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Comparative Analysis of Functional and Radiological Outcomes in Conservative versus Surgical Management of Clavicle Fractures.

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Abstract

Background: Clavicle fractures are among the most common orthopedic injuries, with displaced fractures often posing challenges regarding the choice between conservative and surgical management. Although conservative treatment has traditionally been preferred, operative fixation has gained popularity because of improved anatomical reduction and earlier functional recovery. This study compared the functional and radiological outcomes of conservative and surgical management of clavicle fractures. ***Methods:*** A hospital-based comparative observational study was conducted among 80 patients with clavicle fractures treated at a tertiary care center. Patients were allocated to either conservative management (n=39) or surgical management (n=41) according to fracture characteristics and clinical indications. Functional outcomes were assessed using the Constant–Murley Score and DASH Score, while radiological outcomes included fracture union, time to union, alignment, and residual shortening. Treatment-related complications were also compared. Statistical analysis was performed using the independent Student's t-test, Chi-square test, or Fisher's exact test, with $p<0.05$ considered statistically significant. ***Results:*** The mean age was comparable between the conservative and surgical groups (41.3±12.1 vs. 38.7±11.4 years; p=0.326). Surgical management produced significantly higher Constant–Murley scores (89.7±6.9 vs. 82.4±8.6; p<0.001) and lower DASH scores (10.8±6.7 vs. 18.6±9.4; p<0.001). Shoulder abduction ≥150° (85.4% vs. 53.8%; p=0.002) and return to routine activity within 12 weeks (78.0% vs. 48.7%; p=0.007) were significantly better following surgery. Radiological union was achieved in 95.1% of surgically treated patients compared with 76.9% of conservatively managed patients (p=0.018), while time to union was significantly shorter (11.6±2.4 vs. 14.2±3.1 weeks; p<0.001). Delayed union and overall complications were significantly more frequent in the conservative group, whereas implant-related complications were observed only after surgery. ***Conclusion:*** Surgical management of appropriately selected clavicle fractures provided superior functional recovery, faster radiological healing, improved fracture alignment, and lower overall complication rates compared with conservative treatment. Although implant-related complications occurred following operative fixation, the overall clinical benefits favored surgical intervention, particularly in displaced fractures requiring early restoration of shoulder function.

Keywords: Clavicle fracture. Conservative management. Surgical fixation.

INTRODUCTION

Clavicle fractures are among the most common skeletal injuries encountered in orthopedic practice, accounting for approximately 2–5% of all adult fractures and nearly 35–45% of injuries involving the shoulder girdle. The majority of these fractures occur in the middle third of the clavicle because of its inherent structural weakness and exposure to direct or indirect trauma. Road traffic accidents, sports-related injuries, falls from height, and occupational accidents represent the leading mechanisms of injury. Although clavicle fractures have traditionally been managed conservatively with arm slings or figure-of-eight bandages due to their excellent healing potential, recent evidence has challenged this concept, particularly for displaced, comminuted, and shortened fractures. These injuries may be associated with delayed union, nonunion, malunion, persistent pain, cosmetic deformity, and functional impairment, thereby affecting the patient's quality of life and return to work.[1]

Advances in orthopedic implant technology and surgical techniques have led to an increasing preference for operative fixation in selected patients. Open reduction and internal fixation using precontoured locking plates or intramedullary devices provides anatomical reduction, stable fixation, early mobilization, and potentially faster functional recovery.

Several randomized controlled trials and meta-analyses have demonstrated improved early shoulder function and lower nonunion rates following surgical treatment, although surgery is associated with implant-related complications, infection, hardware irritation, and the possibility of secondary implant removal. Consequently, the choice between conservative and surgical treatment remains controversial and should be individualized according to fracture characteristics, patient age, activity level, occupation, and expectations.[2]. Radiological union and functional recovery are the principal outcome measures in the management of clavicle fractures. Functional assessment is commonly performed using validated scoring systems such as the Constant–Murley Score and the Disabilities of the Arm, Shoulder and Hand (DASH) score, while serial radiographs are used to evaluate fracture healing, alignment, and complications. Conservative treatment generally provides satisfactory outcomes in minimally displaced fractures, whereas surgery may offer superior results in displaced fractures by reducing the incidence of nonunion and facilitating earlier rehabilitation. Nevertheless, long-term functional differences between the two treatment modalities remain inconsistent across published studies.[3]

The increasing incidence of high-energy trauma in developing countries has resulted in a greater number of displaced clavicle fractures presenting to tertiary care hospitals. Identifying the optimal treatment modality is essential for maximizing functional outcomes while minimizing complications and healthcare costs. Comparative evaluation of conservative and surgical management provides valuable evidence for guiding clinical decision-making and establishing treatment protocols tailored to individual patient characteristics. Therefore, the present study was undertaken to compare functional recovery, radiological union, and complication rates between conservative and surgical management of clavicle fractures in patients treated at a tertiary care center.[4]

AIM

To compare the functional and radiological outcomes of conservative and surgical management in patients with clavicle fractures.

OBJECTIVES

1. To compare functional outcomes between conservatively and surgically managed clavicle fractures using standardized functional scoring systems.
2. To evaluate radiological union, time to fracture healing, and alignment in both treatment groups.
3. To compare postoperative and treatment-related complications associated with conservative and surgical management.

MATERIALS AND METHODS

Source of Data

The data were collected from patients diagnosed with clavicle fractures who attended the Department of Orthopaedics of the tertiary care teaching hospital. Eligible patients were recruited consecutively after obtaining informed written consent and Institutional Ethics Committee approval. Clinical records, radiographs, operative notes, and follow-up assessments were used for data collection.

Study Design

A hospital-based comparative observational study was conducted.

Study Location

The study was conducted in the Department of Orthopaedics of a tertiary care teaching hospital.

Study Duration

The study was carried out over a period of 18 months, including patient recruitment, treatment, follow-up, data collection, and statistical analysis.

Sample Size

A total of 80 patients with clavicle fractures who fulfilled the eligibility criteria were included in the study. Patients were divided into:

- Conservative management group – 40 patients
- Surgical management group – 40 patients

Inclusion Criteria

- Patients aged 18 years and above.
- Acute clavicle fractures confirmed clinically and radiologically.
- Middle-third, lateral-third, or medial-third clavicle fractures suitable for either conservative or surgical treatment.
- Patients presenting within two weeks of injury.

- Patients willing to provide written informed consent and comply with follow-up visits.

Exclusion Criteria

- Pathological fractures.
- Open clavicle fractures.
- Polytrauma patients requiring life-saving emergency procedures.
- Associated neurovascular injuries requiring immediate vascular surgery.
- Previous fracture or surgery involving the affected clavicle.
- Patients with severe systemic illness precluding surgery.
- Patients unwilling to participate or lost to follow-up.

Procedure and Methodology

After admission, a detailed clinical history regarding age, sex, mechanism of injury, side involved, occupation, comorbidities, and time since injury was obtained. General physical examination and local examination of the shoulder girdle were performed. Standard anteroposterior radiographs with clavicle views were obtained to classify fractures according to the Robinson classification. Patients underwent either conservative or surgical treatment based on fracture characteristics, displacement, shortening, comminution, patient preference, and surgeon's decision. Conservative management consisted of arm sling immobilization, analgesics, gradual shoulder mobilization, and supervised physiotherapy. Surgical management involved open reduction and internal fixation using precontoured locking compression plates or other appropriate fixation devices under standard aseptic precautions. Patients were followed at regular intervals of 2 weeks, 6 weeks, 3 months, and 6 months. Clinical evaluation included pain assessment, shoulder range of motion, return to daily activities, and complications. Functional outcome was assessed using the Constant–Murley Score and/or DASH Score. Radiological evaluation included assessment of fracture alignment, callus formation, cortical continuity, and time to union. Complications such as delayed union, nonunion, malunion, infection, implant failure, implant prominence, shoulder stiffness, neurovascular complications, and reoperation were documented.

Sample Processing

Data obtained from patient interviews, clinical examination, operative records, follow-up assessments, and radiographs were recorded in a structured case record form. Functional scores and radiological findings were entered into a predesigned database. All collected data were verified for completeness and accuracy before statistical analysis.

Statistical Methods

The collected data were entered into Microsoft Excel and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequency and percentage. Comparison between the two groups for continuous variables was performed using the Independent Student's t-test, whereas categorical variables were compared using the Chi-square test or Fisher's exact test, wherever appropriate. A 95% confidence interval (CI) was calculated, and a p-value <0.05 was considered statistically significant.

Data Collection

Data were collected using a structured and prevalidated case record form containing demographic details, clinical history, mechanism of injury, fracture classification, treatment modality, operative details (where applicable), duration of immobilization, rehabilitation protocol, functional assessment scores, radiological findings, time to fracture union, complications, and follow-up outcomes. All patients were evaluated prospectively at predefined follow-up visits until completion of the study period, and the collected data were compiled and analyzed to compare conservative and surgical management outcomes.

RESULTS

Table 1: Overall functional and radiological outcomes between conservative and surgical management

Variable	Conservative (n=39)	Surgical (n=41)	Test	95% CI	p-value
Age, years	41.3±12.1	38.7±11.4	t=0.99	-2.64 to 7.84	0.326
Male	27 (69.2%)	29 (70.7%)	χ^2=0.02	-21.6% to 18.6%	0.884
Road traffic accident	22 (56.4%)	31 (75.6%)	χ^2=3.30	-39.6% to 1.2%	0.069
Fracture shortening, mm	11.6±2.8	9.8±2.4	t=3.08	0.64 to 2.96	0.003*
Final Constant–Murley score	82.4±8.6	89.7±6.9	t=4.17	-10.79 to -3.81	<0.001*
Radiological union achieved	30 (76.9%)	39 (95.1%)	χ^2=5.58	-33.0% to -3.4%	0.018*
Any complication	11 (28.2%)	3 (7.3%)	χ^2=6.04	4.7% to 37.1%	0.014*

A total of 80 patients with clavicle fractures were included in the study, comprising 39 patients managed conservatively and 41 managed surgically. The mean age was comparable between the conservative and surgical groups (41.3±12.1 vs. 38.7±11.4 years), with no statistically significant difference (t=0.99, p=0.326). Similarly, the proportion of male patients was nearly identical in both groups (69.2% vs. 70.7%; χ^2=0.02, p=0.884). Road traffic accidents were the most common mechanism of injury, accounting for 56.4% of the conservative group and 75.6% of the surgical group, although this difference was not statistically significant (χ^2=3.30, p=0.069). Patients undergoing surgical treatment had significantly lower fracture shortening than those managed conservatively (9.8±2.4 mm vs. 11.6±2.8 mm; t=3.08, p=0.003). Functional outcome was significantly superior in the surgical group, with a higher final Constant–Murley score (89.7±6.9 vs. 82.4±8.6; t=4.17, p<0.001). Radiological union was achieved in significantly more patients following surgery than conservative management (95.1% vs. 76.9%; χ^2=5.58, p=0.018). Overall complications were significantly less frequent in the surgical group (7.3%) compared with the conservative group (28.2%) (χ^2=6.04, p=0.014).

Table 2: Comparison of functional outcomes

Variable	Conservative (n=39)	Surgical (n=41)	Test	95% CI	p-value
Constant–Murley score at 6 months	82.4±8.6	89.7±6.9	t=4.17	-10.79 to -3.81	<0.001*
DASH score at 6 months	18.6±9.4	10.8±6.7	t=4.25	4.14 to 11.46	<0.001*
Shoulder abduction ≥150°	21 (53.8%)	35 (85.4%)	χ^2=9.46	-50.5% to -12.5%	0.002*
Return to routine activity within 12 weeks	19 (48.7%)	32 (78.0%)	χ^2=7.39	-49.8% to -8.7%	0.007*
Residual pain present	13 (33.3%)	5 (12.2%)	χ^2=5.10	2.2% to 40.0%	0.024*
Shoulder stiffness	7 (17.9%)	2 (4.9%)	χ^2=3.42	-0.7% to 26.8%	0.064

Functional assessment demonstrated significantly better outcomes among patients managed surgically. The mean Constant–Murley score at six months was significantly higher in the surgical group than in the conservative group (89.7±6.9 vs. 82.4±8.6; t=4.17, p<0.001), indicating superior shoulder function. Likewise, the mean DASH score, where lower scores indicate better function, was significantly lower in surgically treated patients (10.8±6.7 vs. 18.6±9.4; t=4.25, p<0.001). A significantly greater proportion of patients in the surgical group achieved shoulder abduction of at least 150° (85.4% vs. 53.8%; χ^2=9.46, p=0.002). Early return to routine daily activities within 12 weeks was also significantly more common following surgery (78.0% vs. 48.7%; χ^2=7.39, p=0.007). Residual pain was reported significantly less frequently in the surgical group (12.2%) compared with the conservative group (33.3%) (χ^2=5.10, p=0.024). Although shoulder stiffness occurred less often after surgical treatment (4.9% vs. 17.9%), this difference did not reach statistical significance (χ^2=3.42, p=0.064).

Table 3: Radiological union, healing time, and alignment

Variable	Conservative (n=39)	Surgical (n=41)	Test	95% CI	p-value
Radiological union achieved	30 (76.9%)	39 (95.1%)	χ^2=5.58	-33.0% to -3.4%	0.018*
Time to union, weeks	14.2±3.1	11.6±2.4	t=4.18	1.36 to 3.84	<0.001*
Acceptable alignment	24 (61.5%)	36 (87.8%)	χ^2=7.45	-45.4% to -7.2%	0.006*
Malunion	9 (23.1%)	4 (9.8%)	χ^2=2.61	-2.7% to 29.4%	0.106
Mean residual shortening, mm	8.1±2.4	5.9±1.8	t=4.62	1.25 to 3.15	<0.001*
Delayed union	6 (15.4%)	1 (2.4%)	χ^2=4.20	0.7% to 25.2%	0.041*
Nonunion	3 (7.7%)	1 (2.4%)	Fisher's exact	-5.1% to 15.7%	0.352

Radiological evaluation showed significantly improved healing outcomes among surgically managed patients. Radiological union was achieved in 95.1% of patients in the surgical group compared with 76.9% in the conservative group (χ^2=5.58, p=0.018). The mean time required for fracture union was significantly shorter following surgery (11.6±2.4 weeks) than with conservative treatment (14.2±3.1 weeks) (t=4.18, p<0.001). Acceptable fracture alignment was observed significantly more frequently in surgically treated patients (87.8%) than in those managed conservatively (61.5%) (χ^2=7.45, p=0.006).

Although malunion occurred more commonly in the conservative group (23.1% vs. 9.8%), the difference was not statistically significant (χ^2=2.61, p=0.106). Mean residual shortening after healing was significantly lower following surgery (5.9±1.8 mm) compared with conservative management (8.1±2.4 mm) (t=4.62, p<0.001). Delayed union was significantly more frequent in the conservative group (15.4% vs. 2.4%; χ^2=4.20, p=0.041). Nonunion was observed in three conservatively managed patients and one surgically treated patient, without a statistically significant difference (Fisher's exact test, p=0.352).

Table 4: Treatment-related complications

Complication	Conservative (n=39)	Surgical (n=41)	Test	95% CI	p-value
Any complication	11 (28.2%)	3 (7.3%)	χ^2=6.04	4.7% to 37.1%	0.014*
Delayed union	6 (15.4%)	1 (2.4%)	χ^2=4.20	0.7% to 25.2%	0.041*
Nonunion	3 (7.7%)	1 (2.4%)	Fisher's exact	-5.1% to 15.7%	0.352
Malunion	9 (23.1%)	4 (9.8%)	χ^2=2.61	-2.7% to 29.4%	0.106
Implant irritation/prominence		6 (14.6%)			
Superficial infection		2 (4.9%)			
Reoperation/implant removal		3 (7.3%)			
Shoulder stiffness	7 (17.9%)	2 (4.9%)	χ^2=3.42	-0.7% to 26.8%	0.064

*Significant p-value <0.05.

Treatment-related complications were overall more frequent among patients managed conservatively. Any complication occurred in 28.2% of the conservative group compared with only 7.3% of the surgical group, representing a statistically significant difference (χ^2=6.04, p=0.014). Delayed union was also significantly more common with conservative treatment (15.4% vs. 2.4%; χ^2=4.20, p=0.041). Although nonunion (7.7% vs. 2.4%) and malunion (23.1% vs. 9.8%) occurred more frequently in the conservative group, these differences were not statistically significant (p=0.352 and p=0.106, respectively). Surgery-specific complications included implant irritation or prominence in six patients (14.6%), superficial wound infection in two patients (4.9%), and reoperation or implant removal in three patients (7.3%). Shoulder stiffness was observed in 17.9% of conservatively managed patients compared with 4.9% of surgically managed patients; however, this difference was not statistically significant (χ^2=3.42, p=0.064).

DISCUSSION

In the present study, baseline characteristics were comparable between conservative and surgical groups with respect to age and sex, indicating that both groups were broadly similar. Road traffic accident was more common in the surgical group, suggesting that displaced or high-energy fractures were more likely to undergo operative fixation. This pattern was similar to Melean et al. (2015)[1] and Woltz et al. (2017)[2], who observed that displaced midshaft clavicle fractures in active adults were frequently considered for operative fixation. In the present study, fracture shortening was significantly lower in the surgical group, supporting the role of anatomical reduction and fixation. Similar findings were reported by Wang et al. (2015)[3] and Qin et al. (2019)[4], who concluded that operative treatment helped restore clavicular length and alignment better than conservative care.

Functional outcomes were significantly better in the surgical group, with higher Constant–Murley score and lower DASH score at 6 months. Shoulder abduction ≥150° and return to routine activity within 12 weeks were also significantly higher after surgery. These findings were consistent with Melean et al. (2015)[1], Woltz et al. (2017)[2], and Axelrod et al. (2020)[5], who reported better early functional recovery after fixation of displaced clavicle fractures. Shi et al. (2022)[6], in a network meta-analysis, also found that operative methods showed better functional ranking than nonsurgical treatment. However, Kask et al. (2020)[7] noted that long-term functional differences may become minimal, emphasizing that surgery is more useful in selected patients requiring early functional recovery.

Radiological outcomes in the present study favored surgical management. Radiological union was significantly higher in the surgical group, and mean time to union was shorter compared with conservative treatment. Acceptable alignment was also significantly better after surgery, while residual shortening and delayed union were significantly more common in the conservative group. These findings agreed with Wang et al. (2015)[3], Qin et al. (2019)[4], and von Rüden et al. (2023)[8], who reported that operative fixation reduces nonunion, malunion, shortening, and delayed healing in displaced clavicle fractures. Waldmann et al. (2018)[9] also highlighted that conservative treatment may produce satisfactory results in selected patients, but displaced fractures have a higher risk of shortening, malunion, and nonunion.

Complications were significantly more frequent in the conservative group in the present study, mainly due to delayed union, malunion, nonunion, residual pain, and shoulder stiffness. Similar observations were made by Wang et al. (2015)[3] and Axelrod et al. (2020)[5], who found higher rates of nonunion and symptomatic malunion after nonoperative treatment. In contrast, surgery-specific complications such as implant irritation, superficial infection, and implant removal were observed only in the surgical group. This was comparable with Woltz et al. (2017)[2], Kask et al. (2020)[7], and Borg et al. (2025)[10], who stated that although surgery reduces nonunion, it carries implant-related morbidity and risk of reoperation. Kumar et al. (2022)[11] also emphasized that conservative treatment may still be appropriate in selected displaced and comminuted fractures depending on patient factors.

Overall, the present study demonstrated that surgical management provided better early functional recovery, higher union rate, shorter time to union, improved alignment, less residual shortening, and fewer overall complications compared with

conservative treatment. These findings are in agreement with Tamaoki et al. (2017)[12], who supported operative fixation in properly selected patients with displaced clavicle fractures. However, treatment should be individualized according to fracture displacement, shortening, comminution, patient age, occupation, activity level, cosmetic concerns, surgical risk, and cost.

CONCLUSION

The present comparative study demonstrated that surgical management of clavicle fractures resulted in significantly superior functional and radiological outcomes compared with conservative treatment. Patients treated surgically achieved higher Constant–Murley scores, lower DASH scores, greater shoulder range of motion, earlier return to routine activities, and significantly better radiological union with shorter healing time. Surgical fixation also provided improved fracture alignment, reduced residual shortening, and lower rates of delayed union and overall complications. Although implant-related complications such as hardware prominence, superficial infection, and implant removal were observed exclusively in the surgical group, these were relatively infrequent and were outweighed by the benefits of stable fixation and faster rehabilitation. Conservative management remained an effective treatment option for selected minimally displaced fractures but was associated with a higher incidence of delayed union, malunion, residual pain, and shoulder stiffness. Therefore, surgical management should be considered the preferred treatment for appropriately selected displaced clavicle fractures, particularly in young, active individuals requiring rapid functional recovery, while treatment decisions should continue to be individualized based on fracture characteristics, patient expectations, comorbidities, and surgeon expertise.

LIMITATIONS OF THE STUDY

1) The sample size was relatively small (80 patients), which may have reduced the power to detect differences in less frequent complications.
2) Patients were not randomized to treatment groups, introducing the possibility of selection bias.
3) The follow-up duration was limited to early and intermediate outcomes, without assessment of long-term shoulder function or post-traumatic arthritis.
4) Different fracture configurations and degrees of displacement could have influenced treatment allocation and outcomes.
5) Functional assessment was primarily based on clinical scoring systems and did not include objective muscle strength or quality-of-life measurements.
6) Economic evaluation, treatment costs, and patient satisfaction were not assessed.
7) Surgeon experience and implant selection were not standardized and may have influenced surgical outcomes.

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