



## FUNCTIONAL OUTCOME OF LATERAL THIRD CLAVICLE PLATE IN THE MANAGEMENT OF MEDIAL THIRD FRACTURE OF CLAVICLE: A RETROSPECTIVE CASE SERIES

### Orthopaedics

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### ABSTRACT

**Background:** Medial third clavicular fractures are uncommon injuries with traditionally high rates of nonunion and functional impairment when treated conservatively. The use of inverted lateral clavicle plates has emerged as a viable surgical option, but limited data exists on functional outcomes. To evaluate the functional outcomes, union rates, and complications of using inverted lateral third clavicle plates for the management of displaced medial third clavicular fractures. **Methods:** A retrospective analysis was conducted of patients with acute displaced medial third clavicular fractures treated with inverted lateral clavicle plates between January 2018 and December 2022. Patients were evaluated for fracture union, functional outcomes using the DASH score, Constant-Murley score, and complications. Minimum follow-up was 12 months. **Results:** Twenty-four patients (mean age  $34.2 \pm 12.8$  years) were included. All fractures achieved radiographic union at a mean of  $12.4 \pm 2.1$  weeks. Mean DASH score at final follow-up was  $8.2 \pm 6.4$ , and mean Constant-Murley score was  $92.1 \pm 5.8$ . Twenty-two patients (91.7%) returned to their pre-injury activity level. Complications occurred in 3 patients (12.5%): 2 cases of hardware prominence requiring removal and 1 superficial wound infection. **Conclusion:** The use of lateral third clavicle plates in an inverted position achieves favorable functional results, demonstrates strong bone healing rates, and maintains reasonable complication profiles when treating displaced fractures of the medial clavicular third. This technique represents a viable surgical option for these challenging injuries.

### KEYWORDS

Clavicle Fracture, Medial Third, Lateral Clavicle Plate, Functional Outcome, Internal Fixation

### INTRODUCTION

Fractures involving the medial third of the clavicle are relatively uncommon, accounting for just 2-5% of all clavicular fracture cases (1,2). The management of these injuries presents distinct challenges compared to the more frequently encountered midshaft fractures. Historically, orthopedic surgeons have favored nonsurgical approaches for medial clavicular fractures, primarily due to the anatomical complexity of the region and the presence of critical mediastinal structures in close proximity (3,4). Technical obstacles in achieving stable internal fixation have further reinforced this conservative treatment paradigm (3,4).

Despite the traditional preference for nonoperative management, emerging evidence suggests that conservative treatment may not yield optimal results for displaced medial clavicular fractures. Studies have documented nonunion rates ranging from 8.3% to 14.3% in displaced cases treated nonoperatively, with more than half of patients experiencing ongoing functional limitations (5,6).

The surgical treatment of medial clavicular fractures is complicated by the region's intricate anatomy, particularly the relationship between the medial clavicle, the sternoclavicular joint, and adjacent neurovascular structures. Conventional fixation techniques, such as Kirschner wire placement, tension band constructs, and standard small fragment plating systems, have demonstrated inconsistent results and considerable complication profiles (7,8). A promising technical innovation involves the application of anatomically designed lateral clavicle plates in an inverted orientation, which may offer enhanced stability for medial fracture fixation (9,10).

Preliminary case series examining the use of inverted lateral clavicle plates for medial third fractures have reported encouraging results, including satisfactory union rates and minimal complications (11,12). Nevertheless, detailed functional outcome assessments remain sparse in the current literature, and surgical technique refinement is ongoing.

### MATERIALS AND METHODS

#### Study Design and Patient Selection

We conducted a retrospective case series analysis encompassing all consecutive patients who underwent surgical fixation with inverted lateral clavicle plates for acute displaced medial third clavicular fractures at our facility during the period from January 2025 through July 2025. Institutional review board approval was obtained prior to study initiation.

Patient eligibility required satisfaction of specific criteria. Participants ranged in age from 18 to 65 years and presented with acute displaced fractures of the medial clavicular third occurring within three weeks of the initial injury. A minimum follow-up period of 12 months was mandatory, along with comprehensive radiographic and clinical documentation throughout the treatment course. Patients were excluded from analysis if they presented with pathological fractures, open fracture patterns, concomitant shoulder girdle injuries, or prior surgical interventions involving the clavicle. Additional exclusion factors included significant medical conditions known to impair bone healing and loss to follow-up before completion of the 12-month evaluation period.

#### Operative Procedure

Senior orthopedic surgeons performed all surgical procedures using general anesthesia. Patient positioning involved supine placement with a sandbag positioned between the scapulae to facilitate surgical exposure. A transverse skin incision was created parallel to and approximately 1 cm below the medial clavicle, spanning from the sternoclavicular articulation to the transition point between the medial and middle clavicular segments.



**Clinical Image 1: Intra Op Images**

The fixation construct utilized an ipsilateral lateral clavicle locking plate (Acumed, Hillsboro, OR) applied in an inverted configuration after manual contouring to accommodate the medial clavicular morphology. A 90-degree twist was created at the interface between the flared plate segment and the shaft component, enabling placement of the flared portion along the anterior medial clavicular surface while the shaft extended superiorly. Fracture alignment was achieved and temporarily stabilized using bone reduction clamps or provisional Kirschner wires.

Definitive fixation of the medial fracture fragment incorporated multiple 2.7mm locking screws directed anteriorly to posteriorly with unicortical purchase. The lateral plate segment was secured with 3.5mm cortical screws inserted bicortically in a superior-to-inferior trajectory. Intraoperative fluoroscopy verified satisfactory fracture reduction and appropriate hardware positioning before proceeding with wound closure.



**Image 2: Pre Op, Intra Op and Post Op X-ray Images**

### Rehabilitation Protocol

The postoperative recovery protocol initiated with shoulder immobilization using a sling for a two-week period. Subsequently, patients began progressive range of motion exercises under supervised guidance. Load-bearing restrictions limited upper extremity activity to 5kg for six weeks postoperatively, with graduated advancement to unrestricted activity determined by both clinical assessment and radiographic evidence of fracture consolidation.

### Evaluation Parameters

Patient assessment occurred at designated intervals: two weeks, six weeks, three months, six months, and yearly thereafter. The primary outcome measures encompassed fracture union, defined radiographically as bridging callus formation across a minimum of three cortices accompanied by clinical absence of tenderness on direct palpation. Functional status was quantified using standardized instruments including DASH questionnaire and the Constant-Murley shoulder assessment scale. Additional primary endpoints included successful return to baseline activity participation and complication occurrence, specifically infection, hardware mechanical failure, fracture nonunion, and requirement for secondary surgical procedures.

Secondary outcome variables comprised time elapsed to radiographic union, shoulder range of motion measurements across all planes, and subjective patient satisfaction ratings.

### Data Analysis

Descriptive statistical methods were applied to all collected variables. Continuous data are reported as mean values  $\pm$  standard deviation or median values with corresponding interquartile ranges depending on distribution characteristics. Categorical data are expressed as frequencies with associated percentages. All statistical computations were executed using SPSS version 28.0 software (IBM Corp, Armonk, NY). Statistical significance was established at a p-value threshold below 0.05.

## RESULTS

### Patient Demographics

Twenty-four patients met the inclusion criteria during the study period. Patient demographics and fracture characteristics are summarized in Table 1. The mean age was  $34.2 \pm 12.8$  years (range 19-58 years), with 18 male patients (75%). Right-sided fractures occurred in 14 patients (58.3%). The most common mechanism of injury was motor vehicle accident (8 patients, 33.3%), followed by sports-related trauma (7 patients, 29.2%) and falls (9 patients, 37.5%).

### Fracture Characteristics

According to the classification system described by Robinson, 16 patients (66.7%) had Type II fractures (displaced), and 8 patients (33.3%) had Type III fractures (comminuted). Intra-articular extension into the sternoclavicular joint was present in 11 patients (45.8%). The mean time from injury to surgery was  $8.4 \pm 4.2$  days (range 2-18 days).

### Surgical Outcomes

All 24 patients achieved radiographic union at a mean of  $12.4 \pm 2.1$  weeks (range 8-16 weeks). No cases of nonunion or delayed union were observed. Clinical union, defined as absence of tenderness at the fracture site, was achieved at a mean of  $10.8 \pm 1.9$  weeks.

The mean operative time was  $78.5 \pm 15.2$  minutes (range 55-105

minutes). Estimated blood loss was minimal ( $<50$ ml) in all cases. No intraoperative complications were encountered.

### Functional Outcomes

Functional outcome scores at final follow-up (mean  $28.4 \pm 8.7$  months) are presented in Table 2. The mean DASH score was  $8.2 \pm 6.4$  (range 0-22), indicating excellent functional outcomes. The mean Constant-Murley score was  $92.1 \pm 5.8$  (range 78-100).

Range of motion measurements showed excellent recovery in most patients. Mean forward flexion was  $172^\circ \pm 8^\circ$  (compared to  $175^\circ \pm 5^\circ$  on the uninjured side), and mean abduction was  $168^\circ \pm 10^\circ$  (compared to  $174^\circ \pm 6^\circ$  on the uninjured side). No significant difference was observed between injured and uninjured sides ( $p > 0.05$ ).

Twenty-two patients (91.7%) returned to their pre-injury activity level within 6 months of surgery. Two patients had slight activity modifications due to persistent mild discomfort during overhead activities but reported overall satisfaction with their outcomes.



**Clinical Image 3: One Year Follow up Range of Motion**

### Complications

Complications occurred in 3 patients (12.5%) and are detailed in Table 3. Two patients developed hardware prominence causing local irritation, requiring plate removal at 18 and 24 months post-surgery respectively. Both patients maintained excellent functional outcomes after hardware removal. One patient developed a superficial wound infection treated successfully with oral antibiotics without further sequelae.

No cases of deep infection, implant failure, neurovascular injury, or symptomatic malunion were observed. Patient satisfaction was high, with 23 patients (95.8%) reporting they would undergo the same procedure again if faced with a similar injury.

### Radiographic Analysis

Serial radiographic analysis demonstrated progressive healing in all cases. Callus formation was evident by 6 weeks in 21 patients (87.5%) and by 8 weeks in all patients. Cortical bridging was observed at a mean of  $10.2 \pm 2.4$  weeks. No cases of hardware loosening or migration were identified during the follow-up period.

## DISCUSSION

Our investigation reveals superior functional results and consistently high rates of fracture consolidation following surgical treatment of displaced medial third clavicular fractures using inverted lateral clavicle plates. These findings align with emerging evidence favoring operative intervention for such injuries, as demonstrated by universal fracture union achievement and restoration of baseline activity levels in 91.7% of our patient cohort.

The complete absence of nonunion in our patient series represents a

marked improvement over historical outcomes associated with nonoperative treatment approaches, where failure of bony consolidation has been documented in 8.3-14.3% of displaced medial clavicular injuries (5,6). Furthermore, our observed mean healing duration of 12.4 weeks parallels other published surgical series while demonstrating accelerated consolidation compared to conservative management protocols (13,14).

Patient-reported and objective functional assessment metrics from our cohort, reflect substantial recovery of upper extremity function. These measurements exceed established thresholds for minimal clinically important differences in both assessment tools and demonstrate outcomes superior to alternative medial clavicular fixation techniques reported in the literature (15,16).

The application of lateral clavicle plates in an inverted configuration effectively addresses the unique anatomical and biomechanical challenges inherent to medial clavicular fracture management. When positioned in reverse orientation, the anatomical contours of lateral-specific plates conform well to the medial clavicular morphology while simultaneously providing multiple anchor points for the frequently diminutive medial fracture fragment (17). Incorporating a 90-degree rotational twist in the plate enables strategic positioning of the expanded plate terminus along the anterior medial clavicular surface, thereby preventing impingement on the sternoclavicular articulation and adjacent soft tissue structures.

Our technical approach utilizing an inferior surgical corridor with anterior plate application confers multiple benefits relative to traditional superior plating methods. This approach preserves the integrity of sternoclavicular ligamentous structures while facilitating improved access for screw insertion and reducing the likelihood of symptomatic soft tissue irritation (18). The implementation of unicortical screw purchase in the medial fragment achieves sufficient biomechanical stability while mitigating the risk of iatrogenic injury to posteriorly located vital structures.

The 12.5% complication incidence documented in our series falls within acceptable parameters and predominantly involved symptomatic hardware prominence rather than major surgical morbidity. Notably, no neurovascular complications were encountered, validating the safety profile of our surgical methodology. The two patients requiring secondary hardware extraction maintained excellent functional capacity, indicating that implant removal does not adversely affect long-term clinical results.

The complete absence of deep-seated infections, construct failures, or persistent nonunion in our cohort stands in contrast to certain historical accounts of medial clavicular fracture surgery (19,20). This favorable outcome profile likely reflects progressive refinements in operative technique, implant engineering, and perioperative management strategies.

**Study Limitations**

Several inherent limitations warrant acknowledgment. The retrospective study architecture and modest sample size constrain the robustness of our conclusions. The lack of a comparison cohort managed either nonoperatively or through alternative surgical strategies precludes direct comparative analysis of treatment efficacy. Moreover, the single-institution design and specific technical approach employed may limit the external validity of our findings to other clinical settings or surgical practitioners.

While the mean follow-up duration of 28.4 months provides adequate observation for assessing fracture consolidation and short-term functional recovery, this timeframe may prove insufficient for detecting delayed complications or progressive degenerative alterations. Extended longitudinal investigations would enhance understanding of outcome durability.

**Clinical Significance**

Our findings substantiate the utilization of inverted lateral clavicle plates as a highly effective therapeutic strategy for displaced medial third clavicular fractures. The combination of superior functional outcomes, consistent fracture union, and manageable complication rates suggests that operative management merits strong consideration for these injuries rather than reflexive selection of conservative protocols.

The described surgical technique provides distinct advantages over alternative operative approaches, encompassing robust fixation stability, preservation of native sternoclavicular joint architecture, and limited soft tissue trauma. The elevated patient satisfaction indices and successful restoration of baseline functional capacity underscore the clinical utility of this treatment paradigm.

**Future Investigation**

Subsequent research endeavors should prioritize prospective comparative trials evaluating surgical versus nonsurgical treatment strategies for medial clavicular fractures. Extended follow-up investigations examining the persistence of functional gains and potential development of degenerative sequelae would contribute valuable insights. Additionally, systematic exploration of optimal timing and indications for hardware extraction could facilitate minimization of complications while preserving excellent clinical outcomes.

**CONCLUSION**

Inverted lateral third clavicle plates represent a highly effective fixation solution for displaced medial third clavicular fractures, yielding superior functional outcomes, consistent fracture union, and manageable complication profiles. This surgical technique achieves stable fracture stabilization while maintaining sternoclavicular joint integrity and limiting soft tissue morbidity. Our findings support consideration of operative management using inverted lateral clavicle plates as a preferred treatment strategy for appropriately selected patients with displaced medial third clavicular injuries.

The universal achievement of fracture union, outstanding functional assessment scores, and high frequency of activity restoration validate the efficacy of this surgical approach. Although complications may arise, they typically remain minor in severity and do not compromise ultimate functional recovery. This technique constitutes a meaningful advancement in the therapeutic management of these technically demanding injuries.

**Table 1: Patient Demographics and Fracture Characteristics**

Variable	Value
<b>Demographics</b>	
Number of patients	24
Age (years), mean ± SD	34.2 ± 12.8
Age range	19-58
Male sex, n (%)	18 (75.0)
Right side, n (%)	14 (58.3)
<b>Mechanism of Injury</b>	
Motor vehicle accident, n (%)	8 (33.3)
Sports-related trauma, n (%)	7 (29.2)
Fall, n (%)	9 (37.5)
<b>Fracture Classification</b>	
Robinson Type II (displaced), n (%)	16 (66.7)
Robinson Type III (comminuted), n (%)	8 (33.3)
Intra-articular extension, n (%)	11 (45.8)
<b>Surgical Variables</b>	
Time to surgery (days), mean ± SD	8.4 ± 4.2
Operative time (minutes), mean ± SD	78.5 ± 15.2
Follow-up (months), mean ± SD	28.4 ± 8.7

**Table 2: Functional Outcomes at Final Follow-up**

Outcome Measure	Mean ± SD	Range	Normal Values
DASH Score	8.2 ± 6.4	0-22	0-15 (excellent)
Constant-Murley Score	92.1 ± 5.8	78-100	>80 (excellent)
<b>Range of Motion (degrees)</b>			
Forward flexion - injured	172 ± 8	155-180	
Forward flexion - uninjured	175 ± 5	165-180	
Abduction - injured	168 ± 10	145-180	
Abduction - uninjured	174 ± 6	160-180	
External rotation - injured	78 ± 12	55-90	
External rotation - uninjured	82 ± 8	70-90	
<b>Functional Recovery</b>			
Return to pre-injury activity, n (%)	22 (91.7)		
Time to return to work (weeks), mean ± SD	8.4 ± 3.2	4-16	
Patient satisfaction (1-10), mean ± SD	9.1 ± 0.8	7-10	

**Table 3: Complications and Management**

Complication	Number (%)	Time of Occurrence	Management	Outcome
Hardware prominence	2 (8.3)	18, 24 months	Plate removal	Excellent function maintained
Superficial wound infection	1 (4.2)	2 weeks	Oral antibiotics	Complete resolution
Deep infection	0 (0)	-	-	-
Nonunion	0 (0)	-	-	-
Implant failure	0 (0)	-	-	-
Neurovascular injury	0 (0)	-	-	-
Symptomatic malunion	0 (0)	-	-	-
Total complications	3 (12.5)			

**Table 4: Radiographic Healing Timeline**

Radiographic Parameter	Time (weeks), mean ± SD	Range (weeks)	Number achieving milestone (%)
Callus formation	6.8 ± 1.4	4-10	24 (100)
Cortical bridging	10.2 ± 2.4	7-14	24 (100)
Clinical union	10.8 ± 1.9	8-14	24 (100)
Radiographic union	12.4 ± 2.1	8-16	24 (100)

**Table 5: Comparison with Literature**

Study	n	Union Rate (%)	Mean DASH Score	Complications (%)	Follow-up (months)
Current Study	24	100	8.2	12.5	28.4
Titchener et al. [12]	8	100	5.4*	0	30.5
Sidhu et al. [11]	25	100	NR	24	24
Wang et al. [21]	6	100	3.8	0	18
Low et al. [22]	13	100	NR	15.4	36

\*QuickDASH score NR = Not reported

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