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Case Series

Functional outcome of displaced clavicle fractures treated with locking compression plate

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ABSTRACT

Clavicle fractures, common in young, active individuals, often occur due to trauma or repetitive stress and account for about 2.6% to 5% of all fractures. These fractures typically happen in the midshaft and are often displaced. Historically, they were treated conservatively, but this approach often led to malunion and poor shoulder function. Recent studies show that surgical interventions, particularly with locking compression plates (LCP), improve healing, shoulder function, and reduce complications like non-union and malunion. Surgical treatments, such as open reduction internal fixation (ORIF) or closed reduction internal fixation (CRIF), are especially beneficial for displaced fractures or those with additional complications. LCPs provide better stability, especially in osteoporotic patients, although potential complications include screw loosening and infection. Overall, evidence supports surgical treatment with LCPs for better functional outcomes and fewer complications compared to nonoperative methods. This study is being done to assess functional outcome of clavicle fractures managed with open reduction with LCP. A prospective interventional study was conducted to assess functional outcome of clavicle fractures managed with ORIF with LCP. Constant-Murley score was evaluated before the treatment and were repeated after 6 weeks (T1), 12 weeks (T2) and 24 weeks (T3). The study involved 30 participants with an average age of 31.23 years, consisting of 80% males and 20% females. Of these, 53% had right-sided clavicular fractures, and 47% had left-sided fractures. Most surgeries were performed within 2-3 days of admission, with 93.33% of fractures showing union within 12 weeks. The constant Murley's score, which measures functional outcomes, improved significantly over time: from 5.28 before surgery to 91.09 after 24 weeks. The functional outcome was graded excellent in 90% of patients. Statistical analysis showed significant improvement in scores post-surgery ($p<0.001$). Age had a weak positive correlation with better outcomes, while time from admission to surgery and time to union had strong negative correlations with functional outcomes. These findings suggest that faster surgery and quicker union lead to better functional recovery, and age has a slight impact on outcomes.

Keywords: Clavicle fractures, Locking compression plates, Open reduction internal fixation

INTRODUCTION

Fractures are common bone injuries caused by trauma or repetitive stress, requiring proper management for healing and function restoration. Clavicle fractures, often seen in young, active individuals (especially in sports), account for about 2.6% to 5% of all fractures. Most occur in the midshaft and are typically displaced due to muscle attachments and gravity. Historically, these fractures were treated conservatively, but recent studies highlight the frequent occurrence of malunion and poor shoulder function with this approach. Newer surgical techniques, such as using an LCP, have significantly improved outcomes, with higher union rates and lower complications.

Recent studies have highlighted the benefits of surgical intervention over nonoperative treatment for displaced

midshaft clavicle fractures, particularly with the use of plate fixation. Traditionally, these fractures were treated conservatively, but increasing evidence suggests that surgery improves healing and functional outcomes.[1,2] Studies by Altamimi et al, Have et al and Golish et al further emphasise this.[3-5] Similarly, It has been found that operative treatment with plate fixation led to faster healing, better shoulder function, and reduced rates of non-union and malunion compared to nonoperative methods along with better functional scores and fewer complications, including lower rates of non-union.[6,7]

Internal fixation, such as ORIF with anatomical plates or CRIF with intramedullary nailing, is often required for displaced fractures or when there are additional complications like neurovascular injury or floating shoulders. LCPs, which provide fixed-angle constructs, are particularly effective for stabilizing fractures, including in osteoporotic patients. They offer advantages such as better stability and biological healing, but potential complications include screw loosening and infection.[8] Overall, these studies advocate for surgical treatment, particularly with locking plates, as the preferred method for displaced clavicle fractures, providing superior functional outcomes and reducing complications compared to nonoperative management. Hence, this study was conducted to evaluate the functional outcomes and radiological union of clavicle fractures treated with LCPs.

Aim

This study is being done to assess: Clinical and radiological union and functional outcome of clavicle fractures managed with open reduction with LCP

CASE SERIES

A prospective interventional study was conducted in Kempegowda institute of medical sciences, Bangalore to assess functional outcome of clavicle fractures managed with ORIF with LCP. The study was conducted for a period of 18 months between August 2022 to December 2023. Prior to the study, ethical clearance was obtained from institutional ethical review board.

Age of patients should be adults (above 18 years), all displaced clavicle fractures, Gustilo Anderson type 1 and 2 compound fractures and impending open fractures with soft tissue compromise were included. Pathological fractures, type 3 (Gustilo Anderson) compound fractures, associated ipsilateral upper limb fractures and patient not giving consent for the study were excluded.

Considering nonresponse or loss to follow-up, the sample size (n) estimation was determined that at-least 25 patients had to be included in the study to yield a statistically significant result. It was concluded to rounded off the sample size be to 30.

After obtaining approval and clearance from the institutional ethics committee, the patients who were complying with the inclusion criteria were enrolled for the study. Informed consent was obtained from the participants to enroll them for the study.

The demographic details and detailed history of the patient were collected. After clinical and radiological examination, the diagnosis was made and recorded. Further, the treatment plan was finalised and discussed with the patient.

Pre-operative investigations and fitness for surgery were undertaken for all the patients to evaluate their readiness for surgery. Patients were posted for the surgery upon their consent. Constant - Murley score was evaluated before the treatment and were repeated after 6 weeks (T1), 12 weeks (T2) AND 24 weeks (T3).[9]

Procedure

After the administration of anaesthesia (either general / regional), the patient was placed in supine position on table with a sandbag under same side shoulder. The injured extremity was painted and draped from the midline to the arm.

A longitudinal or curvilinear incision was made over the fractured clavicle, just lateral to the sternoclavicular joint, to avoid damaging nearby neurovascular structures. The soft tissues, periosteum, and pectoral fascia were carefully dissected to expose the fracture, and the underlying muscles were elevated from the clavicle. The fractured ends of the clavicle were then realigned using traction, manipulation, or reduction clamps, ensuring proper anatomical alignment and length. A LCP was selected based on the clavicle's length and curvature and positioned along the superior surface of the bone, spanning the fracture site and temporarily secured with K-wires or clamps. Locking screws were inserted into the plate in a predetermined, divergent pattern to provide stability and compression. After confirming proper fixation, the wound was irrigated, and the skin and subcutaneous tissues were closed with absorbable sutures or staples, followed by sterile dressing. Postoperatively, the shoulder was immobilized with a sling, and early mobilization and physical therapy began from the second day to restore range of motion and strength. The sling was removed after about 4 weeks. Patients were advised to avoid strenuous activities until cleared by their surgeon. Follow-up appointments were scheduled to monitor healing progress, reassess the treatment plan, and provide instructions for home care, including activity restrictions and exercises.

Post-surgical follow-up

The functional outcome was evaluated using constant-Murley's score. The cases were followed for a period of 6 months following surgery at the regular intervals of 6, 12 and 24 weeks during which the constant-Murley's score recorded. Radiographic union was considered as evidence of bridging callus or obliteration of fracture lines.

Clinical union was defined as absence of tenderness at the fracture site. Time to achieve union was noted.

Outcome measures

Efficacy parameters (Clinical outcome parameters)

Clinical union was considered as absence of tenderness at the fracture site. Secondary measures of outcome encompassed perioperative factors such as duration of surgery, dimensions of incision, complications like wound infections, neurovascular damage, malunion, non-union, implant displacement, soft tissues irritation, malfunction of implant, refracture after implant removal, and cosmetic considerations including visible deformities, prominence of hardware, and scarring.

Assessment tools

Functional outcome was assessed by the constant-Murley score at 6 weeks, 12 weeks and 24 weeks' post-surgery, taking into account: Pain, limitation of activities of daily living, range of movement and power.

Descriptive statistics

Descriptive analysis of all quantitative explanatory and outcome parameters was done using mean and standard deviation while frequency and proportions were used for categorical variables.

Inferential statistics

Friedman's test analysis was used to compare mean Murley's scores between different time intervals [6, 12 and 24 weeks] among study patients. Pearson correlation was used to assess the association between the different variables of the study for the purpose of understanding the influence of these factors on the outcome of the study.

A total of 30 people, with mean age of 31.23±8.48 years (range 19-55) participated in the study. The study participants included were found to be 80% (n=24) males and 20% (n=6) females. Further descriptive are given in the table (Table 1).

Table 1: Summary of descriptive data.

Variables	N	Min	Max	Mean	SD
Age (in years)	30	19	55	31.23	8.480
A2S	30	0	5	2.30	1.368
T2U	30	6	24	9.20	4.916
T0	30	0	9	5.33	1.918
T1	30	55	86	72.93	6.807
T2	30	70	91	83.17	5.025
T3	30	76	98	91.10	5.346

Where A2S: admission to surgery time; T2U: Time to union; T0: Pre-treatment constant Murley's score value; T1: Week 6 Constant Murley's score value; T2: Week 12 constant Murley's score value; T3: Week 24 constant Murley's score value.

Functional outcome of the surgery was graded excellent in 90% of the patients (n=27) who had undergone the surgery.

The Friedman's 2-way ANOVA demonstrated significant improvement of Constant score from T0, T1, T2 and T3 ($p<0.001$) following surgical correction of clavicle fractures using LCP.

There was a negative correlation between age and functional outcomes of surgery when using LCP (Table 2) Further, it was found that there was a negative correlation between Admission to surgery time and functional outcomes of the surgery when using LCP (Table 2). There was negative correlation between the time to union of the patient and the functional outcome of the treatment (Table 2).

Table 2: Correlation between age, A2S, T2U and T3.

Correlations		Age	A2S	T2U
T3	Pearson correlation	-0.414	-0.721	-0.721
	P value	0.023	0.0001	0.0001

DISCUSSION

Clavicle fractures are common, especially among young, active individuals, representing 2.6-5% of all fractures and 44% of shoulder girdle fractures, with the majority occurring in the midshaft.[10,11] While older studies considered even displaced fractures to have a good prognosis, recent findings show that malunion is frequent.[12] Various techniques, including ORIF with LCP plates, anatomical plates, closed reduction with intramedullary nailing, and TENS, are used to treat midshaft clavicle fractures. Plate osteosynthesis remains the standard approach, providing excellent reduction and stable fixation. Studies show better functional recovery with plate fixation compared to non-operative management, which can lead to symptomatic malunion and non-union. However, complications such as implant failure, infections, and fractures after implant removal can occur in about 10% of cases.[12] Less severe issues include keloid scars and implant loosening, but complication rates in the study were lower.

Historically, midshaft clavicle fractures were treated conservatively, assuming minimal impact on shoulder function. However, recent research shows that such fractures can impair orthopedic, neurologic, and cosmetic outcomes.[11-13] Studies indicate that surgically corrected fractures (with anatomical alignment) lead to better outcomes compared to conservative treatment, with a lower rate of malunion and functional impairments.[14,15]

The study population in this case had an average age of 31 years, consistent with the typical age group for clavicle fractures due to high-energy injuries. Most fractures

occurred equally on both sides, with 53% on the right and 47% on the left.

A study by Nowak et al found that 46% of patients remained symptomatic even 10 years after conservative treatment for clavicle fractures.[16] Similarly, our study showed that delayed surgery resulted in poorer functional outcomes, emphasizing the importance of early surgical intervention. Most patients in our study underwent surgery within two days of injury, and early access to surgical care led to better clinical results and functional outcomes. LCPs were found to provide quicker surgical support, aiding in better functional recovery.

Mishra et al study on non-surgically treated clavicle fractures identified several indicators for surgical intervention, including displacement over 21 mm, shortening greater than 15 mm, non-union, and malunion.[13] Our study supports these findings, showing significant improvement in functional outcomes post-surgery, particularly within six weeks. The use of LCPs facilitated faster healing due to the rigidity of the fracture fixation, and continued improvement was noted up to 24 weeks.

Further studies suggest that while displacement and comminution are key predictors, angulation, location, and shortening do not significantly affect cosmetic outcomes.[17] Our study aligns with this, showing that earlier union led to better functional outcomes. No non-union cases were observed, supporting the effectiveness of LCPs in preventing complications. The majority of patients in our study achieved union within 6 to 12 weeks, and shorter union times were associated with better functional recovery.

This study found improvement in functional outcomes among the study patients overtime following surgery using LCP in which constant Murley's Score improved from 5.28±1.88 at the time of evaluation prior to surgery, to 72.92±6.67. After 6 weeks and 91.09±5.25 after 24 weeks following the surgery. It was noted that treatment of clavicle fractures with LCP resulted in excellent outcome in 90% of the patients and the rest demonstrated good outcomes.

Limitations

While the study was immaculately planned and conducted, it did have some limitations. During the study period, one of the patients who underwent surgery died in the post-operative period due to head injury sequale, hence that case was excluded from the study. Further, in our study three patients had hardware prominence but only one of them had skin irritation and hence early implant removal was performed after the union of fracture clinically and radiologically. All the cases in our study had primary healing of the operative scar. We have not encountered any infection in our study cases.

CONCLUSION

In conclusion, our study highlights the significant benefits of surgical management for clavicle fractures using LCPs, leading to improved functional outcomes, quicker healing, and early return to pre-injury activity levels. Further, we can conclude that using LCP for the surgical fixation of clavicle fractures offers several advantages: Anatomical reduction of the fracture using pre-contoured plates. Early mobilization of the injured limb. Improved functional outcomes. Faster return to pre-injury function and activities.

The simplicity of LCPs facilitates quicker and more effective treatment, and reducing the time between admission and surgery leads to better functional results. In conclusion, early treatment of clavicle fractures with LCPs ensures faster recovery and restoration of the patient's pre-injury status.

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