A Prospective Study on the Operative Management of Fractures of The Lateral End of Clavicle And Acromio-Clavicular Joint Disruption

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Abstract
Introduction: Clavicular fractures are relatively common due to its subcutaneous position. They can be due to low or high energy trauma, as isolated injury or part of a polytrauma spectrum. Distal clavicular fracture is a special form of injury and have been estimated to account for only 12% to 15% of all clavicle fractures. The present study is to evaluate the feasibility and the eventual outcome in the study subjects following operative management of the fractures of the lateral end of the clavicle and acromioclavicular disruption with clavicular hooked plates and locking compression clavicular plates.

Methodology: In a prospective controlled study was carried out for one year which included patients having fracture lateral end clavicle and patients having acromioclavicular joint dislocation. The age group of the patients is 18 to 60 years. The surgery and follow-up conducted at the same centre. Patients will be followed up at regular intervals and outcome variables assessed and recorded.

Results: In our study, in the subgroup of fracture lateral end clavicle, 66.67% had excellent results at the end of evaluation while 33.33% had good results while with AC joint dislocation, 62.50% had excellent and 37.50% had good results and none had poor results based on Disability of Arm Shoulder and Hand (DASH) score.

Conclusion: Clavicle hook plate is a very good implant for treating fractures of the lateral end of clavicle and displaced AC joint dislocation. The overall prognosis in our study was very good with excellent improvement of symptoms following the procedure. The use of this implant warrants quicker rehabilitation and return to normal activities of daily living with better patient satisfaction and clinical outcome.

Keywords: Clavicle hook plate, lateral end clavicle, acromioclavicular joint dislocation.

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I. Introduction

Clavicular fractures are relatively common in the modern society which is filled with activities which can be termed both hectic and hazardous. Thus the clavicle is a bone that frequently gets fractured. The injuries can be due to low or high energy trauma, as isolated injury or part of a poly-trauma spectrum. The clavicle is very prone to injury following direct violence because of its subcutaneous and superficial presence. The serpiginous shape of the bone along with its precarious position and its vulnerability leads to its fracture and dislocations in a manner which can be termed not quite uncommon. Its peculiarity of being the only horizontal long bone and its strut like disposition also accounts for its uniqueness in both function and its injuries.

Clavicle fractures account for 2.6% of all fractures of the body and 44% to 66% of all shoulder fractures. Due to this frequency of occurrence of fractures in the clavicle there have been many methods and modalities that came up. These modalities have been revised and corrected and modified across the centuries. The sad fact is although we have a very good understanding of the mechanics and the physiology of the fractures of the clavicle, we still do not have a universal consensus regarding their absolute and definitive management. In our study we chose the operative fixation of the displaced fractures of the lateral end of the clavicle using the clavicle hook plate. Lateral end of clavicle fractures are somewhat unstable and requires surgical fixation. Distal third clavicle fracture is a special form of injury and has been estimated to account for only 12% to 15% of clavicular fractures. Coming to the acromioclavicular injuries, though they are less frequently encountered in clinical practice we cannot deny that subclinical and non-diagnosed cases form the base of the iceberg of this entity. The superficial disposition of this joint and its proximity to the glenohumeral joint, any significant pathology to it drastically decreases shoulder function. Just like the clavicle its superficial disposition is an important reason for it to get injured in direct trauma to the shoulder. The AC joint is a diarthrodial joint located between the lateral end of the clavicle and the medial margin of the acromion process of the scapula. The articular surfaces initially are hyaline
cartilage. The joint has very little rotatory movements
Lateral end of clavicle fractures and acromioclavicular disruption can be operatively treated with Kirschner wires or coracoclavicular screws. Moreover they can be operatively managed by using clavicle hook plates or locking compression clavicle hook plates. The present study was aimed at evaluating the feasibility and the eventual clinical and radiological outcome following operative management of fractures lateral end of the clavicle and displaced acromioclavicular joint dislocations using the clavicle hook plate. The present study was aimed at evaluating the feasibility and the eventual clinical and radiological outcome following operative management of fractures lateral end of the clavicle and displaced acromioclavicular joint dislocations using the clavicle hook plate. The outcome was evaluated using the Karlsson’s criteria and the DASH score. The Karlsson’s criteria are a qualitative assessment of function while the DASH score is a quantitative one. The parameters of the Karlsson’s criteria are tabulated below.

Karlsson’s criteria:

<table>
<thead>
<tr>
<th>Category</th>
<th>Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>No</td>
</tr>
<tr>
<td>Myodynia</td>
<td>Normal</td>
</tr>
<tr>
<td>Movement</td>
<td>Flexible</td>
</tr>
<tr>
<td>Criteria</td>
<td>A</td>
</tr>
</tbody>
</table>

In our study criterion A was categorized as excellent outcome while B and C categorized as good and poor respectively. DASH (Disability of the Arm, Shoulder and Hand) score is a quantitative assessment score of the shoulder function. It was used in this study to quantitatively assess the improvement or deterioration of the shoulder function in the patients. It’s a questionnaire with 30 items on it. For disability/symptom score at least 27 out of 30 should be completed. 100 is the score for totally disabled limb while 0 is the perfect extremity score

II. Materials And Methods

All patients from age group 18 to 60 years irrespective of sex the study was carried out as a prospective study for one year which included patients having fracture lateral end clavicle and patients having acromioclavicular joint dislocation. All of these patients were treated operatively using the clavicle hook plate. Subsequently these patients were followed up regularly and clinical as well as radiological outcomes were evaluated.

Inclusion criteria of patients:
1) All cases with displaced fracture lateral end of clavicle and acromioclavicular disruption within four weeks of injury.
2) Patients giving consent to surgery.
3) Patients meeting the routine medical standards to undergo surgical procedure.
4) Preoperatively patient is having a limb with intact neurovascular status.
5) Patient willing to cooperate in regular follow-up.

Exclusion criteria:
1) Patient not giving consent to surgery.
2) Patients with associated medical contraindications to surgery.
3) Patients with compound fractures
4) Patients with systemic infections
5) Patients with poor skin conditions

All details of the participating patients were recorded. (Annexure-V). The lateral end of clavicle fractures was assessed by anteroposterior and cephalad-caudal obliquity views x-rays pre-operatively. Postoperatively similar x-rays were taken for the part. For acromioclavicular joint injuries anteroposterior views, an axillary lateral view and the Zanka view (15° cephalic tilt view) were taken preoperatively. Post operatively similar x-rays were taken for the part. In all the patients, blood routine examinations, ECG, chest x-rays, blood glucose levels, bleeding time clotting time were done. Blood grouping and cross matching of patients were done after admission. Patients were given arm sling pouch on their admission. The implant of choice in our study was the clavicle hook plate. It’s a pre-contoured stainless steel, dynamic compression plate with a wider antero lateral end and a lateral extension into a hook which is placed below the acromion. The newer variety of LCP (Locking compression plate) has elongated combination holes [threaded hole for locking head screws (LHS) and dynamic compression unit (DCU) for cortex screws]. Offers better anatomic fit. In our study the LCP variant has been primarily used.

The patients were put in an arm sling pouch after the surgical procedure. The wound was inspected on 3rd day and the patients were discharged on 5th-10th day if no complications were present. Patients discharged on 10th
day had their stitches removed before their discharge. The clinical outcome was evaluated using the Karlsson’s criteria\(^6\) and the DASH\(^7\) (Disability of the Arm, Shoulder and Hand) score. The fractures and the dislocations were assessed radiologically respectively with the predefined views of each type of injury. The physiotherapy regimes were carried out in similar manner for all the patients. The patients were assessed at 4 weeks(1 month), at 8 weeks(2 months) at 3 months and 6 months. Pendulum exercises were started on 3\(^{rd}\) day onwards. From 20\(^{th}\) day full range of motion of the shoulder both assisted and active under the supervision of a physiotherapist were started. The clavicle hook plate is an implant that has to be removed once it has served its purpose for it causes discomfort and some amount of joint mobility restriction because of its design and its unique placement.

### III. Observation And Results

#### For Fracture Of Lateral End Clavicle -

- **Definition of union-** Fracture united within 4 months
- **Non-union-** Fracture not united beyond 6 months
- **Patients followed for 3 months and beyond-** 18

out of total 21 only 18 were followed up beyond 3 months. So only in these patients could we comment on the union. Of these 18 union was achieved in 15 patients. So the union rate is 83.33%. Of these 2 had delayed union and one non-union. So non-union was 5.56% and delayed union was 11.11%.

So the average union time was 3.27 ± 0.59 months for those patients who achieved union.

#### For Subgroup Of Acromioclavicular Dislocation-

- **Definition of the fusion of AC joint post-surgery** is a clinical one as fibrous union was the outcome that was expected after curettage of the articular cartilages of the AC joint. Union was defined as absence of tenderness over the AC joint both anteriorly and superiorly on all range of motions within 3-4 months. Failure to achieve clinical union after 4 months was considered delayed union and failure to achieve union beyond 6 months as non-union. Patients followed up for 3 months and beyond of the total 16 – 13.

In the above table out of 16 only thirteen were followed up beyond 3 months. So only these patients could be chosen to comment on their union. Of these, 2 achieved delayed union while there was no case of non-union. So the rate of union was 84.61% and the rate of delayed union was 15.38%.

The average period of union was 3.88 ± 0.46 months.

#### Functional outcome:

Based on Disability of Arm Shoulder and Hand (DASH)\(^7\) score and the Karlsson’s criteria\(^6\) the patients were evaluated both quantitatively and qualitatively respectively. The score for perfect extremity for DASH is 0 while a disabled limb it is 100. For Karlsson’s criteria the limb function was graded excellent, good and poor depending on the criteria i.e. A, B, and C attained on limb function assessment.

#### For the group of fracture lateral end of clavicle:

- **Preoperative mean DASH score-** 82.76 ± 6.42
- **Mean DASH score at final evaluation (pre implant removal-all patients)-** 17.76 ± 10.12
- **Mean DASH score before implant removal(of the patients that underwent removal)-** 12.54 ± 8.71
- **Mean DASH score of patients who underwent implant removal( final evaluation)-** 8.54 ± 3.93

It is seen that there was significant reduction in the DASH scores from the time of injury till final evaluation. Of these 11 patients underwent implant removal. Of these 14 patients out of 21 had Karlsson’s A score while 7 had B. Thus 66.67% had excellent results at the end of evaluation while 33.33% had good results. None had poor results in our study in the subgroup of fracture lateral end clavicle.

For the group having their implants removed the mean DASH score before removal was 12.54 ± 8.71 and after removal it was 8.54 ± 3.93. This difference was found to be not quite significant (P value-0.0902).

For the subgroup of AC joint dislocation:

- **Preoperative mean DASH score-** 83.25 ± 6.88
- **Mean DASH score at final evaluation (pre implant removal-all patients)-** 13.81±7.90
- **Mean DASH score before implant removal(of the patients that underwent removal)-** 13.17 ± 9.11
- **Mean DASH score of patients who underwent implant removal( final evaluation)-** 11.17 ± 7.31

It is thus seen that there was significant reduction in the DASH scores at final follow up compared to the scores at presentation. The total number of patients with AC joint dislocation was 16. Out of these 6 underwent implant removal. Of the total 16, 10 i.e. 62.50% had Karlsson’s criteria A at final evaluation while 6(37.50%) fulfilled criteria B. Thus 62.50% had excellent and 37.50% had good results and none had poor results.

For the group having their implants removed the mean DASH score before removal was 13.17±9.11 and after removal it was 11.17±7.31. This difference was found to be not significant (P value 0.4496).
IV. Complications:

For the subgroup of fracture lateral end clavicle:

In our study it’s seen that the major complication for the group of fracture of the lateral end clavicle was subacromial osteolysis and impingement syndrome, both comprising of 28.57% of the sample each. They are followed by delayed union which comprised of 9.52% of the total sample of the patient. Subacromial osteolysis is seen on x-rays as lucency around the tip of the hook.

For the subgroup of ac joint dislocation:

In our study for the subgroup of AC joint dislocation the major complication we encountered was impingement syndrome (37.5%). It was followed by subacromial osteolysis(12.5%) and delayed union(12.5%). About one case i.e. 6.25% case had AC joint arthrosis.

V. Discussion

Fracture union in case of the group of fracture lateral end of the clavicle in our study was found to be 83.33 %. The rate of delayed union was 11.11% and non union was 5.56%. The average time of union was 3.27 ± 0.59 months. As only 18 patients of the total 21 patients were followed up till 3 months or more so union was commented on only these patients. 15 patients of these 18 achieved union. Neer had found in his study that fractures of the lateral end clavicle is a special entity and is prone to undergo non-union. Davut Tiren et al. had achieved a union rate of 87.5 % comparable to our study and a non-union rate of 12.5%. Tapio Flinkkilä et al. achieved union rate of 93.65%. While the rate of non-union was found to be 4.76 % and delayed union to be 1.6%. Hong-Lve-Tan et al. achieved union at 8.75 ± 2.55 weeks (range 6-13 weeks). Tzu Liang Hsu et al. achieved union at a mean of 14.2 weeks. One patient in which there was non union in our study, the cause was found to be a misplaced screw which was in the fracture site, thus preventing bridging callus formation. The patient however had no clinical disability and had full range of movements after implant removal and didn’t require any other surgical procedure to address the same. Daniel W. Good et al. in their study achieved union in 95% of the cases and in a period of 3 months. Chun-kuan Lu et al. achieved union in 100% of their cases.

For our group of AC joint dislocation as fibrous ankylosis at the AC joint was the goal to be achieved after reduction with a hook plate, we defined fibrous union to have occurred when there is absence of tenderness over the AC joint both anteriorly and superiorly at all range of motion. For our study it was achieved at a mean period of 3.88 ± 0.46 months. The union rate achieved in our study was 84.61%. The rate of delayed union was found to be 15.38%. De Baets et al. achieved this clinical union in 75% patients at an average 12 weeks. The rate of non union was 25%.

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VI. Conclusion
Displaced fractures of the lateral end of the clavicle are notorious for delayed and non-union while displaced AC joint dislocation contribute quite a bit in causing morbidity and decreased shoulder joint function. Previously these two entities were treated non-operatively leading to myriads of complications. Our study aimed at operative fixation of these two entities with the clavicle hook plate and study the role of operative management.

Our study showed that operative fixation of the aforesaid entities with clavicle hook plate gave very good patient oriented, surgeon oriented outcomes with very early rehabilitation leading to excellent clinical outcome in majority of the patients. There was better outcome than previously mentioned studies of conservative management of the same. There was excellent fracture healing following the use of these plates in the fractures of the lateral end of the clavicle. It also lead to very sound fibrous ankylosis with a very anatomically aligned sound functioning AC joint when used in AC joint dislocation.

In our study there were no intra-operative complications and all surgeries went smoothly. There were no hardware related problems in our study. We encountered complications like impingement and subacromial osteolysis due to the subacromial positioning of the hook. But these were not too disabling to the patients and were improved on physiotherapy. Non-union and delayed union were found too in a very small number of patients but these were related to wrong placement of screws, not because of the implant per se. However a second operation to remove the implant is a potential drawback of this implant which may be cause of decreased patient and surgeon compliance with the procedure. The principal drawback of our study was the limited number of patients and the limited duration of study which may have affected the results. We conclude that clavicle hook plate is a very good implant for treating fractures of the lateral end of clavicle and displaced AC joint dislocation. The overall prognosis in our study was very good with excellent improvement of symptoms following the procedure. The use of this implant warranties quicker rehabilitation and return to normal activities of daily living with better patient satisfaction and clinical outcome.

Case 1: 28 Yo Male Left Sided Fracture Of Lateral End Clavicle

Post operative X-ray
Preoperative X-ray

Movements at 3rd month post surgery

Case 2: 48 year old male with right sided ac joint dislocation.
Post operative X-ray
Preoperative X-ray

Movements at one month after surgery.

REFERENCE


Hong-Lye Tan, Jin-Kun Zhao, Chen Qian, Yan Shi, Qi Zhou. Clinical Results of Treatment Using a Clavicular Hook Plate Versus a T-plate in Neer Type II Distal Clavicle Fractures. Orthopaedics, August 2012, Vol 35, No. 8.


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