Original Research

FUNCTIONAL AND RADIOLOGICAL OUTCOME OF HOOK PLATE FIXATION IN DISPLACED LATERAL END CLAVICLE FRACTURES: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Displaced lateral end clavicle fractures are unstable injuries with a higher risk of delayed union, non-union and shoulder dysfunction when treated conservatively. Hook plate fixation provides stable fixation, especially when the distal fragment is small or comminuted.

Methods: This prospective observational study was conducted in the Department of Orthopaedics, SMS Medical College and Attached Hospitals, Jaipur. A total of 34 adult patients with displaced lateral end clavicle fractures underwent open reduction and internal fixation using a clavicular hook plate. Patients were assessed clinically and radiologically during follow-up. Functional outcome was evaluated using the Constant-Murley score, while radiological outcome was assessed by fracture union and maintenance of reduction.

Results: The mean age of patients was 38.7 ± 10.4 years, and 73.5% were males. Road traffic accident was the most common mode of injury. Mean VAS score reduced from 8.0 ± 0.8 preoperatively to 0.8 ± 0.4 at 6 months. Mean Constant-Murley score improved to 89.6 ± 5.8 at final follow-up. Radiological union was achieved in all patients, with mean union time of 12.1 ± 1.2 weeks.

Conclusion: Hook plate fixation is an effective option for displaced lateral end clavicle fractures, providing reliable union, pain relief and good functional recovery.

Keywords: Clavicle Fracture, Lateral End Clavicle, Hook Plate, Constant-Murley Score, Radiological Union.

INTRODUCTION

Clavicle fractures are common injuries in orthopaedic practice and account for about 2.6–5% of all adult fractures. The clavicle acts as a strut between the sternum and scapula and plays an important role in shoulder stability, upper limb movement and force transmission. Because of its subcutaneous position and S-shaped contour, it is vulnerable to injury following road traffic accidents, direct trauma, falls on the shoulder or falls on an outstretched hand.[1,2]

Anatomically, the clavicle is divided into medial, middle and lateral thirds. Midshaft fractures are the most frequent, while lateral end clavicle fractures account for approximately 10–25% of cases. Although less common, lateral end fractures are important because they are more prone to displacement, delayed union and non-union.

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The stability of these fractures mainly depends on the integrity of the coracoclavicular ligaments. The Neer classification is widely used for distal clavicle fractures, with type II fractures considered unstable due to disruption of ligamentous support. In these fractures, the medial fragment is pulled superiorly by the sternocleidomastoid muscle, while the lateral fragment tends to displace inferiorly with the weight of the arm.[3,4]

Traditionally, most clavicle fractures were managed conservatively with an arm sling or figure-of-eight bandage. This approach is still suitable for stable and undisplaced fractures. However, displaced lateral end fractures, particularly Neer type II fractures, have shown higher rates of non-union, malunion, persistent pain and functional limitation when treated non-operatively. Rokito et al. reported a high non-union rate in type II distal clavicle fractures treated conservatively, and later systematic reviews have supported operative fixation for unstable fracture patterns.[5,6,7] Therefore, surgical management is now commonly preferred for displaced and unstable lateral end clavicle fractures, especially in active adults.

The goals of surgical treatment are anatomical reduction, stable fixation, fracture union, pain relief and early mobilisation of the shoulder. Various techniques have been described, including Kirschner

wire fixation, tension band wiring, coracoclavicular screw fixation, locking plate fixation, coracoclavicular ligament reconstruction and hook plate fixation. However, each method has its limitations. Kirschner wires may migrate, tension band wiring may fail in comminuted fractures, coracoclavicular screws restrict physiological movement, and locking plates may not provide adequate purchase when the distal fragment is small.[8,9]

The clavicle hook plate was designed to address these difficulties. It consists of a plate fixed to the clavicle and a hook placed beneath the acromion, allowing indirect stabilisation of the distal fragment. This is particularly useful in unstable and comminuted distal clavicle fractures where direct screw fixation of the lateral fragment is difficult. The hook acts as a lever arm and counteracts the deforming forces across the fracture, thereby maintaining reduction and allowing early shoulder mobilisation.[10]

Several studies have shown favourable outcomes with hook plate fixation. Meda et al. reported good union and functional results following clavicular hook plate fixation for lateral end fractures.[11] Flinkkilä et al. reported satisfactory outcomes in unstable lateral clavicle fractures treated with hook plates, while Tiren et al. found good mid-term results after hook plate fixation in acute displaced lateral clavicle fractures.[12,13] Systematic reviews have also shown high union rates after operative treatment of Neer type II distal clavicle fractures, with hook plates providing reliable stability in unstable patterns.[6,7,14]

Functional assessment after fixation is essential because radiological union alone does not always reflect complete recovery. The Constant-Murley score is one of the most widely used tools for evaluating shoulder function, as it assesses pain, activities of daily living, range of motion and strength.[15] Radiological assessment includes evaluation of fracture union, maintenance of reduction, implant position and complications such as acromial osteolysis or implant failure.

Despite its advantages, hook plate fixation may be associated with complications such as subacromial impingement, shoulder pain, acromial osteolysis, rotator cuff irritation, implant-related discomfort and the need for implant removal after union. These complications are influenced by hook depth, implant positioning and duration of plate retention. Oh et al. and Lee et al. highlighted implant-related complications following hook plate fixation and emphasised proper surgical technique and timely implant removal.[16,17]

In the Indian setting, displaced lateral end clavicle fractures are frequently encountered in tertiary trauma centres due to road traffic accidents and falls. Early restoration of shoulder function is important, particularly in young and working adults. However, limited region-specific data are available regarding both functional and radiological outcomes after hook plate fixation. Therefore, the present study was conducted in the Department of Orthopaedics, SMS Medical College and Attached Hospitals, Jaipur, to evaluate the functional and radiological outcome of hook plate fixation in adult patients with displaced lateral end clavicle fractures.

MATERIALS AND METHODS

The present study was conducted in the Department of Orthopaedics, SMS Medical College and Attached Hospitals, Jaipur, Rajasthan. It was designed to evaluate the functional and radiological outcome of hook plate fixation in adult patients with displaced lateral end clavicle fractures.

This was a prospective observational study. Patients aged more than 18 years presenting with displaced lateral end clavicle fractures, particularly Neer type II fractures, were included after obtaining written informed consent. Patients with open fractures, pathological fractures, associated neurovascular injury, medical unfitness for surgery or unwillingness to participate were excluded from the study.

All eligible patients were enrolled by consecutive sampling during the study period. A detailed clinical history was recorded, followed by general, systemic and local examination of the affected shoulder. Standard anteroposterior radiographs of the shoulder were obtained to confirm the diagnosis and classify the fracture pattern. Routine preoperative investigations were performed, and patients were prepared for surgery after anaesthetic fitness.

All patients underwent open reduction and internal fixation using a clavicle hook plate under appropriate anaesthesia. The patient was positioned in the beach-chair position, and a standard incision was made over the lateral clavicle. After adequate exposure, the fracture was reduced anatomically. The hook of the plate was placed beneath the acromion, and the plate was fixed to the clavicle using screws. Proper reduction, implant position and stability were confirmed intraoperatively.

Postoperatively, the operated limb was supported in an arm sling. Passive shoulder mobilisation was started as tolerated, followed by active mobilisation and progressive rehabilitation. Patients were followed up at regular intervals for clinical and radiological assessment. Functional outcome was assessed using the Constant-Murley score, which includes pain, activities of daily living, range of motion and strength. Pain was assessed using the visual analogue scale. Radiological outcome was evaluated using serial radiographs for fracture

union, maintenance of reduction, implant position and complications.

The main outcome measures were functional recovery, radiological union, time to union, range of shoulder movement and postoperative complications such as subacromial impingement, acromial osteolysis, infection, implant-related discomfort or implant failure. Hook plate removal was considered after radiological union, depending on symptoms and the presence of complications.

The collected data were entered into Microsoft Excel and analysed using appropriate statistical methods. Quantitative variables were expressed as mean and standard deviation, while qualitative variables were expressed as frequency and percentage. Data were presented in the form of tables, charts and graphs. A p-value of less than 0.05 was considered statistically significant.

Ethical approval was obtained from the Institutional Ethics Committee before starting the study. Written informed consent was taken from all participants, and confidentiality of patient information was maintained throughout the study.

RESULTS

A total of 34 patients with displaced lateral end clavicle fractures were included in the study. All patients underwent fixation with a clavicular hook plate and were followed up for functional and radiological assessment. Quantitative variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequency and percentage.

Table 1: Baseline and injury profile of study participants

Variable	Category / Value	Frequency	Percentage
Mean age	38.7 ± 10.4 years	-	-
Age group	20–30 years	9	26.5%
	31–40 years	10	29.4%
	41–50 years	8	23.5%
	51–60 years	7	20.6%
Sex	Male	25	73.5%
	Female	9	26.5%
Residence	Urban	19	55.9%
	Rural	15	44.1%
Mode of injury	Road traffic accident	22	64.7%
	Fall	12	35.3%
Side of injury	Right	21	61.8%
	Left	13	38.2%

The majority of patients were young to middle-aged adults, with the highest proportion in the 31–40 years age group. Males constituted 73.5% of cases. Road traffic accident was the most common mode of injury, seen in 64.7% of patients, and the right side was more frequently involved.

Table 2: Surgical and perioperative profile

Parameter	Result
Mean time to surgery	4.3 ± 1.5 days
Surgery within 2–3 days	12 (35.3%)
Surgery within 4–5 days	14 (41.2%)
Surgery within 6–7 days	8 (23.5%)
Mean operative duration	79.6 ± 6.5 minutes
Mean blood loss	134.2 ± 22.1 mL
Mean hospital stay	5.2 ± 0.9 days
Mean preoperative VAS score	8.0 ± 0.8

Most patients underwent surgery within 4 - 5 days of injury. The mean operative duration was 79.6 ± 6.5 minutes, with mean blood loss of 134.2 ± 22.1 mL and mean hospital stay of 5.2 ± 0.9 days.

Table 3: Pain and functional outcome during follow-up

Follow-up period	VAS score, mean ± SD	Constant-Murley score, mean ± SD
Preoperative	8.0 ± 0.8	-
2 weeks	5.8 ± 0.6	41.2 ± 5.3
6 weeks	2.9 ± 0.5	64.8 ± 6.1

6 months	0.8 ± 0.4	89.6 ± 5.8
Statistical test	Repeated measures ANOVA	Repeated measures ANOVA
p-value	<0.001	<0.001

Pain showed a progressive and statistically significant reduction over follow-up. The mean VAS score decreased from 8.0 ± 0.8 preoperatively to 0.8 ± 0.4 at 6 months. Functional recovery also improved significantly, with the mean Constant-Murley score increasing from 41.2 ± 5.3 at 2 weeks to 89.6 ± 5.8 at 6 months.

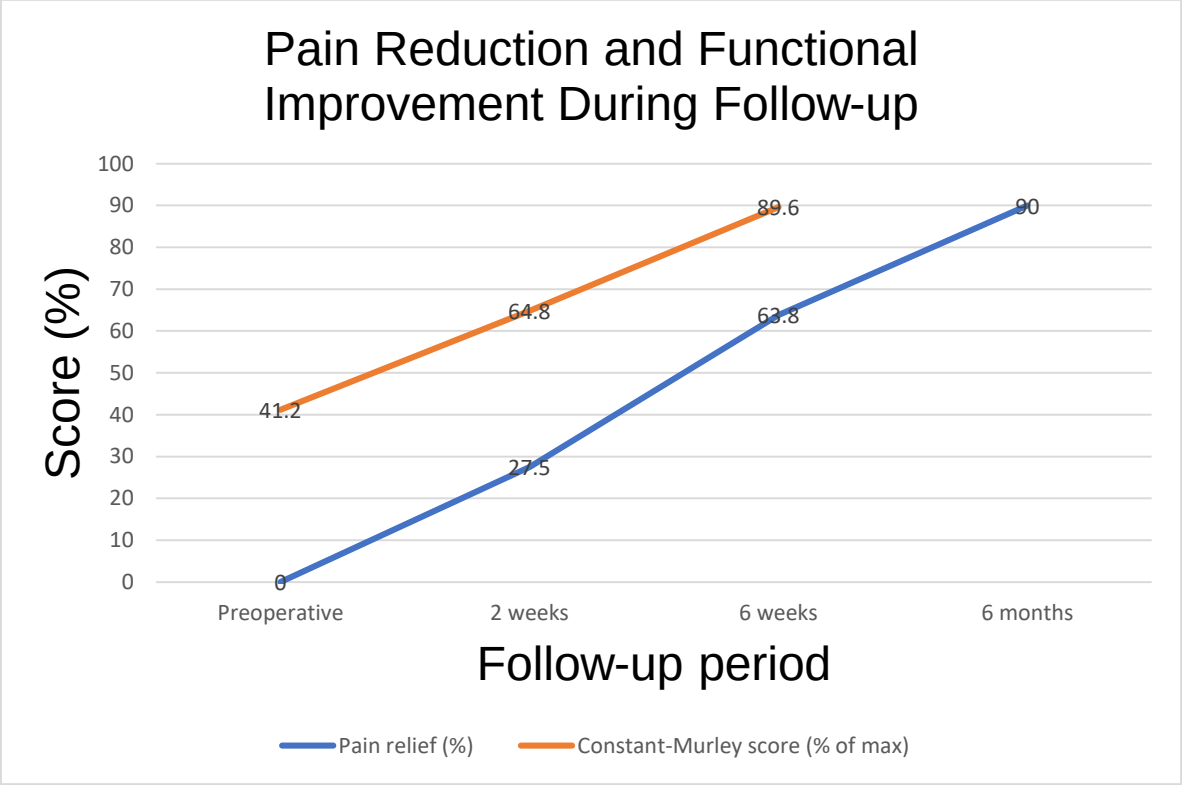

Figure 1: Trend of mean VAS score and Constant-Murley score during follow-up

Table 4: Final functional and radiological outcome

Outcome parameter	Category / Value	Frequency	Percentage
Final Constant-Murley score	89.6 ± 5.8	-	-
Functional outcome	Excellent (>90)	20	58.8%
	Good (75–89)	10	29.4%
	Fair (60–74)	4	11.8%
	Poor (<60)	0	0.0%
Mean union time	12.1 ± 1.2 weeks	-	-
Radiological union	10–11 weeks	11	32.4%
	12–13 weeks	17	50.0%
	>13 weeks	6	17.6%

At final follow-up, excellent functional outcome was observed in 58.8% of patients and good outcome in 29.4%. No patient had a poor functional outcome. Radiological union was most commonly achieved within 12–13 weeks, with a mean union time of 12.1 ± 1.2 weeks.

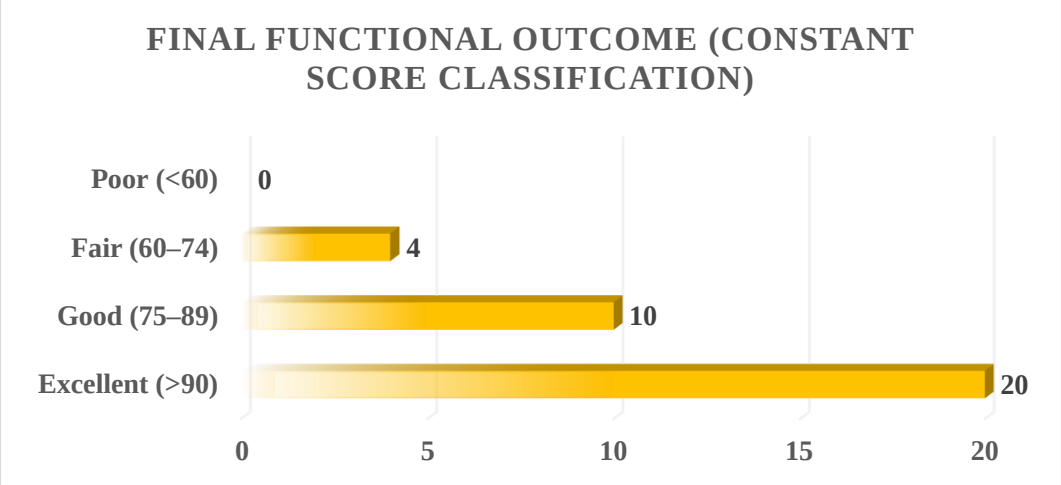

Figure 2: Final functional outcome after hook plate fixation

Table 5: Complications and their association with functional outcome

Parameter	Category	Frequency	Percentage
Complications	Infection	2	5.9%
	Subacromial impingement	5	14.7%
	Osteolysis	3	8.8%
	No complication	24	70.6%
Overall complication rate	Any complication	10	29.4%

Most patients had no postoperative complications. Among the complications, subacromial impingement was the most common, followed by osteolysis and infection. Patients without complications had better functional outcomes, and the association between complications and functional outcome was statistically significant (p = 0.032).

Functional outcome	Complication present	No complication	Total
Excellent	3	17	20
Good	4	6	10
Fair	3	1	4
Total	10	24	34

Statistical test - Chi-square test, p-value - 0.032

Overall, hook plate fixation provided significant pain relief, progressive functional recovery and timely radiological union in patients with displaced lateral end clavicle fractures. The majority of patients achieved excellent to good functional outcomes, while complications were observed in a minority and were significantly associated with poorer functional recovery.

DISCUSSION

Displaced lateral end clavicle fractures are challenging injuries because of their unstable fracture pattern, small distal fragment and close relationship with the coracoclavicular ligament complex. In the present study, hook plate fixation was used for displaced lateral end clavicle fractures, and the results showed good pain relief, progressive functional improvement and satisfactory radiological union in most patients.

In the present study, the mean age of patients was 38.7 ± 10.4 years, with the highest proportion of patients in the 31–40 years age group. This indicates that these fractures were more common among young and middle-aged active adults. Similar observations were reported by Nordqvist and Petersson, who noted that clavicle fractures are commonly seen in younger adults due to trauma.[1] Robinson also described clavicle fractures as frequent injuries in the adult population, commonly related to direct trauma and road traffic accidents.[2] The male predominance in the present study, with 73.5% males, is also comparable with previous studies, where higher involvement of males was attributed to greater exposure to outdoor activities, occupational risks and vehicular trauma.[1,2]

Road traffic accident was the most common mode of injury in the present study, accounting for 64.7% of cases, followed by fall in 35.3%. This finding is consistent with the traumatic nature of displaced

lateral end clavicle fractures. In Indian tertiary care settings, road traffic accidents remain an important cause of shoulder girdle injuries, particularly among working-age adults. The right side was more commonly involved in the present study, which may be related to limb dominance and the mechanism of fall or impact during trauma.

The present study included displaced lateral end clavicle fractures, mainly unstable fracture patterns. Neer described the importance of coracoclavicular ligament integrity in distal clavicle fractures and classified type II fractures as unstable injuries.[3] Kim et al. also emphasised that distal clavicle fractures with ligamentous disruption have a higher risk of displacement and non-union.[4] This explains why conservative management may not be suitable for many displaced lateral end fractures.

Traditionally, clavicle fractures were treated non-operatively; however, unstable distal clavicle fractures have shown a higher risk of non-union with conservative treatment. Rokito et al. reported a high rate of non-union in type II distal clavicle fractures treated non-operatively.[5] Stegeman et al., in a meta-analysis, also supported surgical treatment for Neer type II fractures due to better union rates.[6] More recently, Uittenbogaard et al. reported that operative treatment of Neer type II distal clavicle fractures was associated with a union rate of about 98%, although functional outcome and complication profile should also be considered during decision-making.[7] These findings support the use of operative fixation in selected unstable fractures, as done in the present study.

In the present study, hook plate fixation provided stable fixation with progressive improvement in pain and function. The mean preoperative VAS score was 8.0 ± 0.8, which decreased to 0.8 ± 0.4 at 6 months. This reduction was statistically highly significant. This finding suggests that anatomical reduction and stable fixation provided effective pain relief over time. Similar improvement in pain after hook plate fixation has been reported by Meda et al., who observed good clinical recovery after clavicular hook plate fixation for lateral end fractures.[11] Tiren et al. also reported favourable mid-term outcomes after hook plate fixation for acute displaced lateral clavicle fractures.[13]

Functional outcome in the present study improved progressively during follow-up. The mean Constant-Murley score increased from 41.2 ± 5.3 at 2 weeks to 89.6 ± 5.8 at 6 months, which was statistically significant. At final follow-up, 58.8% of patients had excellent outcome and 29.4% had good outcome, while no patient had poor outcome. These findings are comparable with Flinkkilä et al., who reported satisfactory shoulder function after hook plate fixation of unstable lateral clavicle fractures.[12] Constant and Murley described this score as a useful clinical method for assessing shoulder function, including pain, daily activity, range of motion and strength.[15] Therefore, improvement in Constant-Murley score in the present study reflects meaningful functional recovery.

Radiological union was achieved in all patients in the present study, with a mean union time of 12.1 ± 1.2 weeks. Most patients achieved union within 12–13 weeks. This is consistent with previous studies reporting high union rates after hook plate fixation. Meda et al. reported reliable union after clavicular hook plate fixation.[11] Flinkkilä et al. also reported good union rates in unstable lateral clavicle fractures treated with hook plates.[12] Asadollahi and Bucknill, in their systematic review and meta-analysis, concluded that hook plate fixation provides reliable union in acute unstable distal clavicle fractures.[14] Beisemann et al., in a recent study on Neer type II distal clavicle fractures, also reported favourable radiological and clinical outcomes with hook plate fixation.[18]

The advantage of the hook plate is that it provides indirect stabilisation of the distal fragment by engaging beneath the acromion. This is especially useful when the lateral fragment is small or comminuted and cannot hold multiple screws. Zhang et al. compared distal clavicle locking plates with hook plates and reported that both implants can provide good outcomes, although hook plates remain useful in unstable patterns with small distal fragments.[9] Li et al., in a meta-analysis comparing hook plates and locking plates for Neer type II fractures, found that both techniques achieved union, but locking plates may have fewer implant-related problems in selected cases.[19] Thus, while hook plates are effective, implant choice should depend on fracture pattern, distal fragment size and surgeon experience.

Complications were observed in 29.4% of patients in the present study. Subacromial impingement was the most common complication, followed by acromial osteolysis and infection. The association between complications and poorer functional outcome was statistically significant. This finding is clinically important because hook plate-related complications can affect shoulder movement and patient comfort. Oh et al. highlighted complications associated with hook plate fixation, especially subacromial impingement and implant-related irritation.[16] Lee et al. also reported that AO-type hook plates have a high success rate but are associated with complications such as peri-implant problems and subacromial erosion.[17] Takahashi et al. further observed that hook plates may show slower functional recovery compared with locking plates in some cases.[20]

The need for implant removal is another important issue with hook plate fixation. Because the hook lies

beneath the acromion, prolonged retention may cause mechanical irritation, impingement or osteolysis. In the present study, implant removal was considered after radiological union depending on symptoms and complications. Lee et al. and Oh et al. emphasised that proper implant positioning and timely removal are important for reducing complications.[16,17] Thurston et al., in a recent systematic review, also noted that treatment decisions in displaced distal clavicle fractures should be individualised, considering union, function, complication risk and patient expectations.[21]

Overall, the findings of the present study suggest that hook plate fixation is an effective method for displaced lateral end clavicle fractures. It provided stable fixation, significant pain reduction, good functional recovery and reliable radiological union. However, the complication rate, particularly subacromial impingement and osteolysis, indicates that careful surgical technique, correct hook depth, proper plate positioning, regular follow-up and timely implant removal are essential for optimal outcomes.

Limitations

The present study had certain limitations. First, the sample size was small, as only 34 patients were included, which limits the generalisability of the findings. Second, this was a single-centre prospective observational study without a control group; therefore, direct comparison with other treatment methods such as locking plate fixation, coracoclavicular ligament reconstruction or conservative management could not be performed. Third, the follow-up duration was relatively limited, so long-term complications such as persistent shoulder dysfunction, degenerative changes or late implant-related problems could not be fully assessed. Fourth, functional outcome was mainly assessed using the Constant-Murley score, and additional patient-reported outcome measures such as DASH or Oxford Shoulder Score were not included. Finally, rehabilitation compliance and patient activity level may have influenced functional recovery, but these factors were not analysed in detail.

Despite these limitations, the study provides useful clinical evidence from a tertiary care trauma centre and supports hook plate fixation as a reliable option for displaced lateral end clavicle fractures when used with proper surgical technique and follow-up.

CONCLUSION

The present study showed that hook plate fixation is an effective treatment option for displaced lateral end clavicle fractures in adults. It provided stable fixation, significant pain relief, progressive improvement in shoulder function and reliable radiological union. Most patients achieved excellent to good functional outcomes, with mean Constant-Murley score improving markedly by final follow-up. Although complications such as subacromial impingement, acromial osteolysis and implant-related discomfort were observed in some patients, these were manageable with regular follow-up and appropriate implant removal after union. Thus, hook plate fixation remains a useful surgical method for unstable lateral end clavicle fractures, particularly when the distal fragment is small or comminuted.

Recommendations

Displaced and unstable lateral end clavicle fractures, especially Neer type II fractures, should be carefully evaluated for operative management to reduce the risk of non-union and functional disability. Hook plate fixation may be preferred in selected cases where stable fixation of the distal fragment is difficult with conventional plating. Proper implant selection, accurate hook placement, avoidance of excessive hook depth, structured postoperative rehabilitation and regular radiological follow-up are recommended to achieve better outcomes. Timely implant removal after fracture union should be considered to minimise complications such as subacromial impingement and acromial osteolysis. Larger multicentric comparative studies with longer follow-up are recommended to further compare hook plate fixation with locking plates and coracoclavicular reconstruction techniques.

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