score of 82.00 ± 8.00. The nailing group CMS mean score was 82.00 ± 8.00, and the DASH mean score was 10.50 ± 5.20. ANOVA showed statistically significant differences among the groups ($p < 0.001$ for both scores.

Conclusion: The overall results of this study showed that plating provides superior functional outcomes and lower complication rates compared to nailing and conservative treatment for displaced midshaft clavicle fractures. It is recommended particularly for active individuals or those requiring early return to function.

Keywords: Midshaft clavicular fractures, Functional outcomes, Constant-Murley Score, DASH score.

INTRODUCTION

Clavicle fractures are frequently encountered injuries in orthopedic practice. It is estimated to occur at a rate of 2.6 – 5% of all fractures and approximately 35 – 45% of injuries involving the shoulder girdle.[1] Because of the typical anatomy of clavicle fractures, midshaft fractures occur in 70 – 80% of cases due to its subcutaneous position and exposure to axial skeletal bending forces during trauma.[2] These fractures are very common in young and active individuals following road traffic accidents, followed by falls or sports injuries. Clavicular injuries pose a significant challenge for the restoration of optimal shoulder function. The traditional method of treatment of midshaft clavicular fractures was done by the conservative method with slings or figure-of-eight bandages. Studies done with conservative

management reported high union rates and satisfactory functional outcomes with non-operative management, and they reinforced the fact that surgery was not required for these cases.[3] More recent evidence has disputed this paradigm, especially in displaced fractures of the clavicle. Many studies have now established that conservative intervention can be linked to increased rates of non-union, malunion, clavicular shortening, cosmetic deformity, and persistent shoulder disability, particularly in fractures that are accompanied by large displacement or comminution. [4,5] Owing to these limitations, the contemporary approach is more towards operative management because of the constraints offered by conservative methods. Surgical fixation is also focused on restoring clavicular length and positioning, providing a stable fixation, early mobilization, and better functional outcomes.[6] The most widely used surgical procedures are open reduction and internal fixation by the use of plates and intramedullary nailing. Plate fixation, especially the usage of precontoured locking compression plates, provides rigid fixation and good control of fracture alignment. Several randomized controlled trials have demonstrated that plating has lower rates of non-union and better functional outcomes than conservative treatment, particularly in the case of displaced midshaft fractures.[7,8] Nonetheless, plate fixation demands a great deal of soft tissue dissection and is known to cause such side effects as infection, implant prominence, neurovascular irritation, and a comparatively high secondary implant removal rate.[9] A minimally invasive plating substitute is intramedullary nailing. Intramedullary fixation may have several benefits because it preserves the periosteal blood supply, limits the amount of soft tissue trauma, decreases scarring, and recovers faster than conventional approaches.[10] Comparison of intramedullary nailing and plating has shown similar union and functional results, although complications of implant migration, skin irritation, and technical problems associated with comminuted fractures have also been reported.[11,12] Despite the available pieces of evidence in favour and against each technique, there is no consensus on the optimal treatment modality for midshaft clavicular fractures. While operative treatment is recently favoured, the choice between plating, intramedullary nailing, and conservative management must be determined by fracture characteristics, patient factors, functional demands, and possible complications of each. With this background, we aimed to evaluate the clinical and functional outcomes of clavicular plating, intramedullary nailing, and conservative management in patients with midshaft clavicle fractures.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Orthopedics, Govt Medical College and Hospital, Rajanna Sircilla, Telangana. Institutional Ethical approval was obtained for the study after duly following the format for human research. Written informed consent was obtained for the study after explaining the nature of the study and possible outcomes in the vernacular language.

Inclusion Criteria

1. Clinically and radiologically confirmed cases of midshaft clavicular fractures
2. Midshaft clavicular fractures of Robinson Type2B1 and 2B2
3. Adult patients aged more than 18 years
4. Males and Females
5. Displaced midshaft clavicular fractures (>2cms).

Exclusion Criteria

1. Pathological fractures
2. Open fractures
3. Associated with neurovascular injuries
4. History of previous surgery on the clavicle
5. Not available for follow-up evaluations

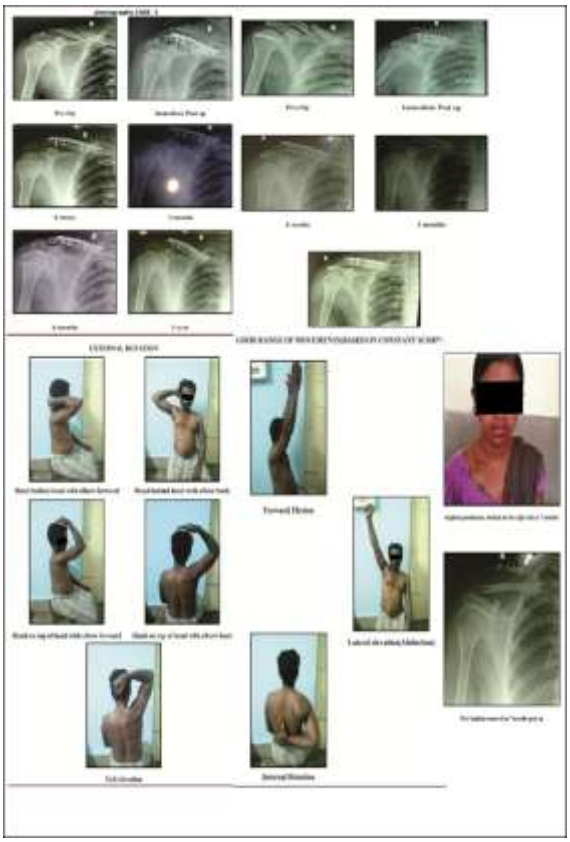
Based on the above inclusion and exclusion criteria, during the study period, a total of 20 cases of confirmed midshaft clavicle fractures were included in the study. Patients were divided into three groups based on the treatment method used in each case. Plating Group (n=9): Treated with open reduction and internal fixation using plates and screws. Nailing Group (n=4): Treated with intramedullary fixation using a titanium elastic nail. Conservative Group (n=7): Managed non-operatively with sling immobilization or figure-of-eight bandage

Surgical Procedure in brief: All surgeries were performed under general or regional anesthesia, depending upon the patients' health conditions. Plating cases were treated with open reduction and internal fixation with pre-contoured locking compression plates. Intramedullary nailing was done using a minimally invasive approach, with proper entry point selection and careful nail insertion into the medullary canal. Conservative management included immobilization for 3–4 weeks, followed by gradual physiotherapy.

Outcome Measures in the cases was done for functional and clinical outcomes were assessed using the Constant-Murley Score (higher scores = better function; maximum 100) and Disabilities of the Arm, Shoulder, and Hand (DASH) Score (lower scores = better function; maximum 100). The Complication rates, such as malunion, nonunion, hardware-related issues, and soft tissue complications, were recorded in all the cases of the study. The follow-up assessments were conducted at regular intervals after 6 weeks, 3 months, and 6 months post-treatment.

Statistical analysis: All the available data were segregated, refined, and uploaded to an MS Excel spreadsheet and analysed by SPSS version 26 in Windows format. Descriptive statistics such as mean, standard deviation, percentage, and frequency were used for continuous variables. The categorical variables between the three groups were calculated using one-way ANOVA analysis to determine the differences between the groups for outcomes. The

values of p (<0.05) were considered statistically significant.



RESULTS

The Baseline characteristics of the cohort of the study are given in Table 1. Analysis of the table showed that three groups were broadly comparable in terms of age, sex distribution, side of involvement, mechanism of injury, fracture displacement, comminution, and time to treatment. The mean age range of the cases was from 32.4 to 38.2 years, and male predominance was present in all the groups, showing the incidence of clavicular fractures. Road Traffic Accidents (RTA) were the frequent cause of injury in 55% this was, followed by sports injuries. About 50% of cases were comminuted fractures, and a displacement of more than 2 cm was present in all cases, showing the relatively severe injury profile.

The clinical outcomes and complications in the cohort are presented in Table 2. Analysis of the table showed that there were differences in the results based on management strategies. It was found that the highest proportion of good outcomes 88.9% were in the plating group, with only one minor complication due to hypertrophic scar and hardware irritation. Conservatively treated patients showed a higher proportion of complication 71.4% and 14.3% cases showed good results. The complications were primarily due to malunion and nonunion. In two cases of the conservative group, non-union occurred, requiring secondary surgical intervention. The nailing group showed intermediate results, with 50% good outcomes and a 50% complication rate. The complications were predominantly related to nail migration and hardware irritation. Time to union and return to work favored operative management. Plating resulted in the fastest union (12.4 weeks) and the earliest return to work (8.2 weeks), followed by nailing. Conservative management was associated with significantly delayed union (18.6 weeks) and prolonged functional recovery (14.8 weeks), reflecting inferior biological and mechanical stability.

Table 1: Baseline Demographic and Clinical Characteristics by Management Group

Characteristic	Plating Group (n=9)	Conservative Group (n= 7)	Nailing Group (n=4)	Total (N=20)
Age (Years)	32.4 ± 8.7	38.2 ± 10.5	35.8 ± 9.3	35.1 ± 9.5
Sex (Male: Female)	7:2	5:2	3:1	15:5
Side (Right: Left)	5:4	4:3	3:1	12:8
Mechanism of Injury				
• Road Traffic Accident	5 (55.6%)	4 (57.1%)	2 (50.0%)	11 (55.0%)
• Sports Injury	3 (33.3%)	2 (28.6%)	1 (25.0%)	6 (30.0%)
• Simple Fall	1 (11.1%)	1 (14.3%)	1 (25.0%)	3 (15.0%)
Fracture Pattern				
• Displaced (>2 cm)	9 (100%)	7 (100%)	4 (100%)	20 (100%)
• Comminuted	4 (44.4%)	3 (42.9%)	2 (50.0%)	9 (45.0%)
Time to Treatment (Days)	3.2 ± 1.8	2.8 ± 1.5	3.5 ± 2.1	3.1 ± 1.7

Table 2: Clinical Outcomes and Complication Profile

Outcome Parameter	Plating Group (n=9)	Conservative Group (n=7)	Nailing Group (n=4)
Good Clinical Outcomes	8 (88.9%)	1 (14.3%)	2 (50.0%)
Complication Rate	1 (11.1%)	5 (71.4%)	2 (50.0%)
Specific Complications			
• Hypertrophic Scar	1 (11.1%)	0	0
• Malunion	0	3 (42.9%)	0
• Nonunion	0	2 (28.6%)	0
• Nail Migration	0	0	2 (50.0%)
• Hardware Irritation	1 (11.1%)	0	1 (25.0%)
Time to Union (Weeks)	12.4 ± 2.1	18.6 ± 4.3^	14.2 ± 2.8
Return to Work (Weeks)	8.2 ± 1.5	14.8 ± 3.2^	10.5 ± 2.4
^*Includes 2 cases of delayed union progressing to non-union requiring secondary surgery. Good clinical outcome = Fracture union with full functional recovery and no major complications			

Functional outcomes at 6 months are depicted in Table 3. Analysis of the table showed that the plating group achieved excellent Constant-Murley scores (mean 89.56). DASH scoring indicated minimum disability and near-normal shoulder function. The nailing group demonstrated good functional outcomes, while the conservative group showed fair-to-poor Constant scores and moderate disability on DASH. The differences among groups were statistically highly significant ($p<0.001$), confirming a true treatment effect rather than random variation.

Table 3: Functional Outcome Scores at Final Follow-up (6 Months)

Management Group	Constant-Murley Score (Mean ± SD)	DASH score (Mean ± SD)
Plating	89.56 ± 2.67	7.11 ± 2.33
Conservative	68.14 ± 7.76	21.86 ± 7.09
Nailing	82 ± 8	10.50 ± 5.20
Statistical Significance	F(2,17)=23.6, p<0.001	F(2, 17)=18.4, p<0.001
Score Interpretation:		
Constant-Murley score: Excellent (90-100), Good (80-89), Fair (70-79), Poor (<70) DASH Score: Minimal disability (0-20), Moderate disability (21-40), Severe disability (41-100)		

Post-hoc analysis of the cohort is given in Table 4. The results showed that plating was significantly superior to conservative management in both Constant and DASH scores. Nailing also performed significantly better than conservative treatment but did not show statistical superiority over plating, indicating its role as an alternative rather than a replacement for plate fixation.

Table 4: Statistical Analysis of Inter-group Differences (Post-hoc Tests)

Comparison	Constant Score Difference (Mean)	p-value	DASH Score Difference (Mean)	p-value
Plating vs Conservative	+21.42	<0.001	-14.75	<0.001
Plating vs Nailing	+7.56	0.067	-3.39	0.185
Nailing vs Conservative	+13.86	0.012	-11.36	0.009
Post-hoc analysis using Tukey's HSD test revealed that plating produced significantly better functional outcomes than conservative management, while nailing showed intermediate results without statistical superiority over plating.				

Overall treatment efficacy in the cohort is depicted in Table 5. A critical analysis of the table showed that plating was able to achieve 100% union rate, the lowest complications, best functional recovery, and faster return to work. Conservative treatment showed a poor outcome and higher rates of complications, which showed that it must be reserved for patients with low functional requirements. The intramedullary nailing provided acceptable results, and it may be used in cases where a less invasive approach is required.

Table 5: Summary of Treatment Efficacy and Recommendations

Parameter	Plating	Conservative	Nailing
Union Rate	100%	71.4%*	100%
Complication Rate	11.10%	71.40%	50.00%
Functional Outcome (Excellent/Good)	88.90%	14.30%	50.00%
Time to Return to Work	Fastest (8.2 weeks)	Slowest (14.8 weeks)	Intermediate (10.5 weeks)
Hardware Removal Rate	11.10%	N/A	25.0%

DISCUSSION

Midshaft clavicle fractures are frequent injuries, especially among young and active people, and their optimal management is still a matter of debate. Conservative management used to be the main mode of managing most clavicle fractures, but the available evidence indicated that displaced and comminuted fractures can benefit from surgical management. The current study was done to compare plating, intramedullary nailing, and conservative management in the fractures of the midshaft of the clavicle in relation to clinical and functional modalities. The three groups divided in our study for comparison based on the treatment modality were found to be similar in the baseline demographic and injury characteristics, and the most frequent mechanism of injury was road traffic accidents, and a majority of patients were young men [Table 1]. Fractures were displaced in all cases, and almost 50% were comminuted, which indicated that cohort distribution was comparable for evaluating the effectiveness of surgery versus non-surgery. The fact that there was a similarity between the baseline parameters implies that the difference in outcomes was differentiated due to the modality of the treatment and not due to confounding factors. Plate fixation resulted in the best outcome, which included a 100 percent union rate, the lowest complication rate, and excellent functional restoration. These results are in line with previous studies, which showed that an open reduction and internal fixation using plates offers rigid fixation, clavicular length restoration, and early mobilization, resulting in high union rates and shoulder function.[2,6] The low rate of complications that was witnessed in the plating group in this study correlates with the contemporary literature that indicates that the modern plating

methods have been linked to low complication rates because of meticulous surgical technique evolution.[13] Conversely, conservative management was associated with a high rate of complications, which consisted of malunion and non-union, delayed union, and poor functional outcome. Two patients in this study required secondary surgery because of non-union, highlighting the shortcomings of non-operative therapy of displaced fractures. These findings are in agreement with previous studies by Hill et al. and McKee et al., who showed that there was increased non-union, cosmetic disfigurement, and functional impairment after conservative treatment of the displaced midshaft clavicle fractures.[4,7] The fact that it took longer for the union and more time to get back to work among the conservative group further underscores its negative side, especially in the active or working-age population. Intramedullary nailing demonstrated moderate results as compared to plating and conservative care. The complication rate was far higher than the plating, though the union rates were equally high, mainly because of nail migration and irritation of the hardware. The same complications are reported in other studies that assessed the elastic stable intramedullary nailing, where the issues with implants were of primary concern. [14,15] In functional terms, nailing yielded superior results than conservative treatment, but failed to have statistically better results than plating. It implies that intramedullary nailing is less invasive and preserves the soft tissue, but might have lesser rotational stability than plating, especially in comminuted fractures. The functional outcome scores also supported the excellence of the operative management. The plating group had very high mean Constant-Murley scores and low disability on DASH scoring, whereas the conservative management had fair or poor results. Our results are in agreement with randomized controlled trials and meta-analyses that have demonstrated consistent results of better functional scores and patient satisfaction with surgical fixation over no operation in displaced midshaft clavicle fractures. [16,17] The post-hoc analysis of the current study established that plating was much better than conservative management, where nailing was an option in a few cases. The results of this study support growing evidence that operative management and plate fixation should be the choice for displaced midshaft clavicular fractures in active individuals. Conservative management is reserved for those with low-demand patients, and intramedullary nailing may be kept for fractures that require a less invasive approach.

CONCLUSION

Within the limitations of the present study, we found that plate fixation provides superior clinical and functional outcomes in cases of displaced midshaft clavicular fractures when the treatment was compared with intramedullary nailing and conservative management. It was found that plating results in higher union rates, a low rate of complications, and provides faster fracture healing and return to work early with better functional recovery. Therefore, plate fixation must be done in young and active individuals, and intramedullary nailing may be reserved for a few selected cases and conservative management for older individuals with low functional demands.

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