

SURGICAL MANAGEMENT OF UNSTABLE LATERAL END CLAVICLE FRACTURES USING HOOK PLATE: A PROSPECTIVE STUDY

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Orthopaedics

Article Submitted on: 17
 March 2019
 Article Accepted on: 27
 March 2019

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Abstract:

Background: Lateral end clavicle fractures are commonly encountered. Several studies have shown that Hook plates improve shoulder function and prevent non-union, also promote early recovery of shoulder mobility, thus are very effective option for treatment of acromio-clavicular joint dislocation or lateral clavicle fractures. The present study was done to evaluate the functional outcome following surgical treatment of unstable/displaced (Neer Type II lateral clavicle fractures, and acromio-clavicular joint dislocations Rockwood grade III to V) lateral end clavicle fractures using hook plate.

Methodology: A prospective study among 39 patients with fractures of the lateral end of the clavicle was conducted in a tertiary care centre. Outcome was assessed using the Constant Murley Score. Results: Mean age of the patients was 42.72±12.68 years.

Males were 31 (79.49%) and females 08 (20.51%). Right sided fractures were 22 (56.41%) and left sided 17 (43.59%). RTA was the most common mode of injury, 30 (76.92%) and fall 9 (23.08%). Complications occurred only in 8 (20.51%). Functional outcome was excellent in 8 (20.51%), good in 25 (64.11%), fair in 5 (12.82%) and poor in only 1 (2.56%) case.

Conclusion: The present study suggests that hook plate fixation for the treatment of unstable distal clavicle fractures can achieve good results.

Keywords: Surgical Management, Unstable Lateral End Clavicle Fractures, Hook Plate.

Introduction:

Anatomically, fractures of the clavicle have been classified into three groups Allman.¹ The first group (group I) include the middle third fractures, the most common type making almost 80% cases of clavicular fractures, more commonly among young adults. The second group

(group II) consists of fractures of lateral end of the clavicle, approximately 15 – 25%. The third group (group III) has fractures of the proximal third, accounting for only about 5%.²⁻⁴

Lateral end clavicle fractures are commonly encountered in clinical practice with the incidence about 29 per 100,000 population

per year⁵ and accounts for 2.6–4% of the total adult fractures. Almost 10–52% lateral end clavicle fractures are displaced fractures⁶ resulting in higher rate of nonunion, because non union is more common in displaced fractures compared to undisplaced fractures of the lateral end clavicle. The management of fractures of lateral end clavicle remains challenging.

The risk of non – consolidation being high (30%) surgical treatment is indicated for displaced fractures of the lateral end of the clavicle.^{7,8} Yet, standardized method for surgical treatment of fractures of the lateral end of the clavicle is unclear.⁹ Various techniques have been used, such as fixation with screw,¹⁰ metal wires,^{11,12} hook plate,¹³ locking Plate¹⁴ or use of cerclage.^{9,15}

Several studies have shown that Hook plates improve shoulder function and prevent non-union, also promote early recovery of shoulder mobility, thus are very effective option for treatment of acromio-clavicular joint dislocation or lateral clavicle fractures.¹⁶⁻²⁰ While having favorable outcome^{16,19} some complications such as non-union, infection and acromial osteolysis^{17,18,20} have also occurred.

Biomechanics of the clavicle and scapula have been confirmed by many studies. Rotational movement occurs between them producing problems in movement if rigid fixation methods are used. This problem is addressed by the hook plate due to its design.^{21,22} Hook plate allows early mobilization because it maintains the biomechanics of the acromioclavicular joint and in addition, avoids the need for reconstruction of the coracoclavicular ligaments.²¹ Some surgeons do not consider plate removal necessary, though plate removal could be done usually 3 to 4 months after insertion, if recommended.^{21,23}

The present study was done to evaluate the functional outcome following surgical treatment of unstable/displaced (Neer Type II lateral clavicle fractures, and acromio-clavicular joint dislocations Rockwood grade III to V) lateral end clavicle fractures using hook plate.

Material and methods

It is a prospective study conducted in the orthopaedics department of a tertiary care centre for a period of 3 years (October 2015 to September 2018). A total of 42 patients reporting to the Orthopaedics OPD were included in the

study, of which complete details could be collected from 39 patients, since 3 patients were lost to follow up. All the patients who presented to the orthopaedic OPD with fractures of the lateral end of the clavicle during the first year (October 2015 to September 2016) of the study period, required surgical treatment and consented for the study were included. Exclusion criteria was patients presenting with Pathological fractures, fractures of the middle or proximal thirds of the clavicle, past or present history of any injuries or fractures of the ipsilateral upper limb (humerus head/neck), scapula fracture, presence of neurovascular injuries along with fractures or fractures with associated bone disorders. A predesigned pretested questionnaire was used to collect data. The questionnaire had questions about the socio – demographic details, clinical and surgical details.

The Implant:

The clavicle hook plate used in this study is a pre-contoured stainless steel, dynamic compression plate with a wider anterolateral end and a lateral extension into a hook which is placed below the acromion. The holes accept 3.5 mm cortical bone screws and 4.0 mm cancellous bone screws. The anterolateral screw holes provide additional options for screw fixation of the lateral metaphyseal part of the clavicle. These plates are available with 6 or 8 holes and the hook depth is variable between 15 and 18 mm's.

Surgical procedure:

The surgical technique consisted of basic reduction and plating methods, following the operative procedure as advised by the 'Synthes clavicle hook plate - technique guide' (2003 Synthes). The patients were operated in beach chair position under general anaesthesia. An incision was placed just medial to the acromioclavicular joint over the fracture. Full thickness skin flaps were prepared until the clavicle. The fracture was exposed and reduced with K-wires preliminarily in case of comminution and sometimes a lag screw was used. No repair of the torn ligaments was performed. Without opening the AC joint, the location of the joint was marked with a needle, and confirmed with fluoroscopy. The soft tissue dorsal to the AC joint was dissected and prepared for the insertion of the hook of the plate. First the 15 mm hook depth (18 mm in cases with difficulty lowering the plate shaft) was used and passed below the acromion. The shaft of the plate

was placed on the superior aspect of the clavicle. Pre – contouring of the clavicle portion of the plate was done to ensure central placement of the plate on the clavicle. Before definitive fixation, plate position and full shoulder motion was verified using fluoroscopy. The plate was anchored to the shaft with four 3.5 mm cortical screws. cancellous screws were used to secure the distal metaphyseal end if necessary. Longer length plate was used in osteoporotic bones. The wound was closed in layers and sterile dressing applied.

Postoperative Physiotherapy:

Patients started physiotherapy on the first postoperative day following a standard rehabilitation protocol: active and passive range of movements were encouraged within the pain free arc. Later with strengthening exercises of the rotator cuff and shoulder muscles were started. Return to sportive activity of the upper extremities was allowed after radiological union of fracture.

X-rays were taken preoperative, immediate postoperative and subsequently at 4 Weeks, 8 weeks, 12 weeks and 6 months. Placement of plate, implant loosening, osteolysis at the tip of the hook, cut out of the hook and fracture union were assessed at serial intervals.

Signs to elicit subacromial impingement were done at each visit and these included the Neer impingement sign, Hawkins-Kennedy sign, and Jobe supination test.

Follow up:

Post – operatively, all the patients were followed up at 1, 2, 3, 6, 12, 18 and 24 month intervals over a period of 3 years.

Outcome was assessed using the **CONSTANT MURLEY SCORE**²⁵

1. Pain (15 Points)	Do you have pain in your shoulder during normal activities?
2. Activities of Daily Living (20 points): Total (1+2+3+4)	1. Is your occupation or daily living limited by your shoulder? No=4 Moderate limitation=2 Severe limitation=0 2. Are your leisure and recreational activities limited by your shoulder? No=4 Moderate limitation=2 Severe limitation=0 3. Is your night sleep disturbed by your shoulder? No=4 Moderate limitation=2 Severe limitation=0 4. State to what level you can use your arm for painless work-related or daily activities. Waist=2 Xiphoid (sternum)=4 Neck=6 Head=8 Above head=10 No=15 Mild=10 Moderate=5 Severe or permanent=0
3. Range of Motion (40 points): Total (1+2+3+4)	1. Forward flexion 0-30 --- 0 31-60 --- 2 61-90 --- 4 91-120 --- 6 121-150 --- 8 >150 --- 10 2. Abduction 0-30 --- 0 31-60 --- 2 61-90 --- 4 91-120 --- 6 121-150 --- 8 >150 --- 10 3. External Rotation Hand behind head & elbow forward 2 Hand behind head & elbow back 4 Hand above head & elbow forward 6 Hand above head & elbow back 8 Full elevation of arm 10 4. Internal Rotation Dorsum of hand to Lateral thigh 0 Buttock 2 LS junction 4 Waist (L3) 6 T12 8 Interscapular area T7 10
4. Strength of Abduction (25 points):	Average (kg)
GRADING OF SCORE	91 – 100 Excellent 81 – 90 Good 71 – 80 Fair 61 – 70 Poor

Statistical analysis: The data collected were entered in the Microsoft excel sheet and double checked for errors. Categorical variables are expressed in percentages and proportions while mean and standard deviation are used to express continuous variables. Association between continuous variables are determined using independent samples ‘t’ test and Chi – square test is used to determine the association between categorical variables. A ‘P’ value of < 0.05 is considered statistical significant and < 0.01 highly statistically significant.

Ethical clearance: Obtained from the institutional ethics committee. All the participants were explained about the purpose of the study in vernacular language in understandable manner. Confidentiality of the information was assured and the participants were free to withdraw anytime from the study if there was any breach in ethics during the course of the study.

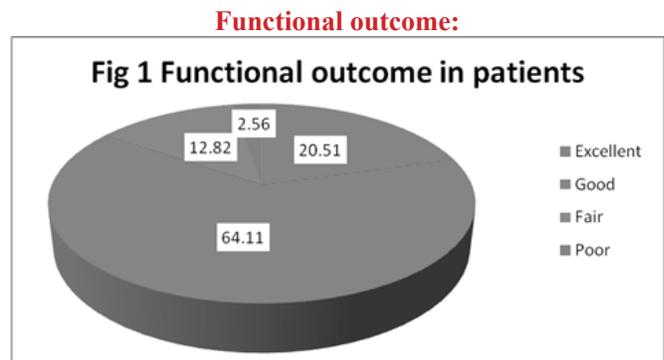
Results:

A total of 39 patients came for complete follow up. Mean age of the patients was 42.72±12.68 years.

Characteristic	Number (n = 39)	Percentage (%)
Age (in years)		
18 – 30	07	17.95
31 – 40	09	23.08
41 – 50	13	33.33
>51	10	25.64
Gender		
Male	31	79.49
Female	08	20.51
Side of fracture		
Right	22	56.41
Left	17	43.59
Mode of injury		
RTA	30	76.92
Fall	09	23.08
Associated injuries		
Ipsilateral rib fracture	05	12.82
Ipsilateral tibia fracture	02	05.13
Contralateral Lateral Malleoli Fracture	01	02.56
Ipsilateral radius fracture	01	02.56
None	30	76.92

Complications		
Impingement	03	07.69
Subacromial osteolysis	05	12.82
None	31	79.49
Functional outcome (Fig 1)		
Excellent	08	20.51
Good	25	64.11
Fair	05	12.82
Poor	01	02.56

The time from trauma to surgery ranged from 0-15 days with a mean of 4 days and the mean operating time was 41 minutes ranging between 23-70 minutes. Mean duration to union was 12.92 weeks and the mean Constant Murley score was 86.28



Discussion

Surgical treatment as an option is used generally for displaced fractures of lateral end clavicle, which account for only about one – third of all the lateral end clavicle fractures.³ In the present study, a total of 39 cases of lateral end clavicle fractures were treated using hook plate and evaluated for functional outcome. The treatment of fractures of the lateral end of the clavicle using a hook plate has been shown to be good and acceptable.²⁶ Several studies have shown good results in terms of bony union and in terms of shoulder function.^{16,19,20} Mean age of the patients was 42.72±12.68 years in the present study consistent with the findings of Tambe AD et. al.²⁰ showing a mean age of 41 (range 22–62) years. In the present study impingement complaints was seen in 7.69% and subacromial osteolysis in 12.82% of the patients, which is very less compared to the findings of Davut Tiren et. al.,²⁷ reporting impingement in 32% and subacromial osteolysis in 25% patients. The mean Constant Murley score in this study was 86.28 which is comparable to 88.5 obtained by Tambe et. al.²⁰ and 90 reported by Flinkilla et al.²⁸ In the present study, according to the Constant Murley score, functional outcome was excellent in 20.51% patients, good in 64.11%, fair in

12.82% and poor in 2.56% patients and the mean duration to union was 12.92 weeks. Studies have reported good union rate and good shoulder function following hook-plate fixation of unstable lateral clavicle fractures.¹⁹

Some of the studies have reported complications such as fracture at the medial end of the plate following a new injury,^{28,29} nonunion²⁸ and fixation failure,³⁰ which have not occurred in the present study.

One of the studies comparing the outcomes of unstable lateral clavicle fractures using clavicular hook plate and Kirschner tension band wiring reported that hook plate fixation was associated with statistically better functional outcome (shoulder function) and earlier implant removal than K-wire tension band fixation, with the complications being equivalent. At final follow-up, the hook plate group had significantly higher Constant-Murley score (90.43±4.78) compared with the K-wire group (85.63±5.38). They concluded that hook plates are useful for treating unstable lateral clavicular fractures.³¹

A study comparing the clinical outcomes between the distal clavicular locking plate and clavicular hook plates in the treatment of unstable distal clavicle fractures showed no significant difference was found between locking plate and hook plate groups in union rate and Constant score. They suggested that distal clavicular locking and clavicular hook plates for the treatment of unstable distal clavicle fractures can achieve good results³²

Flinkilla et al.²⁸ compared transacromial fixation versus hook plating for the management of unstable distal clavicular fractures and found no difference in union rate or post-operative function achieved. However, they recommended the use of hook plates because of the very high complication rate associated with the K-wires. With an average follow-up of 6.2 years three of 22 fractures attained union in the K-wire group as against two of 17 in the hook plate group, with an average follow-up of 2 years. The mean constant score was 84 in the K-wire group and 90 in the hook plate groups. In the K-wire group, the wires migrated in 12 patients, resulting in loss of reduction in seven and infection in three as compared with one clavicular fracture in the hook plate group.

In a study by Tambe AD et.al,²⁰ two non-unions, and satisfactory shoulder function was achieved in 14 of the 15 shoulders. Asymptomatic acromial osteolysis was seen

in five cases which compelled them to removal the plate routinely. They concluded that hook plate fixation is a useful method of treating unstable fractures of the lateral end of the clavicle. High union rates and good shoulder function are achieved while avoiding the potential complications associated with transacromial wire fixation. They however recommended that the plates need to be removed once union is achieved in order to avoid progressive acromial osteolysis, thus preventing potential problems in the future.

Conclusions and Recommendations

Various techniques have been tried to manage unstable distal clavicle fractures Although there is no consensus as to a “gold standard” fixation method for unstable distal clavicle fractures, satisfactory outcomes could be obtained using the Hook plate resulting in sufficient stabilization and good functional outcome. Clavicle hook plate fixation is an absolute indication for the comminuted lateral clavicle fracture. It facilitates early mobilization of the shoulder postoperatively and results in a high percentage of union with a good objective and subjective shoulder function. The present study suggests that hook plate fixation for the treatment of unstable distal clavicle fractures can achieve good results. More multicentre studies in large samples with longer follow up may be conducted. Comparative studies with other modalities are recommended for further evidence.

Limitations

This is a study done with a small sample in a single setting. There were no controls in the study for accurate comparison. However, comparison has been made with results from previous studies.

Acknowledgements

We sincerely acknowledge the patients for their kind co – operation for the study. We are grateful to the editor and the publisher of the journal.

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